JProfiler Manual

Index

Welcome To JProfiler

Thank you for choosing JProfiler. To help you get acquainted with JProfiler's features, this manual is divided into two sections:

- Help topics [p. 10]

  Help topics present important concepts in JProfiler. They are not necessarily tied to a single view. Help topics are recommended reading for all JProfiler users.

  The help topics section does not cover all aspects of JProfiler. Please turn to the reference section for an exhaustive explanation of all features that can be found in JProfiler.
- Reference [p. 58]

  The reference section covers all views, all dialogs and all features of JProfiler. It is highly hierarchical and not optimized for systematic reading.

  The reference section is the basis for JProfiler's context sensitive help system. Each view and each dialog have one or more corresponding items in the reference section.

We appreciate your feedback. If you feel that there's a lack of documentation in a certain area or if you find inaccuracies in the documentation, please don't hesitate to contact us at support@ej-technologies.com.

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A Help Topics

A.1 Profiling

A.1.1 Profiling Modes

Introduction

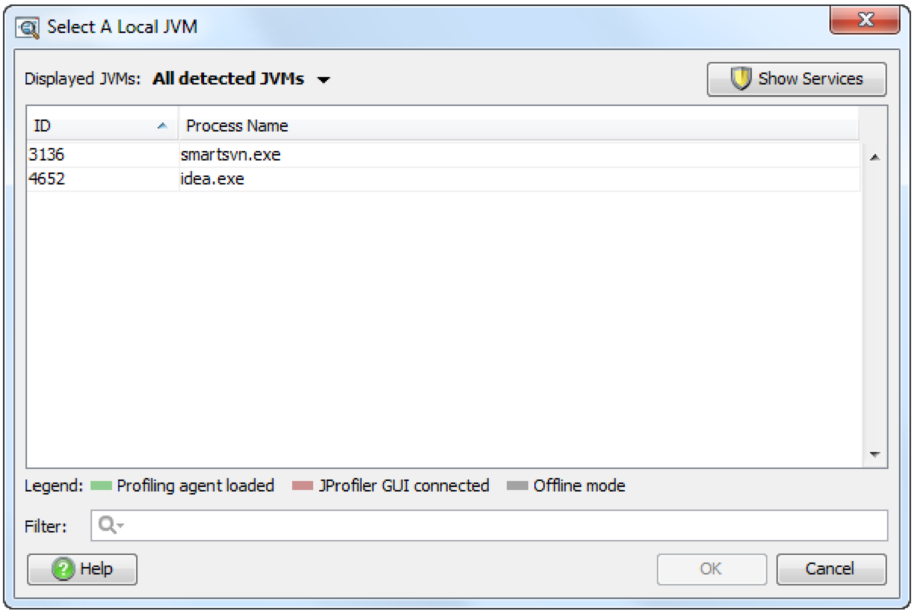
There are four different profiling modes in JProfiler. Three of them involve a connection with the JProfiler GUI so you can see and analyze data immediately.

The three GUI modes result from trade-offs between convenience and efficiency. It is most convenient to simply attach the JProfiler GUI to any running JVM ("Attach mode"), but it is most efficient to load the profiling agent and startup and tell it about the profiling settings immediately ("Profile at startup"). A compromise is to load the profiling agent at startup and tell it later on what the profiling settings should be ("Prepare for profiling").

The fourth mode is used when the use of a JProfiler GUI is not desired or technically possible ("Offline mode").

Attach mode

For profiling Java 1.6 or higher, JProfiler supports attaching to a running JVM [p. 104] and loading the profiling agent on the fly.



Displayed JVMs: **All detected JVMs**

ID	Process Name
3136	smartsvn.exe
4652	idea.exe

Attach mode has some drawbacks since some capabilities of the profiling interface are not available that way. JProfiler notifies you in the GUI where this is the case. Also, to instrument classes, JProfiler has to retransform them, which takes more time and resources compared to the "Profile at startup" mode.

To attach to a remote JVM that has not been prepared for profiling, JProfiler offers a command line tool *`jpenable`* that loads the profiling agent and makes it possible to connect with a remote session from another computer.

Profile at startup

To profile an application at startup, the profiling agent has to be activated before the JVM is created. This is achieved by adding the special JVM parameter

```
-agentpath:[path to jprofilerti library]
```

for Java >=1.5.0 (JVMTI). You rarely need to add this JVM parameter manually. For launched sessions [p. 74] and IDE integrations [p. 61] JProfiler does this automatically, for other cases, there are integration wizards [p. 61] . They also take care of potential other VM parameters that are required for profiling.

By default, the profiling agent listens on port 8849. You can change that port by appending `=port=8849` to the above VM parameter. Except for remote sessions [p. 105] , you do not have to choose a port explicitly.

The profiling agent pauses the JVM at startup and waits for a connection from the GUI to receive information about profiled classes and other profiling settings. After the connection, the normal execution in the JVM is continued. This is the most efficient way to profile an application, since no retransforming of already loaded class files has to be performed.

Prepare for profiling

Alternatively, it is possible to let the application start up immediately and connect with the JProfiler GUI at a later time. In that case, the instrumented classes have to be retransformed after the JProfiler GUI tells the profiling agent about the profiled classes.

This mode is activated by appending [p. 108] `,nowait` to the `-agentpath` VM parameter. In most cases, this is handled by the integration wizard. For maximum efficiency, it's also possible to append `,config=[config file]` and `,id=[id]` parameters to instruct the profiling agent to take the profiling settings from a particular session in a particular config file. If you connect with the same profiling settings, no classes will have to be retransformed.

In any case, this mode is more efficient than attach mode since a lot of instrumentations are independent of the profiling settings. Those instrumentations are performed as the classes are loaded and the number of retransformed classes is lower. Also, all capabilities of the profiling interface of the JVM are available in this mode.

Offline profiling

For automated profiling or for situations where it is not possible to attach a JProfiler GUI due to network restrictions, you can profile without a profiling GUI. In that case, you need to instruct the profiling agent when to record data, what data should be recorded and when snapshots should be saved. This is done with triggers [p. 28] which are activated for certain events and can execute a series of configurable actions.

This mode is activated by appending [p. 108] `,offline,config=[config file],id=[id]` to the `-agentpath` VM parameter. Usually this is handled by the integration wizard. Similar to the "Prepare for profiling" mode, the selected session in the specified config file will be used for the profiling settings. The trigger configuration from that session controls recording and saving.

The profiling results are only saved to snapshot files, it is not possible to attach a JProfiler GUI in offline mode. However, you can control data recording and snapshot saving manually with the jpcontroller [p. 262] command line controller. If the JVM was not configured for offline profiling at startup, you can use the jpenable command line utility to start offline profiling at any time.

A.1.2 Remote Profiling - Application Servers And Standalone Applications

Introduction

Although it is easiest to profile applications and application servers that are running on your local machine, sometimes it is not possible to replicate the execution environment on your computer. If you have no physical access to the remote machine or if the remote machine has no GUI where you could run JProfiler, you have to set up remote profiling.

Remote profiling means that the profiling agent is running on the remote machine and the JProfiler GUI is running on your local machine. Profiling agent and JProfiler GUI communicate with each other through a socket. This situation is fundamentally the same as running a session that is launched on the local machine, except that the communication socket connects between different machines. The main difference for you is that for sessions launched by JProfiler you don't have to worry about the location of native libraries and that the startup sequence can be managed by JProfiler.

The jpenable command line utility

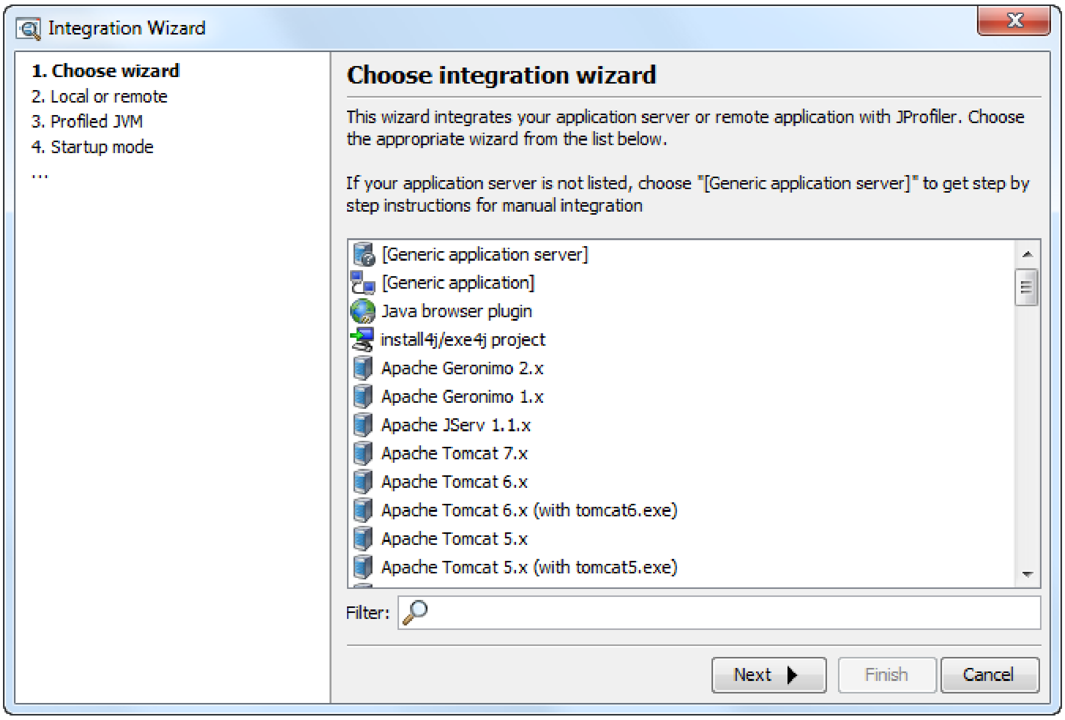
To avoid running an integration wizard or modifying the VM parameters of the profiled application, just extract the JProfiler archive from the download page on the remote machine. You do not have to enter a license key there. Run the `bin/jpenable` command line application on the remote machine. You will be able to select a JVM and load the profiling agent into it so that it listens on a specific profiling port. In your local JProfiler GUI, you can then connect with an "Attach to profiled JVM (local or remote)" session.

This only works with a Java VM of version 1.6 or higher and has the drawback that array allocations are not recorded, i.e. stack trace information for array allocations is not available. Also, if you're profiling regularly, it might be more convenient to prepare a permanent setup that does not require you to run the `jpenable` executable every time.

To avoid the use of the JProfiler GUI, jpenable also offers an offline mode where you specify a config file with the desired session settings. Session settings can be exported from the JProfiler GUI. Either the session settings contain triggers that record data and save snapshots or you use the `bin/jpcontroller` command line application to control data recording and to save snapshots.

The remote integration wizard

All integration wizards in JProfiler can help you with setting up remote profiling. After choosing the integration type or application server, the wizard asks you where the profiled application is located. If you choose the remote option, there will be additional questions regarding the remote machine.



Choose integration wizard

This wizard integrates your application server or remote application with JProfiler. Choose the appropriate wizard from the list below.

If your application server is not listed, choose "[Generic application server]" to get step by step instructions for manual integration

- [Generic application server]
- [Generic application]
- Java browser plugin
- install4j/exe4j project
- Apache Geronimo 2.x
- Apache Geronimo 1.x
- Apache JServ 1.1.x
- Apache Tomcat 7.x
- Apache Tomcat 6.x
- Apache Tomcat 6.x (with tomcat6.exe)
- Apache Tomcat 5.x
- Apache Tomcat 5.x (with tomcat5.exe)

When the remote integration wizard asks you for startup scripts or other files of the application server on the remote machine it brings up a standard file selector. If the file system of the remote machine is accessible as a network drive or mounted into your file system, you can select those files and JProfiler will directly write modified files to the right location.

If you do not have direct access to the file system of the remote machine, you have two options: You can use the console integration wizard by executing *`bin/jpintegrate`* on the remote machine. Alternatively, you can copy the required files to the local machine and use the "remote" option in the integration wizard. However, you must then transfer the modified or new files back to the remote machine after the integration wizard has completed.

Requirements for remote profiling

Although the integration wizards in JProfiler give you all required information, it's always a good idea to have a little more inside knowledge about the mechanics and the requirements of remote profiling. When trouble-shooting a failed integration, you should check that the requirements below are fulfilled correctly.

The following requirements have to be satisfied for remote profiling:

1. JProfiler has to be installed on the local machine **and** on the remote machine. If the remote machine is a Unix machine, you might not be able to run the GUI installer of JProfiler. In this case, please use the `.tar.gz` archive to install JProfiler.

   Unless you specified the "nowait" parameter on the command line together with a "config" argument, (only necessary for pre 1.6 JVMs), you do **not** have to enter a license key on the remote machine. The license key is always provided by the JProfiler GUI. Because of that, it is sufficient to unpack JProfiler to any directory where you have write permission.
2. The operating system and the architecture of the remote machine must be explicitly supported by JProfiler. Please see the list of supported platforms for more information. JProfiler is not a pure Java application, it contains a lot of native code which is not easily portable to unsupported platforms.
3. On the remote machine, you have to add a number of VM parameters to the java invocation of your application server or your standalone application. The fundamental VM parameters are

`-Xrunjprofiler` for Java <=1.4.2 (JVMPI) and `-agentpath:[path to jprofilerti library]` for Java >=1.5.0 (JVMTI), which tell the JVM to load the native profiling agent. The help page on remote sessions [p. 105] in the reference section tells you the corresponding path to the jprofilerti library for all platforms.

Depending on your JVM and your platform, you have to add further VM parameters to your java invocation. The remote session invocation table [p. 108] in the reference section gives you the exact parameter sequence for your configuration.

This is all that is required to profile a modern JVM (Java 1.5 and later).

4. For Java <=1.4.2 (JVMPI), more steps are necessary. You also have to add `-Xbootclasspath/a:{path to agent.jar}` which adds required Java classes to the bootclasspath. `agent.jar` is located in the *`bin`* directory of your JProfiler installation. In addition, the native library path on the remote machine must contain the platform-specific directory in the *`bin`* directory of the JProfiler installation. The "native library path" is defined by a different environment variable on each platform. For example, on Windows, it is simply the `PATH` environment variable, on Linux it is `LD_LIBRARY_PATH`. The help page on remote sessions [p. 105] in the reference section tells you the corresponding environment variables for all platforms.
5. On the local machine, you have to define a "Attach to profiled JVM" session whose "host" entry points to the remote machine.

Starting remote profiling

If you run the integration wizard for a local application server, JProfiler will be able to start it and connect to it. JProfiler has no way to start the application server if it is located on a remote machine. For remote applications and application servers, you have to perform **two** actions to start the profiling session:

1. Execute the modified start script on the remote machine. Depending on what option you have chosen in the remote profiling wizard, there are two startup sequences: either the application or application server starts up completely, or it prints a few lines of information and tells you that it is waiting for a connection. With Java 1.6.0 and later, the profiling options will be sent to the profiling agent when the GUI connects and you don't have to copy your config file to the server.

   With Java 1.5.0 and earlier, changing profiling settings at runtime is not possible. In the case where the application does not wait for a connection from the JProfiler GUI, the profiling agent loads the profiling configuration from the `config.xml` file you have copied to the server as instructed by the integration wizard.
2. Start the "Attach to profiled JVM" session in the JProfiler GUI on the local machine. The session will connect to the remote computer and the remote application or application server will then start up if it waited for the GUI connection.

Trouble-shooting

When things don't work out as expected, please have a look at the terminal output of the profiled application or application server on the remote machine. For application servers, the stderr stream might be written to a log file. Depending on the content of the stderr output, the search for the problem takes different directions:

- If stderr contains `"Waiting for connection ..."`, the configuration of the remote machine is ok. The problem might then be related to the following questions:
  - Did you forget to start the "Attach to profiled JVM" session in the JProfiler GUI on your local machine?
  - Is the host name or the IP address correctly configured in the "Attach to profiled JVM" session?

  - Is there a firewall between the local machine and the remote machine?

- If stderr contains an error message about not being able to bind a socket, the port is already in use. The problem might then be related to the following questions:

  - Did you start JProfiler multiple times on the remote machine? Each profiled application needs a separate communication port. Please see below on how to change that port.
  - Are there any zombie java processes of previous profiling runs that are blocking the port? In this case please kill these processes.
  - Is there a different application on the remote machine that is using the JProfiler port? Please see below on how to change the port for JProfiler.

  The communication port is defined as a parameter to the profiling agent VM parameter. To define a communication port of 25000, please change this VM parameter to `-Xrunjprofiler:port=25000` for Java <=1.4.2 (JVMPI) or `-agentpath:[path to jprofilerti library]=port=25000` for Java >=1.5.0 (JVMTI). Also, please make sure that the same port is configured in the "Attach to profiled JVM" session in the JProfiler GUI on your local machine. Please note that this port has nothing to do with HTTP or other standard port numbers and must not be the same as any port that's already in use on the remote machine.
- For Java 1.4.2 and earlier, if stderr contains an error message about not being able to load native libraries, the native library path is not configured correctly. Please see the requirements above on how to configure the native library directory. If the problem persists, it might be a problem with dependencies. On Unix platforms, you can execute

  ```
  LD_LIBRARY_PATH=.:$LD_LIBRARY_PATH ldd libjprofiler.so
  ```

  in the native library directory to get information about missing dependencies. On Microsoft Windows, you can download the dependency walker from http://www.dependencywalker.com to analyze the problem.

  Please note that it is **not** a good idea to define the VM parameter `java.library.path`. If you absolutely have to do that, please make sure that the definition contains the appropriate native library directory for JProfiler.
- For Java 1.4.2 and earlier, if stderr contains a `NoClassDefFoundError` for a class in the `com.jprofiler.agent` package, the bootclasspath has not been configured correctly. Please see the requirements above on how to configure the bootclasspath. Putting `agent.jar` in the regular classpath does **not** help and may actually be harmful.

  `NoClassDefFoundErrors` also occur if there is a classloader problem. The most common case is if the profiled application is an OSGi application. In some OSGi applications, you have to add the JProfiler agent package `com.jprofiler.agent` to the standard variable `org.osgi.framework.bootdelegation` in the OSGi configuration file. For eclipse Equinox, this is the *`config.ini`* file, for Apache Felix, this is the *`config.properties`* file.
- If there are no lines in stderr that are prefixed with `JProfiler>` and your application or application server starts up normally, the `-Xrunjprofiler` for Java <=1.4.2 (JVMPI) or `-agentpath:[path to jprofilerti library]` for Java >=1.5.0 (JVMTI) VM parameter have not been included in the java call. Please find out which java call in your startup script is actually executed and add the VM parameters there.

A.1.3 Behind The Scenes - How Profiling Actually Works

Introduction

Although it is not necessary to know about the internals of profiling to successfully profile your application, it can help you to interpret data that is produced by JProfiler, be more confident when setting up application servers and remote applications for profiling and analyzing problems with profiling in general. You might also just be curious to know what's going on under the hood.

Time, memory and thread profiling

There are three basic aspects to a profiler: A "time profiling" measures the execution paths of your application on the method level whereas "memory profiling" gives you insight into the development of the heap, such as which methods allocate most memory. Most applications are multi-threaded, and "thread profiling" analyzes thread synchronization issues.

Because it often makes sense to compare and correlate data from all three domains, JProfiler combines time, memory and thread profilers in a single application.

Most profilers are "post-mortem" profilers where the profiling wrapper or profiling agent writes out a snapshot file on an explicit instruction or when the profiled application exits. While JProfiler does have this capability, it is also an interactive profiler that shows you data while it is being measured.

Probes

Sometimes information on the basic operations in the JVM is not sufficient to tackle a problem and **higher-level analysis** is required. With "probes", specific subsystems of the JVM, such as file I/O or network I/O or domain-specific subsystems such as JDBC, JMS or JNDI are measured and presented in a concise and useful way.

Apart from the built-in probes [p. 48] , it is possible to create your own probes [p. 53] that measure other subsystems.

How profilers collect data

A profiler must have some means to collect the data it displays. Profiling data can come from an **interface in the execution environment** or it can be generated by **instrumenting the classes of the application**.

One of the most basic common profilers, the Unix shell command `time`, acts as a wrapper to the profiled executable and retrieves post-mortem information about the process from the kernel. Profilers for native applications on Microsoft Windows can attach to running applications and receive available debug information to calculate their profiling data. These are examples of interfaces in the execution environment where the the binary of your application is not modified by the profiler.

The `gprof` Unix profiler (part of Unix since 4.2bsd UNIX in 1983) can be hooked into the compilation process by specifying an additional argument to the compiler (`-pg`). In this way, profiling code is added to your application. When the application exits, a data file is written to disk that contains call trees and execution times to be viewed with the gprof application. gprof is an example of a profiler that instruments your application.

JProfiler takes a mixed approach. It uses the profiling interface of the JVM and instruments classes at load time for tasks where the profiling interface of the JVM doesn't provide any data or adequate performance.

The profiling interface of the JVM

The profiling interface of the JVM is intended for profiling agents that are written in C or C++. If you open the *`include`* directory in your JDK, you will see a number of files with the extension `.h`. Those are the header files that tell a C/C++ library about the interface that is offered by the JVM. The basis for all communication between a native library and the JVM is the Java Native Interface (JNI), defined in *`jni.h`*.

The JNI allows Java code to call methods in the native library and vice versa. From Java code, you can use the `System.load()` call to load a native library into the same memory space. When you call a method whose declaration contains the "native" modifier, such as `public native String getName();`, a function in the list of loaded native libraries is searched for. The required name pattern of the corresponding C-function contains the package, the class and the method of the declaration in Java code. JNI also defines how Java data types are represented in a C/C++ library. When the native C-function is called, it gets a "JNI environment" interface as an additional parameter. With this environment interface, it can call Java methods, convert between C and Java data types, and perform other JVM specific operation such as creating Java threads and synchronizing on a Java monitor.

Until Java 1.5, the JVM offered an ad-hoc profiling interface for tool vendors, the Java Virtual Machine Profiling Interface (JVMPI). The JVMPI was not standardized and its behavior varied considerably across different JVMs. In addition, the JVMPI was not able to run with modern garbage collectors and had problems when profiling very large heaps. With Java 1.5, the JVM Tool Interface (JVMTI) was added to the Java platform to overcome these problems. Since Java 1.6, the JVMPI has been removed. **JProfiler supports both JVMPI and JVMTI** although JVMPI should only be used when profiling Java 1.4. The JVMTI is defined in the header file *`jvmti.h`*. It utilizes the JNI for communication with the JVM, but provides an additional interface to configure profiling options. JVMTI is an event-based system. The profiling agent library can register handler functions for different events. It can then enable or disable selected events.

Disabling events is important for reducing the overhead of the profiler. For example, in JProfiler, object allocation recording is switched off by default. When you switch on allocation recording in the GUI, the profiling agent tells the JVMTI interface that several events for recording object allocations should be enabled. If a lot of objects are created, this can produce a considerable overhead, both in the JVM itself as well as in the profiling agent that has to perform bookkeeping operations for each event. During the startup phase of an application server, a lot of objects are created that you're most likely not interested in. Consequently, it's a good idea to leave object allocation recording switched off during that time. It increases the performance of the profiled application and reduces clutter in the generated data. The same goes for the measurement of method calls, called "CPU profiling" in JProfiler.

The JVMTI offers the following types of events:

- **Events for the life-cycle of the JVM**

  The profiling agent is active before the JVM has been fully initialized. It can monitor how core classes are loaded and what method calls are executed during the initialization phase. When the JVM is initialized just before the main method is called, the profiling agent is notified. Similarly, the impending shutdown of the JVM is reported.

- **Events for the life-cycle of classes**

  When a class is loaded and when it is unloaded, the profiling agent can be notified by the JVMTI. All other events, like the object allocation events or the method call events use the integer class ids and the method ids that are reported with this event. Before a class is loaded, the profiling agent gets a chance to inspect and modify the content of the class file. This is the basis for "dynamic instrumentation" where bytecode is injected into the class file before it is actually loaded by the JVM.

- **Events for the life-cycle of threads**

  To be able to show separate call trees for separate threads as well as to analyze monitor contention, the profiling agent must be aware of when threads are created and destroyed. When a thread is started, its identity is established. All other JVMTI events have a pointer that identifies the originating thread.

- **Events for for the life-cycle of objects**

  The profiling agent can be notified of when objects are allocated, freed and moved in memory by the garbage collector. At this point, the call stack of the allocation spot can be recorded by the profiling agent. If the object allocation event is switched off, the allocation spot will not be available for the object later on. Such objects show up as "unrecorded objects" in the heap walker.

- **Events for monitor contention**

  Whenever you call synchronized methods, use the `synchronize` keyword or call `Object.wait()`, the JVM uses Java monitors. Events that concern these monitors, such as trying to enter a monitor, entering a monitor, exiting a monitor or waiting on a monitor are reported to the profiling agent. From this data, the deadlock graph and the monitor contention views are generated in JProfiler.

- **Events for the garbage collector**

  Garbage collector activity is reported to the profiling agent. The garbage collector telemetry view in JProfiler is based on these events.

Some information, like references between objects as well as the data in objects, are not available from the events that the JVMTI fires. To get exhaustive information on all objects on the heap, the profiling agent can trigger a **"heap dump"**. This command is invoked when you take a snapshot in the heap walker. The heap dump is performed differently for JVMPI and JVMTI: The JVMPI packs all the objects on the heap and the references between them into a single byte array and passes it to the profiling agent. That byte array is then parsed by the profiler and converted to an internal representation. Naturally, the memory requirements of this operation are huge: first, the heap is essentially duplicated in the byte array, then the profiling agent must parse it and translate it to data structures. In order to reduce the peak of the memory requirement, JProfiler saves the byte array to a temporary file on disk, releases the array and parses the contents of the temporary file. When profiling an application that maxes out the available physical memory, taking a heap dump can crash the JVM, simply because not enough physical memory is available to allocate the huge required regions of memory. With JVMTI (>= 1.5) the situation is much improved, since JProfiler can incrementally enumerate all existing references in the heap and build up its own data structures.

How the profiling agent is activated

Unlike a JNI library that you load and invoke from Java code, the profiling agent has to be activated at the very beginning of the JVM startup. This is achieved by adding the special JVM parameters

```
-agentpath:[path to jprofilerti library]
```

for Java >=1.5.0 (JVMTI) or

```
-Xrunjprofiler
```

for Java <=1.4.2 (JVMPI) to the java command line. The `-agentpath:` or `-Xrun` parts tell the JVM that a JVMTI/JVMPI profiling agent should be loaded. The remaining characters of the `-Xrun` parameter constitute the name of the native library. The canonical name of a native library depends on the platform. For a base name of `jprofiler`, the library name is `jprofiler.dll` on Microsoft Windows, `libjprofiler.so` on Linux and most Unix variants, and `libjprofiler.dylib` on Mac OS X.

Parameters can be passed to the native profiling library by appending a colon for the JVMPI or an equal sign for the JVMTI to the profiling interface VM parameter and placing the parameter string behind it. If you pass `-Xrunjprofiler:port=10000` or `-agentpath:[path to jprofilerti library]=port=10000` on the Java command line, the parameter `port=10000` will be passed to the profiling agent.

If the JVM cannot load the specified native library, it quits with an error message. If it succeeds in loading the library, it calls a special function in the library to give the profiling agent a chance to initialize itself.

Since Java 1.6, another way to load a profiling agent is via the attach API. The jvmstat mechanism allows JProfiler to discover JVMs that are running on the local computer and the attach API makes it possible to inject the profiling agent into a selected JVM.

Profiling agent and profiling GUI

Unlike profilers that only write out a snapshot file to disk, an interactive profiler like JProfiler can display the profiling data at runtime. Although it would be possible to start the GUI directly from the profiling agent, it would be a bad idea to do so, since the profiled process would be disturbed by the secondary application and remote profiling would not be possible. Because of this, the JProfiler GUI is started separately and runs in a separate JVM. The communication between the profiling agent and the GUI is via a TCP/IP network socket.

The recorded profiling data resides in the internal data structures of the profiling agent. Only a small part of the recorded data is actually transferred to the GUI. For example, if you open the call tree or the back-traces in the hot spots views, only the next few levels are transferred from the agent to the GUI. If the entire call tree were transferred to the GUI, potentially big amounts of data would have to be transmitted through the socket. This would make the profiled process slower and remote profiling between different computers would not be feasible. In essence, you could say that the profiling agent keeps a database of the recorded profiling data while the GUI is a client that sends user-initiated queries to the database.

A.2 Configuration

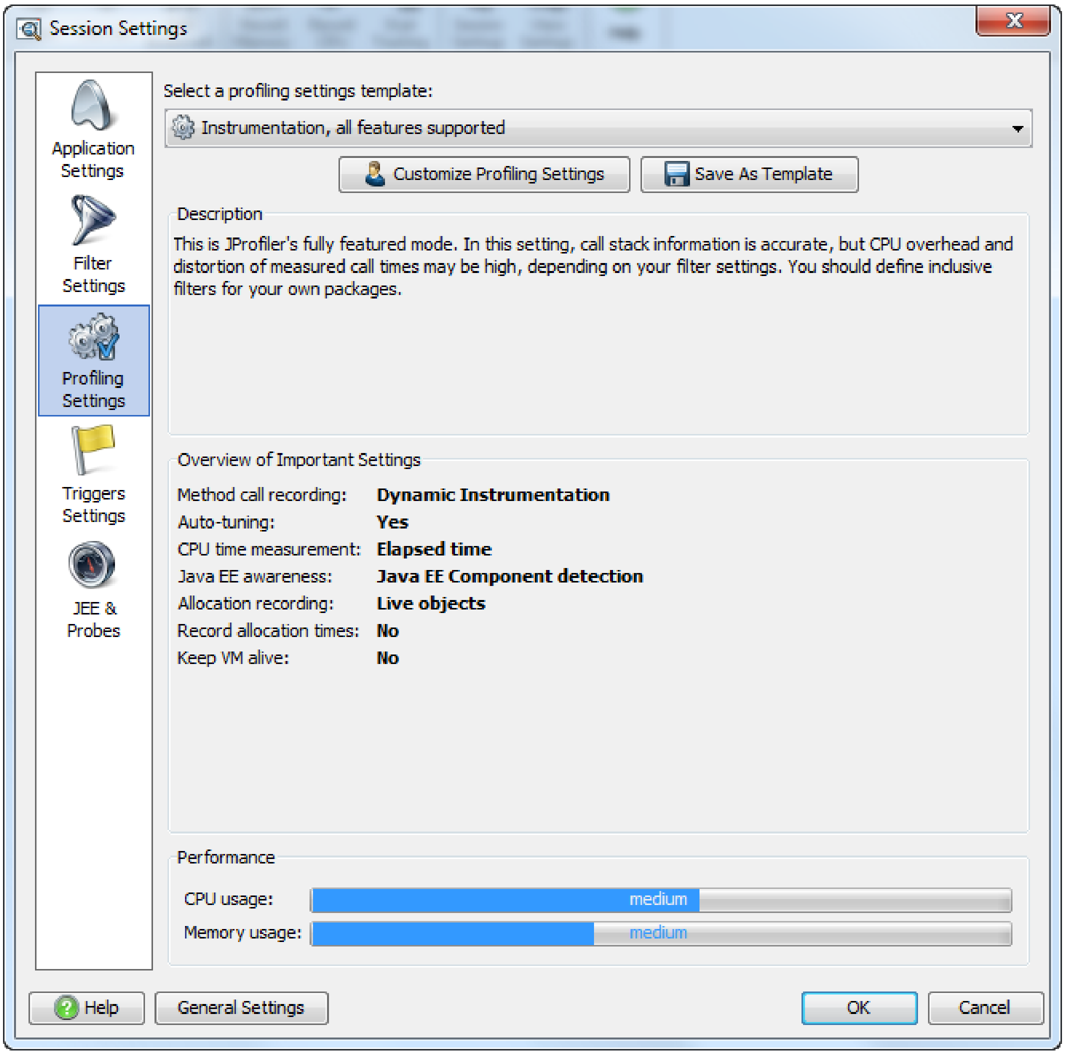
A.2.1 Configuring Session Settings

Introduction

Apart from the application settings which control how a JVM is launched or how a connection is made to a profiled JVM, session settings mostly deal with **the way profiling data is recorded**.

Session settings can be shown by editing a session in the start center or by invoking *Session->Session Settings* from the main menu for the currently running session. Every time a session is started, a startup dialog is displayed that allows you to change the session settings.

On older JVMs (1.5 and earlier), these settings must be adjusted according to your personal needs before the session is started. For modern JVMs (1.6 and later), JProfiler is able to change session settings at runtime. Any change in the session settings clears all recorded data. **View settings** can be changed during a running session without loss of recorded data. The primary distinction between session settings and view settings is that session settings determine **how much data is recorded**.



Select a profiling settings template: Instrumentation, all features supported

Description

This is JProfiler's fully featured mode. In this setting, call stack information is accurate, but CPU overhead and distortion of measured call times may be high, depending on your filter settings. You should define inclusive filters for your own packages.

Overview of Important Settings

Method call recording:	**Dynamic Instrumentation**
Auto-tuning:	**Yes**
CPU time measurement:	**Elapsed time**
Java EE awareness:	**Java EE Component detection**
Allocation recording:	**Live objects**
Record allocation times:	**No**
Keep VM alive:	**No**

Performance

CPU usage: medium

Memory usage: medium

Limiting the recorded profiling data

Why doesn't JProfiler just record everything it can and show it to the user? The answer is twofold:

- **There's a trade-off between information depth and runtime overhead**

Profiling adds overhead to the profiled application. It runs more slowly and consumes more memory. As an example, consider the call tree. JProfiler records separate call trees for each thread. If all method calls in all classes are recorded, the profiling agent has to do a lot of bookkeeping operations and its internal data structures use a lot of memory.

- **You want to reduce clutter in the recorded data**

  Maximum detail doesn't lead to maximum insight. On the contrary, excessive detail will often be in the way. If there's too much information available, you're likely to get lost in it. Let's continue the above example: most of the time, you're not interested in the internal call tree of framework classes. Say, if you call `HashMap#get()`, the sufficiently detailed information will be the duration of this call. When you're not familiar with an implementation or if you're not in control of it, the internal call structure is not helpful information, but rather just clutter, that you can ignore.

In principle, reducing the information depth can be done after recording. The view filters in the CPU views are such an example: the internal call structure of all classes that do not match the selected view filter is removed from the call tree. However, especially the increased memory consumption of profiling is critical: if you do not have enough physical memory available, the profiled JVM might become unstable or even crash. So in practice, you should record as little data as possible. With appropriate profiling settings you choose the required detail while retaining an acceptable runtime performance.

Profiling settings templates

Except for application, filter, trigger and probe settings, all other session settings are grouped into the "profiling settings" tab of the session settings dialog. Most of those settings are advanced settings and do not need to be adjusted under normal circumstances.

JProfiler offers **templates for profiling settings**. When you start a new session, JProfiler asks you whether you want to start with the "Sampling" or "Instrumentation" template. On the startup dialog, overhead meters for CPU and memory overhead help you in judging whether the current profiling settings are acceptable for you. Please note that the overhead meters do not represent any absolute values, because JProfiler has no way of knowing the runtime characteristics of your application. Rather, they are hints that allow you to compare different profiling settings.

Each profiling settings template defines certain values for the profiling settings that can be viewed and modified by clicking the **[Customize Profiling Settings]** button on the profiling settings tab of the session settings dialog. When you modify and save those settings, the template combo box displays that the profiling settings are "Customized".

Important session settings

The most important profiling settings are:

- **the method call recording type**

  This profiling setting determines performance overhead and informational detail in the CPU and memory views that show call trees. A detailed presentation of the various method call recording types is available in a separate article [p. 22] .

- **the filter settings**

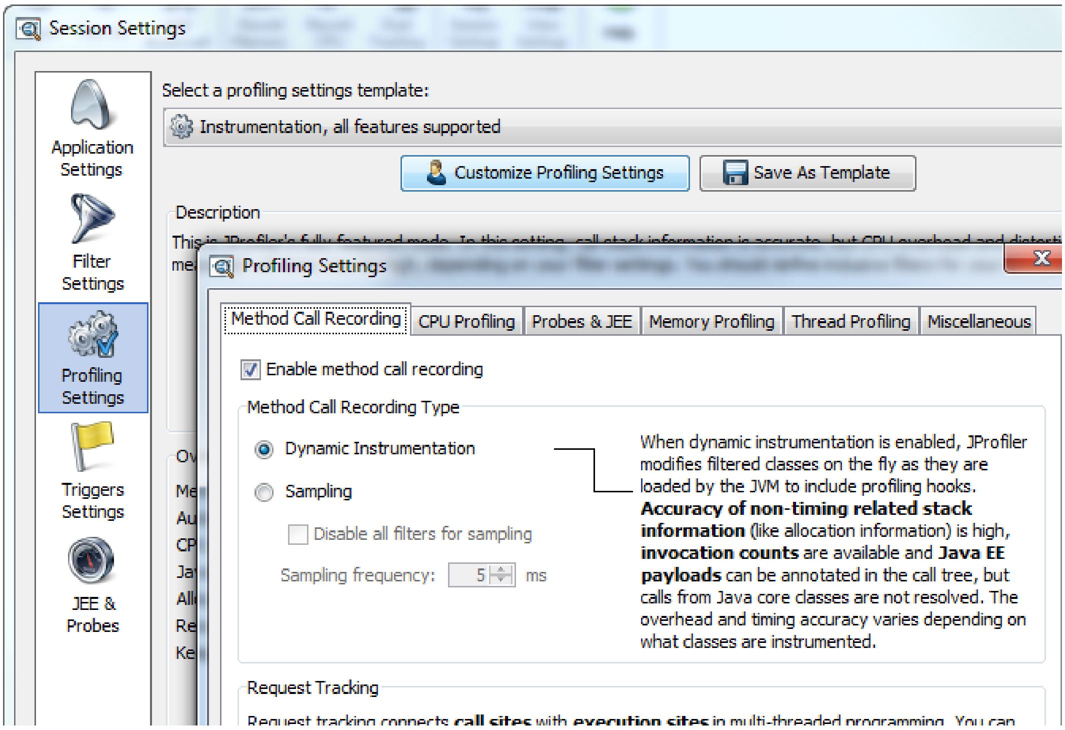
  The filter settings determine the detail that is shown in any call tree or call stack in JProfiler. In brief, they define the set of classes whose internal call structure is shown while method calls into all other classes are treated as opaque. Please see the article on filters for method call recording [p. 24] for a thorough discussion.

A.2.2 Method Call Recording - Influence On Performance And Accuracy

Introduction

At first glance, it might seem that the method call recording settings only influence the CPU section of JProfiler. However, the memory section as well as the thread and monitor sections show information that originates from the call tree that is built by the profiling agent of JProfiler: the call tree view, the allocation call tree, the stack traces in the monitor views and locking graphs as well as many other views all depend on the current call stack which is always recorded, even if "CPU recording" is switched off in JProfiler.

Selecting the right method call recording type is crucial for a successful profiling run. As explained in the article on session settings [p. 20] , the aim is to get the best runtime performance while retaining an acceptable level of informational detail. While the most important profiling setting in this regard is the filter configuration [p. 24] , the method call recording type complements this choice. Each method call recording type has various limitations that you should bear in mind when configuring filter settings.



Select a profiling settings template: Instrumentation, all features supported

☑ Enable method call recording

Method Call Recording Type

● Dynamic Instrumentation

○ Sampling

☐ Disable all filters for sampling

Sampling frequency: 5 ms

When dynamic instrumentation is enabled, JProfiler modifies filtered classes on the fly as they are loaded by the JVM to include profiling hooks. **Accuracy of non-timing related stack information** (like allocation information) is high, **invocation counts** are available and **Java EE payloads** can be annotated in the call tree, but calls from Java core classes are not resolved. The overhead and timing accuracy varies depending on what classes are instrumented.

Request Tracking

Dynamic instrumentation

For instrumentation, JProfiler **injects bytecode into the methods of profiled classes** that report the entry and exit of a method as well as the invocation of methods in unprofiled classes. Unprofiled classes are not touched and run without overhead.

If most classes are unprofiled, this mode causes low overhead while providing highly detailed measurements. Typically, the entire JRE and any framework classes are unprofiled so that dynamic instrumentation is most often the best choice. Since there are some classes in the `java.*` and `sun.*` packages that the profiling agent does not get a chance to modify, the internal calls of these packages cannot be resolved with dynamic instrumentation. However, for most applications this is not a problem.

Sampling

"Sampling" means to periodically take measurements that are called "samples". In the case of profiling, an additional thread periodically **halts the entire JVM and inspects the call stack of each thread**. The period is typically 5 ms, so that a large number of method calls can occur between two samples.

The advantage of sampling is that its performance overhead is not very sensitive to the filter settings. Even without any filters, sampling is still fast since it operates with big granularity in time. You might ask why it is not possible to decrease the sampling time into the microsecond range to achieve a better resolution. The answer is that the process of sampling is a very expensive operation. Halting the entire JVM and querying the call stacks of all threads takes a lot of time. If you do this too often, sampling will actually become slower than dynamic instrumentation.

Sampling has two other important informational deficiencies: Since sampling does not monitor the entry and the exit of method calls, there's **no invocation count** in the CPU views of JProfiler. Furthermore, the **allocation spots for objects are only approximate**. The actual call stack might always be deeper than the reported one. In addition, this informational deficiency is not systematic, but statistical: Objects allocated by the same method may be recorded to be spread out among methods that are called shortly before or after it.

To get around this deficiency for probes, JProfiler has an option to record the exact allocation spots for payloads. In this case, the profiling agent does not rely on the call tree as recorded by the sampler. Rather, after each probe event that should be associated with a call stack, it queries the JVMTI for the call stack of the current thread. However, this is an expensive operation and if there are a lot of probe events, the overhead will be increased considerably.

To conclude, sampling is best suited for performance bottleneck searches with all filters turned off and for profiling with broad or no filters.

A.2.3 Filters For Method Call Recording - How They Work And How They Are Configured

Introduction

Filter settings determine the detail level that JProfiler uses when recording call sequences in the profiled application. Filtering helps to eliminate clutter and decrease the profiling overhead for the profiled application. Also see the article on profiling settings [p. 20] for a discussion of profiling settings in general.

Since the internal data storage of CPU data in JProfiler is similar to the invocation tree, method call recording filters are most easily explained while looking at the call tree view [p. 192] . As an example, we profile the "Animated Bezier Curve" demo session that comes with JProfiler. When talking about filters, it is important to define the distinction between your code and framework or library code. Your classes should be profiled, framework or library code should not be profiled. In our example, the `BezierAnim` class is code written by you and the JRE is library code.

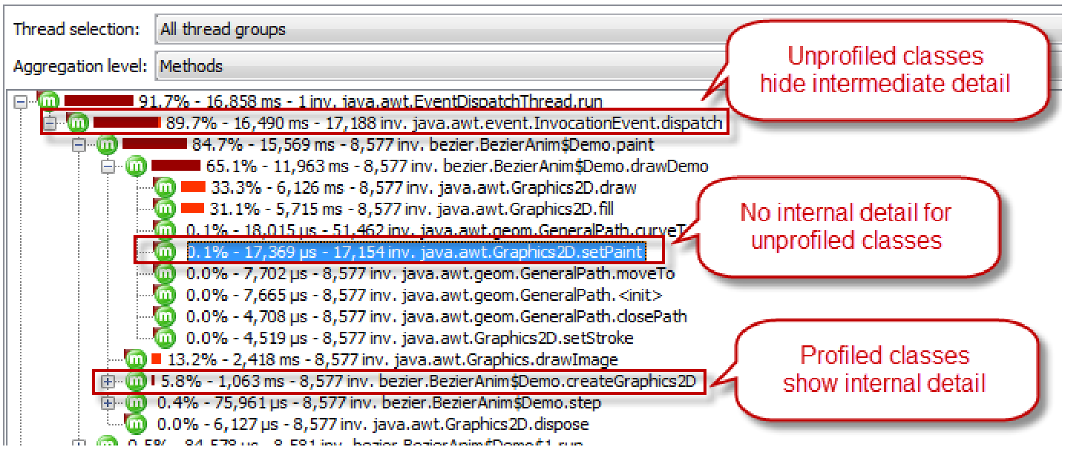
What are method call recording filters?

The call tree shows call sequences. Each node and each leaf of the call tree corresponds to a certain call stack that has existed one or multiple times while CPU recording was switched on. You will notice that there are different icons for nodes in the tree. Among other things, these icons serve to highlight if classes are filtered or not.

The methods of an unprofiled class (alternatively the class or containing package itself, depending on the aggregation level) are endpoints in the call tree, i.e. their internal call structure will not be displayed. Also, any methods in other unprofiled classes that are called subsequently, are not resolved. If, at any later point in the call sequence, the method of a profiled class is called, it will be displayed normally. In that case, the call tree shows the icon of the unprofiled parent method with a red top-left corner that indicates that it is from an unprofiled class and that there may be other intermediate method calls in between. The inherent time of those missing methods is added to the time of the unprofiled parent method.

Example with and without filters

The image below illustrates the different node types for a profiling run of the BezierAnim class:



Thread selection: All thread groups

Aggregation level: Methods

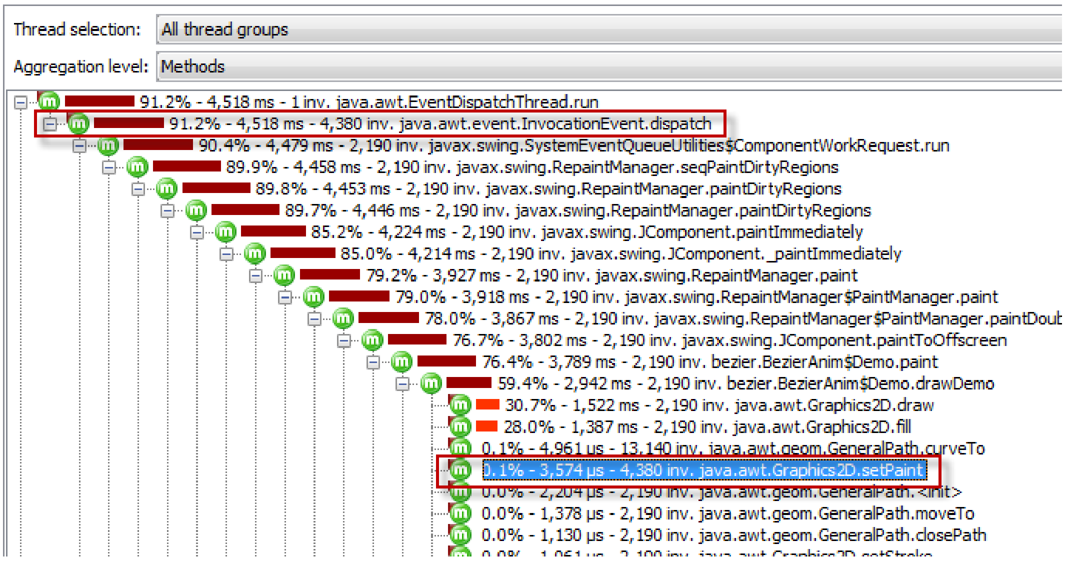
```
91.7% - 16,858 ms - 1 inv. java.awt.EventDispatchThread.run
  89.7% - 16,490 ms - 17,188 inv. java.awt.event.InvocationEvent.dispatch
    84.7% - 15,569 ms - 8,577 inv. bezier.BezierAnim$Demo.paint
      65.1% - 11,963 ms - 8,577 inv. bezier.BezierAnim$Demo.drawDemo
        33.3% - 6,126 ms - 8,577 inv. java.awt.Graphics2D.draw
        31.1% - 5,715 ms - 8,577 inv. java.awt.Graphics2D.fill
        0.1% - 18,015 µs - 51,462 inv. java.awt.geom.GeneralPath.curveT
        0.1% - 17,369 µs - 17,154 inv. java.awt.Graphics2D.setPaint
        0.0% - 7,702 µs - 8,577 inv. java.awt.geom.GeneralPath.moveTo
        0.0% - 7,665 µs - 8,577 inv. java.awt.geom.GeneralPath.<init>
        0.0% - 4,708 µs - 8,577 inv. java.awt.geom.GeneralPath.closePath
        0.0% - 4,519 µs - 8,577 inv. java.awt.Graphics2D.setStroke
      13.2% - 2,418 ms - 8,577 inv. java.awt.Graphics.drawImage
      5.8% - 1,063 ms - 8,577 inv. bezier.BezierAnim$Demo.createGraphics2D
      0.4% - 75,961 µs - 8,577 inv. bezier.BezierAnim$Demo.step
      0.0% - 6,127 µs - 8,577 inv. java.awt.Graphics2D.dispose
```

Unprofiled classes hide intermediate detail

No internal detail for unprofiled classes

Profiled classes show internal detail

In the above call tree, the `java.*` and `javax.*` packages are filtered, so only the first method in the AWT event dispatch thread is shown. In addition, the `InvocationEvent#dispatch()` method is shown because it is a special method that is used for analyzing long-running AWT events. However, the AWT is a complex system and the `InvocationEvent#dispatch()` method does not call `BezierAnim$Demo#paint()` directly. If we add `javax.swing` in the filter settings, the call tree looks like this:



Thread selection: All thread groups

Aggregation level: Methods

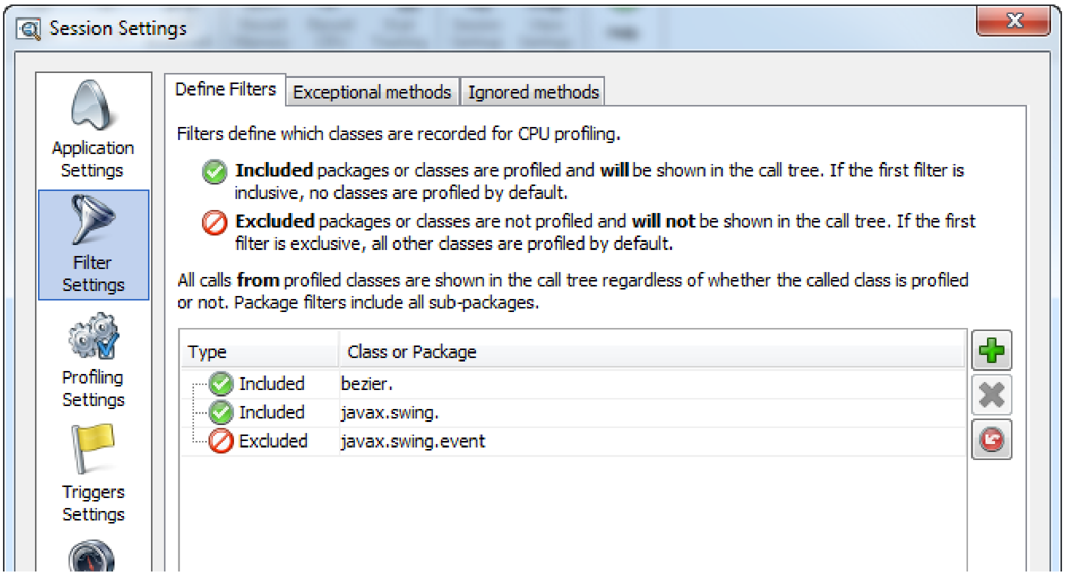
```
91.2% - 4,518 ms - 1 inv. java.awt.EventDispatchThread.run
  91.2% - 4,518 ms - 4,380 inv. java.awt.event.InvocationEvent.dispatch
    90.4% - 4,479 ms - 2,190 inv. javax.swing.SystemEventQueueUtilities$ComponentWorkRequest.run
      89.9% - 4,458 ms - 2,190 inv. javax.swing.RepaintManager.seqPaintDirtyRegions
        89.8% - 4,453 ms - 2,190 inv. javax.swing.RepaintManager.paintDirtyRegions
          89.7% - 4,446 ms - 2,190 inv. javax.swing.RepaintManager.paintDirtyRegions
            85.2% - 4,224 ms - 2,190 inv. javax.swing.JComponent.paintImmediately
              85.0% - 4,214 ms - 2,190 inv. javax.swing.JComponent._paintImmediately
                79.2% - 3,927 ms - 2,190 inv. javax.swing.RepaintManager.paint
                  79.0% - 3,918 ms - 2,190 inv. javax.swing.RepaintManager$PaintManager.paint
                    78.0% - 3,867 ms - 2,190 inv. javax.swing.RepaintManager$PaintManager.paintDoub
                      76.7% - 3,802 ms - 2,190 inv. javax.swing.JComponent.paintToOffscreen
                        76.4% - 3,789 ms - 2,190 inv. bezier.BezierAnim$Demo.paint
                          59.4% - 2,942 ms - 2,190 inv. bezier.BezierAnim$Demo.drawDemo
                            30.7% - 1,522 ms - 2,190 inv. java.awt.Graphics2D.draw
                            28.0% - 1,387 ms - 2,190 inv. java.awt.Graphics2D.fill
                            0.1% - 4,961 µs - 13,140 inv. java.awt.geom.GeneralPath.curveTo
                            0.1% - 3,574 µs - 4,380 inv. java.awt.Graphics2D.setPaint
                            0.0% - 2,204 µs - 2,190 inv. java.awt.geom.GeneralPath.<init>
                            0.0% - 1,378 µs - 2,190 inv. java.awt.geom.GeneralPath.moveTo
                            0.0% - 1,130 µs - 2,190 inv. java.awt.geom.GeneralPath.closePath
                            0.0% - 1,061 µs - 2,190 inv. java.awt.Graphics2D.setStroke
```

Now, the entry method into your code - `BezierAnim$Demo#paint()` - is substantially more difficult to find. In cases where events are propagated through a complex container hierarchy, the call tree can become many hundreds of levels deep and it becomes next to impossible to interpret the data. In addition, calls like `java.awt.Graphics2D#setPaint()` show their internal structure and implementation classes. As a Java programmer who is not working on the JRE itself, you probably do not know or care that the implementation class is actually `sun.java2d.SunGraphics2D`. Also, the internal call structure is most likely not relevant for you, since you have no control over the implementation. It just distracts from the main goal: how to improve the performance of your code.

Not only is it easier to interpret a call tree that has been recorded with proper filter settings, but also the profiling overhead of the profiled application is much lower. Recording the entire call tree without filters uses a lot of memory and measuring each call takes a lot of time. Both these considerations especially apply to application servers, where the surrounding framework is often extremely complex and the proportion of executed framework code to your own code might be very big.

Configuring filter settings

Filter settings are part of the session settings. Please see the article on session settings [p. 20] for more information. The help on sessions [p. 74] explains under what circumstances changes in the session settings can be applied to an active session.



Filters define which classes are recorded for CPU profiling.

✓ **Included** packages or classes are profiled and **will** be shown in the call tree. If the first filter is inclusive, no classes are profiled by default.

⊘ **Excluded** packages or classes are not profiled and **will not** be shown in the call tree. If the first filter is exclusive, all other classes are profiled by default.

All calls **from** profiled classes are shown in the call tree regardless of whether the called class is profiled or not. Package filters include all sub-packages.

Type	Class or Package
✓ Included	bezier.
✓ Included	javax.swing.
⊘ Excluded	javax.swing.event

There are two ways in JProfiler to specify the profiled classes:

- **by defining exclusive filters**

  An "exclusive filters" means that you specify a package or class (manual entry for single classes) that should not be profiled. New sessions have a default list of exclusive filters that work for many applications.

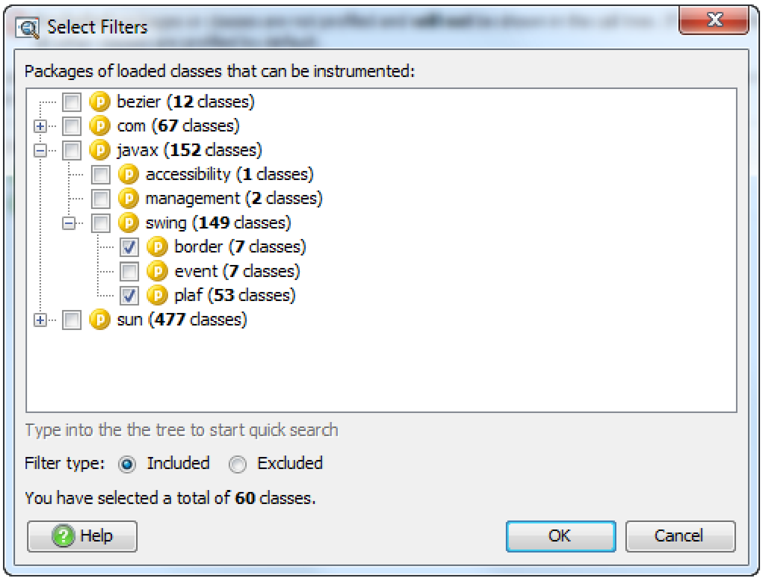
  If the first filter is an exclusive filter, all packages except for the following excluded packages will be profiled. Further inclusive filters can be used to add back some sub-packages.

- **by defining inclusive filters**

  An "inclusive filters" means that you specify a package or class that should be profiled.

  If the first filter is an inclusive filter, only the following included packages will be profiled. Further exclusive filters can be used to remove some sub-packages.

For sessions where JProfiler attaches to a running JVM, you can select filters from a package browser that tells you how many classes will be profiled based on your selection.



Packages of loaded classes that can be instrumented:

- ☐ bezier (**12** classes)
- ☐ com (**67** classes)
- ☐ javax (**152** classes)
  - ☐ accessibility (**1** classes)
  - ☐ management (**2** classes)
  - ☐ swing (**149** classes)
    - ☑ border (**7** classes)
    - ☐ event (**7** classes)
    - ☑ plaf (**53** classes)
- ☐ sun (**477** classes)

Type into the the tree to start quick search

Filter type: ● Included ○ Excluded

You have selected a total of **60** classes.

View filters

In addition to the method call recording filters, there is a view filters control at the bottom of all views that display call trees. View filters are similar to inclusive filters and can be changed during a session. However, they can only **reduce** the recorded information by taking out classes that do not correspond to the selected view filter.

In the call tree, they have a similar behavior like the method call recording filters. In the hot spots views, they simply hide all hot spots that do not correspond to the filter selection. This is very different from method call recording filters, where the hot spots themselves change with different filter settings.

A.2.4 Offline Profiling And Triggers

Introduction

There are two fundamentally different ways to profile an application with JProfiler: By default, you profile with the JProfiler GUI attached. The JProfiler GUI provides you with buttons to start and stop recording and shows you all profiling data. However, there are situations where you would like to profile without the JProfiler GUI and analyze the results later on. For this scenario, JProfiler offers offline profiling. Offline profiling allows you to start the profiled application with the profiling agent but without the need to connect with a JProfiler GUI.

However, offline profiling still requires some actions to be performed. At least one snapshot has to be saved, otherwise no profiling data will be available for analysis later on. Also, to see CPU or allocation data, you have to start recording at some point. Similarly, if you wish to be able to use the heap walker in the saved snapshot, you have to trigger a heap dump at some point.

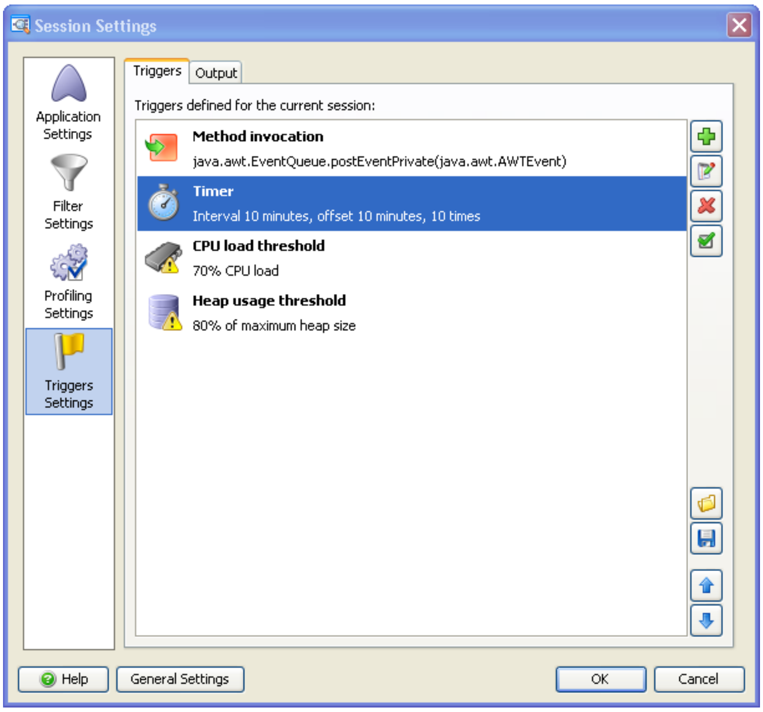
Profiling API

The first solution to this problem is the offline profiling API [p. 259] . With the offline profiling API, you can programmatically invoke all profiling actions in your code.

The drawback of this approach is that you have to add the JProfiler agent library to the class path of your application during development, add temporary profiling code to your source code and recompile your code each time you make a change to the programmatic profiling actions.

Triggers

With triggers [p. 91] , you can specify all profiling actions in the JProfiler GUI without modifying your source code. Triggers are saved in the JProfiler config file. The config file and the session id are passed to the profiling agent on the command line when you start with offline profiling enabled, so the profiling agent can read those trigger definitions.



Triggers defined for the current session:

Method invocation
java.awt.EventQueue.postEventPrivate(java.awt.AWTEvent)

Timer
Interval 10 minutes, offset 10 minutes, 10 times

CPU load threshold
70% CPU load

Heap usage threshold
80% of maximum heap size

In contrast to the profiling API use case where you add calls to your source code, triggers are activated when a certain event occurs in the JVM. For example, if you would have added a call to a certain profiling action at the beginning or at the end of a method when using the profiling API, you can use a method invocation trigger instead. Instead of creating your own timer thread to periodically save a snapshot, you can use a timer trigger.

Each trigger has a list of actions that are performed when the associated event occurs. Some of these actions correspond to profiling actions in the offline profiling API. In addition there are other actions that go beyond the controller functions such as the action to print method calls with parameters and return values or the action to invoke an interceptor for a method.

A.3 Memory Profiling

A.3.1 Recording Objects

Introduction

By default, JProfiler does not track the creation of all objects. This reduces the runtime overhead of the profiling agent regarding execution speed as well as memory consumption.

However, selective allocation recording is not only a way to increase runtime performance, it also helps you to focus on important parts of your application and to reduce clutter in the dynamic memory views ("dynamic" is intended in contrast to the heap walker, which shows a static snapshot of the heap). Imagine you have a web application that's started in the framework of an application server. The server allocates a huge number of objects in a great number of classes. If you want to focus on the objects created by your web application, the objects from the server startup will be in the way. In JProfiler, you can start allocation recording before you perform a certain action and so reduce the displayed objects to those that are allocated as a direct consequence of that action.

Starting and stopping allocation recording

The profiling menu as well as the toolbar allow you to start and stop allocation recording. If no allocations have ever been recorded, the dynamic memory views show placeholders with the corresponding "record" button. If you wish to enable allocation recording for the entire application run, you can do so in the profiling settings dialog

When you stop allocation recording, the garbage collection of the recorded objects will still be tracked by the dynamic memory views. In this way you can observe if the objects created during a certain period of time are actually garbage collected at some point. Please note that the manual garbage collection button in JProfiler just invokes the `System.gc()` method. This leads to a full GC in 1.3 JREs where the garbage collector makes the best effort to remove all unreferenced objects. However, 1.4 and 1.5 JREs perform incremental garbage collection, so full garbage collection is not available when working with such a recent JRE. To check if the remaining objects are really referenced, or if the garbage collector just doesn't feel like collecting them yet, you can take a heap snapshot. The heap walker offers the option "Remove unreferenced and weakly referenced objects" which is the equivalent of a full GC.

JProfiler also keeps statistics on garbage collected objects. All dynamic memory views have a mode selector where you can choose whether to display only live objects on the heap, only garbage collected objects, or both of them.

When you have stopped allocation recording and you restart it, the previous contents of the dynamic memory views will be deleted. In this way, allocation recording gives you the ability to do differencing of the heap between two points in time.

If you have very specific requirements as to where allocation recording should start and stop, you can use the offline profiling API [p. 264] to control allocation recording programmatically.

Implications of unrecorded objects

For "unrecorded" objects there are the following implications:

- JProfiler does not know the allocation spot for an unrecorded object. This becomes apparent in the heap walker. The heap walker takes a heap snapshot and is able to show all objects on the heap, however, the allocation information is not available from the JVMPI/JVMTI and the "Allocations" view will contain top-level method nodes that are labeled as "unrecorded objects".
- JProfiler does not know the class name for an unrecorded object. This influences the monitor views and locking graphs where JProfiler is only able to display the name of a monitor object if the object has been recorded.

The "Memory" graph in the VM telemetry views is not affected by allocation recording.

Allocation recording and the heap walker

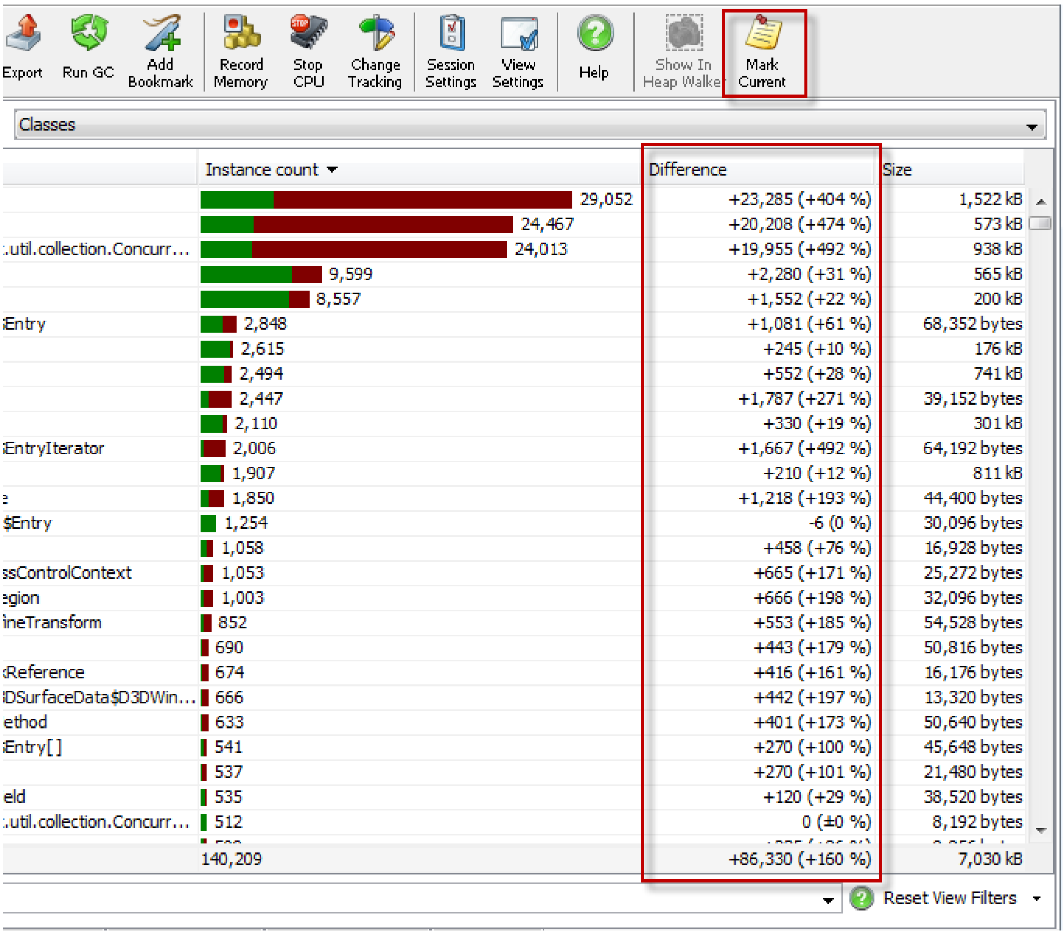
In the heap walker options dialog that is displayed before a heap snapshot is taken, the first option is labeled "Select recorded objects". This allows you to work with a set of objects that has been created during a certain period of time. This is just an initial selection step and does not mean that the heap walker will discard all unrecorded objects. In the references view you can still reach all referenced and referencing objects and create a new object set with unrecorded objects.

If you use the "show selection in heap walker" action in the dynamic memory views, the number of selected objects will only match approximately. If "Select recorded objects" is checked and "Remove unreferenced and weakly referenced objects" is not checked in the heap walker options dialog, the numbers might still not match exactly since the dynamic memory views can change in time while a heap snapshot is fixed.

A.3.2 Using The Difference Column In The Memory Views

Introduction

In contrast to allocation recording [p. 30] , where you can restrict the displayed objects to a certain period of time, a common situation is that you want to retain all recorded objects but still see the difference of object allocations with respect to a certain point in time. In particular, you might be interested in which classes have a decreasing allocation count, something that would not be possible with allocation recording.



	Instance count	Difference	Size
	29,052	+23,285 (+404 %)	1,522 kB
	24,467	+20,208 (+474 %)	573 kB
.util.collection.Concurr…	24,013	+19,955 (+492 %)	938 kB
	9,599	+2,280 (+31 %)	565 kB
	8,557	+1,552 (+22 %)	200 kB
Entry	2,848	+1,081 (+61 %)	68,352 bytes
	2,615	+245 (+10 %)	176 kB
	2,494	+552 (+28 %)	741 kB
	2,447	+1,787 (+271 %)	39,152 bytes
	2,110	+330 (+19 %)	301 kB
EntryIterator	2,006	+1,667 (+492 %)	64,192 bytes
	1,907	+210 (+12 %)	811 kB
	1,850	+1,218 (+193 %)	44,400 bytes
$Entry	1,254	-6 (0 %)	30,096 bytes
	1,058	+458 (+76 %)	16,928 bytes
sControlContext	1,053	+665 (+171 %)	25,272 bytes
gion	1,003	+666 (+198 %)	32,096 bytes
ineTransform	852	+553 (+185 %)	54,528 bytes
	690	+443 (+179 %)	50,816 bytes
Reference	674	+416 (+161 %)	16,176 bytes
DSurfaceData$D3DWin…	666	+442 (+197 %)	13,320 bytes
ethod	633	+401 (+173 %)	50,640 bytes
Entry[]	541	+270 (+100 %)	45,648 bytes
	537	+270 (+101 %)	21,480 bytes
eld	535	+120 (+29 %)	38,520 bytes
.util.collection.Concurr…	512	0 (±0 %)	8,192 bytes
	140,209	+86,330 (+160 %)	7,030 kB

Memory views with differencing

By default the difference column is not displayed. Only when you choose *View->Mark Current Values* or the corresponding toolbar button, the difference column is shown as the next-to-last column. The following views in JProfiler have an optional difference column:

- **all objects view and recorded objects view**

  In the all objects view and the recorded objects view, the difference column displays the number of currently allocated objects of a class minus the number at the point when the values were marked.

- **allocation hotspot view**

  In the allocation hot spots view, the difference column is similar to the recorded objects view, just that the number of allocations in a method are measured. If you select a class in the "Allocation options" dialog that is shown after clicking the "Calculate" button, the number of allocations is for a single package or class only.

In most cases you'll be interested in sorting the view by the values in the difference column. There are two sort modes that can be adjusted in the view settings dialog. By default, sorting is done for object counts ("sort by values"), but you can switch to "sort by percentages", if you want to focus on relative changes.

In addition, you can choose to sort by absolute values. With absolute ordering, the absolute value of the difference will be used for sorting. This is appropriate if you're interested in the biggest changes. With normal ordering, you'll have positive differences at the top, then a usually long list of zero differences and finally the negative differences. This is the right setting if you're looking for a memory leak and are only interested in positive differences.

Differencing and the heap walker

The difference column only shows a calculation, there's no fixed set of objects behind this number. Because of that, it is not possible to select the "difference objects" and work with them in the heap walker. To select objects based on their time of creation, please see the article on allocation recording [p. 30] .

The class tracker

The class tracker view provides a way to capture the history of instance counts over time for selected classes or packages in the form of a graph. However, you have to select the tracked classes or packages in advance, so the class tracker is best used on classes or packages that appear suspicious from the differencing in the all objects or recorded objects view.

A.3.3 Finding A Memory Leak

Introduction

Unlike C/C++, Java has a garbage collector that eventually frees all unreferenced instances. This means that there are no classic memory leaks in Java where you forget to delete an object or a memory region. However, in Java you can forget something else: to remove all references to an instance so that the object can be garbage collected. If an object is only ever held in a single location, this may seem simple, but in many complex systems objects are passed around through many layers, each of which can add a permanent reference to the object.

Sometimes it appears to be clear that an object should be garbage collected when looking at the local environment of where the object is created and discarded. However, any call to a different part of a system that passes the object as a parameter can cause the object to "escape" if the receiver intentionally or by mistake continues to hold a reference to the object after the call has completed. Often, over-eager caching with the intention to improve performance or design mistakes where parallel access structures are built are the reason for memory leaks.

Recognizing a memory leak

The first step when suspecting a memory leak is to look at the "Memory" and "Recorded objects" telemetry views. When you have a memory leak in your application, these graphs must show a linear positive trend with possible oscillations on top.

If there's no such linear trend, your application probably simply consumes a lot of memory. This is not a memory leak and the strategy for that case is straightforward: Find out which classes or arrays use a lot of memory and try to reduce their size or number or instances.

Using differencing to narrow down a memory leak

The first stop when looking for the origin of a memory leak is the differencing action [p. 32] of the all objects view and the recorded objects view. Simple memory leaks can sometimes be tracked down with the differencing function alone.

First, you observe the differences in the all objects view or the recorded objects view and find out which class is causing the problems. Then you switch to the allocation hot spots view, select the problematic class and observe in the difference column in which method the problematic instances are allocated. Now you know the method in which these instances were created.

An analysis of the code for this method and the methods to which these instances are passed may already yield the solution to the memory leak. If not, you have to continue with the heap walker.

Another tool to observe instance counts that also presents a history of values is the class tracker. The class tracker shows graphs of instance counts versus time for selected classes and packages. When the difference columns in the "all objects" or "recorded objects" views identify suspicious classes, the class tracker can often generate further insight into the evolution of these instance counts since you can correlate jumps or increases in the allocation rate with other telemetry views or bookmarks.

The heap walker and memory leaks

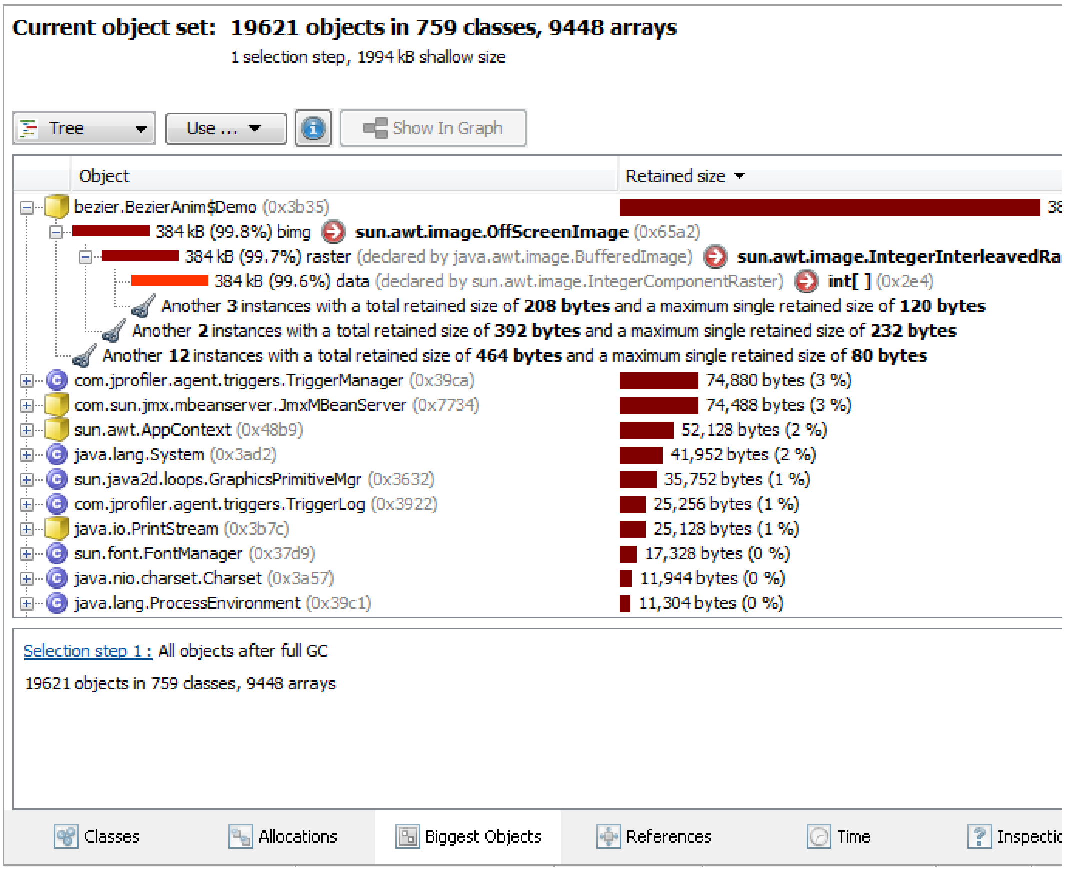
When you take a heap snapshot, you first have to create an object set with those object instances or arrays that should be freed by the garbage collector but are still referenced somewhere. If you've already narrowed down the origin of the memory leak in the dynamic memory views, you can use the "show selection in heap walker" action to save you some work and to start in the heap walker right at the point where you left off in the dynamic memory views.

By default, the heap walker cleans a heap snapshot from objects that are unreferenced but are still not collected by the garbage collector. This behavior can be controlled by the "Remove weakly referenced objects" option in the heap walker options dialog. When searching for a memory leak, this "full garbage collection" is desirable, since unreferenced objects are a temporary phenomenon without any connection to a memory leak.

If necessary, you can now further narrow down the memory leak by adding additional selection steps. For example, you can go to the outgoing references view and look at the instance data to find out a number of instances that definitely should have been freed. By flagging these instances and creating a new set of objects you can reduce the number of objects that are in your focus.

Using the biggest objects view to find the reason for a memory leak

Many memory leaks can be traced to object clusters that should be freed but are erroneously held alive through a single string reference. This will lead to a number of objects that have a very large retained size. "Retained size" is the memory that would be freed by the garbage collector if an object were to be removed from the heap. The biggest objects view lists the objects with the biggest retained sizes together with the tree of retained objects. You can use that tree to drill down to find the erroneous references.



Current object set: 19621 objects in 759 classes, 9448 arrays

1 selection step, 1994 kB shallow size

Object	Retained size
bezier.BezierAnim$Demo (0x3b35)	38
384 kB (99.8%) bimg **sun.awt.image.OffScreenImage** (0x65a2)	
384 kB (99.7%) raster (declared by java.awt.image.BufferedImage) **sun.awt.image.IntegerInterleavedRa**	
384 kB (99.6%) data (declared by sun.awt.image.IntegerComponentRaster) **int[ ]** (0x2e4)	
Another **3** instances with a total retained size of **208 bytes** and a maximum single retained size of **120 bytes**	
Another **2** instances with a total retained size of **392 bytes** and a maximum single retained size of **232 bytes**	
Another **12** instances with a total retained size of **464 bytes** and a maximum single retained size of **80 bytes**	
com.jprofiler.agent.triggers.TriggerManager (0x39ca)	74,880 bytes (3 %)
com.sun.jmx.mbeanserver.JmxMBeanServer (0x7734)	74,488 bytes (3 %)
sun.awt.AppContext (0x48b9)	52,128 bytes (2 %)
java.lang.System (0x3ad2)	41,952 bytes (2 %)
sun.java2d.loops.GraphicsPrimitiveMgr (0x3632)	35,752 bytes (1 %)
com.jprofiler.agent.triggers.TriggerLog (0x3922)	25,256 bytes (1 %)
java.io.PrintStream (0x3b7c)	25,128 bytes (1 %)
sun.font.FontManager (0x37d9)	17,328 bytes (0 %)
java.nio.charset.Charset (0x3a57)	11,944 bytes (0 %)
java.lang.ProcessEnvironment (0x39c1)	11,304 bytes (0 %)

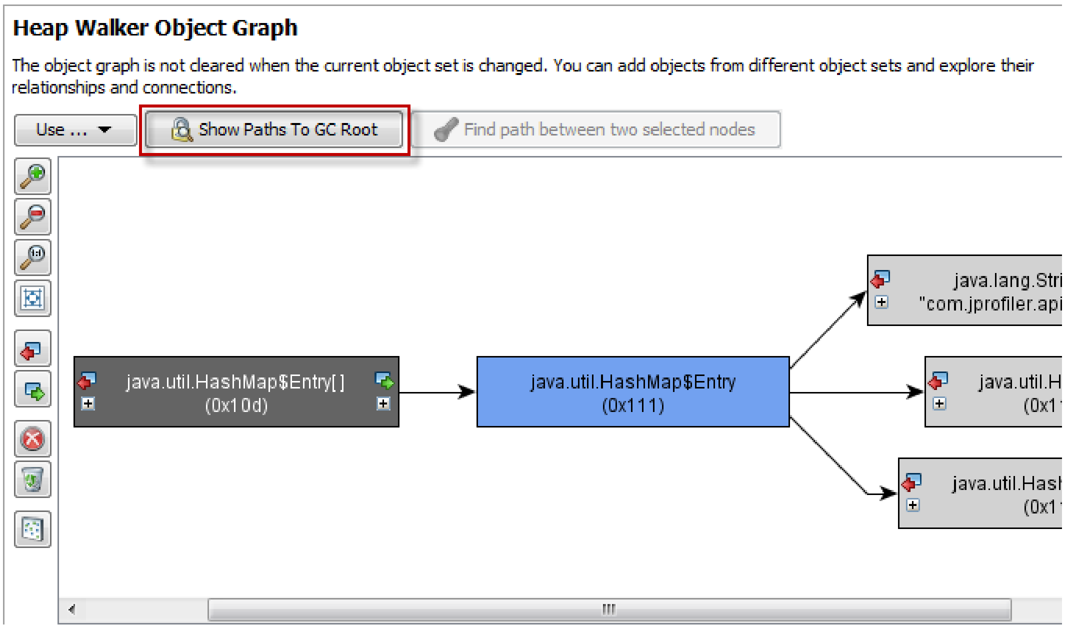
Selection step 1 : All objects after full GC

19621 objects in 759 classes, 9448 arrays

Using the reference graph to find the reason for a memory leak

The core instrument for finding memory leaks is the reference graph in the heap walker. Here you can find out how single objects are referenced and why they're not garbage collected. By successively opening incoming references you may spot a "wrong" reference immediately. In complex systems this is often not possible. In that case you have to find one or multiple "garbage collector roots". Garbage collector roots are points in the JVM that are not subject to garbage collection. These roots emanate strong references, any object that is linked by a chain of references to such a root cannot be garbage collected.

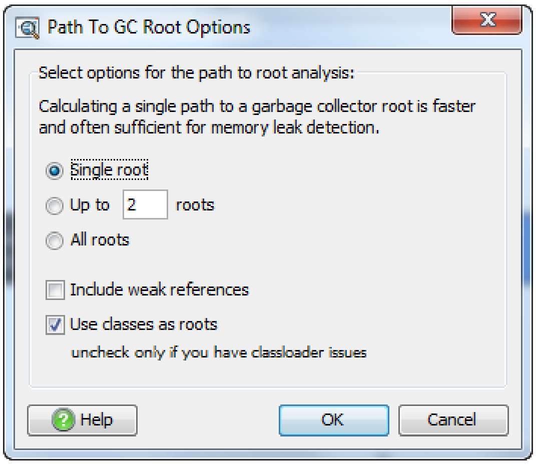
When you select an object in the incoming references or the graph, the **[Show path to GC root]** button at the top is enabled.



Heap Walker Object Graph

The object graph is not cleared when the current object set is changed. You can add objects from different object sets and explore their relationships and connections.

Potentially there are very many garbage collector roots and displaying them all can lead to the situation that a sizable fraction of the entire heap has to be shown in the reference graph. Also, looking for garbage collector roots is computationally quite expensive, and if thousands of roots can be found, the computation can take very long and use a lot of memory. In order to prevent this, it is recommended to start with a single garbage collector root and search for more roots if required. An option dialog is displayed after you trigger the search:



Path To GC Root Options

Select options for the path to root analysis:

Calculating a single path to a garbage collector root is faster and often sufficient for memory leak detection.

● Single root

○ Up to 2 roots

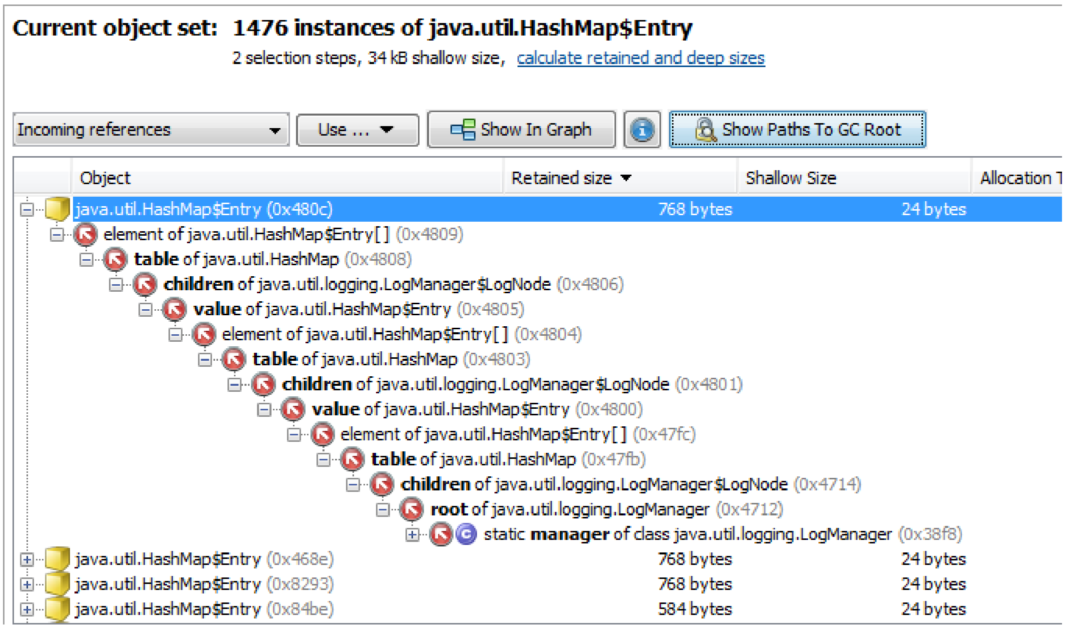
○ All roots

☐ Include weak references

☑ Use classes as roots

uncheck only if you have classloader issues

As you can see in this example, the chain to a garbage collector root can be quite long:



Current object set: 1476 instances of java.util.HashMap$Entry

2 selection steps, 34 kB shallow size, calculate retained and deep sizes

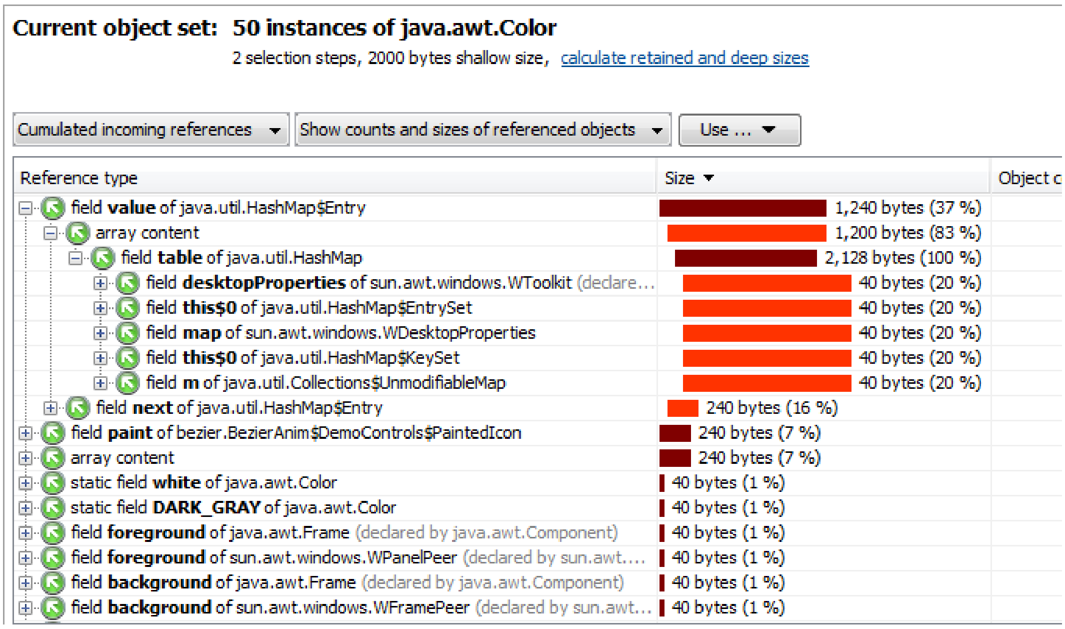
Object	Retained size	Shallow Size	Allocation T
java.util.HashMap$Entry (0x480c)	768 bytes	24 bytes	
element of java.util.HashMap$Entry[] (0x4809)			
table of java.util.HashMap (0x4808)			
children of java.util.logging.LogManager$LogNode (0x4806)			
value of java.util.HashMap$Entry (0x4805)			
element of java.util.HashMap$Entry[] (0x4804)			
table of java.util.HashMap (0x4803)			
children of java.util.logging.LogManager$LogNode (0x4801)			
value of java.util.HashMap$Entry (0x4800)			
element of java.util.HashMap$Entry[] (0x47fc)			
table of java.util.HashMap (0x47fb)			
children of java.util.logging.LogManager$LogNode (0x4714)			
root of java.util.logging.LogManager (0x4712)			
static **manager** of class java.util.logging.LogManager (0x38f8)			
java.util.HashMap$Entry (0x468e)	768 bytes	24 bytes	
java.util.HashMap$Entry (0x8293)	768 bytes	24 bytes	
java.util.HashMap$Entry (0x84be)	584 bytes	24 bytes	

The reason for a memory leak can be anywhere along this chain. It is of a semantic nature and cannot be found out by JProfiler, but only by the programmer. Once you have found the faulty reference, you can work on your code to remove it. Unless there are other references, the memory leak will be gone.

Using the cumulated references views to find the reason for a memory leak

In some cases, you might not succeed in narrowing down the object set to a reasonable size. Your object set might still contain a large number of instances that are OK and using the reference graph might not provide any insight in this situation.

If such a situation arises, the cumulated reference tables available in the references view of the heap walker can be of help. The cumulated incoming reference table shows all possible **reference types** into the current object set:



Current object set: 50 instances of java.awt.Color

2 selection steps, 2000 bytes shallow size, calculate retained and deep sizes

Cumulated incoming references
Show counts and sizes of referenced objects
Use ...

Reference type	Size	Object c
field **value** of java.util.HashMap$Entry	1,240 bytes (37 %)	
array content	1,200 bytes (83 %)	
field **table** of java.util.HashMap	2,128 bytes (100 %)	
field **desktopProperties** of sun.awt.windows.WToolkit (declare...	40 bytes (20 %)	
field **this$0** of java.util.HashMap$EntrySet	40 bytes (20 %)	
field **map** of sun.awt.windows.WDesktopProperties	40 bytes (20 %)	
field **this$0** of java.util.HashMap$KeySet	40 bytes (20 %)	
field **m** of java.util.Collections$UnmodifiableMap	40 bytes (20 %)	
field **next** of java.util.HashMap$Entry	240 bytes (16 %)	
field **paint** of bezier.BezierAnim$DemoControls$PaintedIcon	240 bytes (7 %)	
array content	240 bytes (7 %)	
static field **white** of java.awt.Color	40 bytes (1 %)	
static field **DARK_GRAY** of java.awt.Color	40 bytes (1 %)	
field **foreground** of java.awt.Frame (declared by java.awt.Component)	40 bytes (1 %)	
field **foreground** of sun.awt.windows.WPanelPeer (declared by sun.awt....	40 bytes (1 %)	
field **background** of java.awt.Frame (declared by java.awt.Component)	40 bytes (1 %)	
field **background** of sun.awt.windows.WFramePeer (declared by sun.awt...	40 bytes (1 %)	

From the reference type, you may be able to narrow down the object set. For example, you may know that one type of reference is OK, but another is not. As a hypothetical example, the reference from

`HashMap$Entry` in the table above might be suspicious. By selecting the 31 objects which are referenced in this way, you can discard the other 19 instances and use the reference graph to show the path to a garbage collector root.

A.4 CPU Profiling

A.4.1 Time Measurements In Different CPU Views

Wall clock time and CPU time

When the duration of a method call is measured, there are two different possibilities to measure it:

- Most likely you'll be interested in the **wall clock time**, that is the duration between the entry and the exit of a method as measured with a clock. For the profiling agent this is a straightforward measurement. While it might seem at first glance that measuring times should not have any significant overhead, this is not so if you need a high resolution measurement. Operating systems offer different timers with different performance overheads.

  For example, on Microsoft Windows, the standard timer with a granularity of 10 milliseconds is very fast, because the operating system "caches" the current time. However, the duration of method calls can be as low as a few nanoseconds, so a high resolution timer is needed. A high resolution timer works directly with a special hardware device and carries a noticeable performance overhead. In JProfiler, CPU recording is disabled by default. If you compare the duration of the startup sequence of an application server with and without CPU recording, you will notice the difference.

  Wall clock time is measured separately for each thread. In CPU views where the thread selection includes multiple threads, the displayed times can be larger than the total execution time of the application. If you have 10 parallel threads of the same class `MyThreadClass` whose `run()` method takes 1 second and "All threads" is selected in the call tree, the `MyThreadClass.run()` node in the call tree will display 10 seconds, even though only one second has passed.
- Since the CPU might be handling many threads with different priorities, the wall clock time is not the time the CPU has actually spent in that method. The scheduler of the operating system can interrupt the execution of a method multiple times and perform other tasks. The real time that was spent in the method by the CPU is called the **CPU time**. In extreme cases, the CPU time and the wall clock time can differ by a large factor, especially if the executing thread has a low priority.

  The standard time measurement in JProfiler is wall clock time. If you wish to see the CPU time in the CPU views, you can change the measurement type in the profiling settings. The problem with CPU time measurements is that most operating systems provide this information with the granularity of the standard timer - high resolution measurements would carry too much overhead. This means the CPU times are only statistically valid for methods that have a CPU time bigger than the typical granularity of 10 milliseconds.

Thread statuses

The notion of time measurement must be refined further, since not all times are equally interesting. Imagine a server application with a pool of threads waiting to perform a task. Most of the time would then be spent in the method that keeps the threads waiting while the actual task will only get a small part of the overall time and will be hard to spot. The necessary refinement is done with the concept of **thread status**. There are 4 different thread statuses in JProfiler:

- **Runnable**

  In this case the thread is ready to execute code. The reason that this is not called "Running" is that it may actually not be running due to the scheduler of the operating system. However, if given a chance, the thread will execute instructions.
- **Waiting**

  This means that the thread has deliberately decided to enter into hibernation until a certain event occurs. This happens when you call `Object.wait()` and the current thread will only become runnable again when some other thread calls `Object.notify()` on the same object.

- **Blocking**

  Whenever synchronized blocks of code or synchronized methods occur, there can be monitor contention. If one thread is in the synchronized area all other threads trying to enter it will be blocked. Frequent blocking can reduce the liveness of your application.

- **Net I/O**

  During network operations, many calls in the Java standard libraries can block because they're waiting for more data. This kind of blocking is called "Net I/O" in JProfiler. JProfiler knows the list of methods in the JRE that lead to blocked net I/O and instruments them at load time.

When looking for performance bottlenecks, you're mostly interested in the "Runnable" thread state although it's always a good idea to have a look at the "Net I/O" and "Blocking" thread states in order to check if the network or synchronization issues are reducing the performance of your application.

Times in the call tree

Nodes in the call tree (methods, classes, packages or Java EE components, depending on the selected aggregation level) are sorted by **total time**. This is the sum of all execution times of this node on the particular call path as given by the ancestor nodes. Only threads in the current thread selection are considered and only measurements with the currently selected thread status are shown.

Optionally, the call tree offers the possibility to show the **inherent time** of a node. The inherent time is defined as the total time of a method minus the time of its child nodes. Since child nodes can only be in unfiltered classes, calls into filtered classes go into the inherent time. If you change your method call recording filters [p. 22] , the inherent times in the call tree can change.

Times in the hot spots view

While the call tree view shows all call stacks in your application, the hot spots view shows the methods that take most of the time. Each method can potentially be called through many different call stacks, so the invocation counts in the call tree and the hot spots view do not have to match. The hot spots view shows the inherent time rather than the total time. In addition, the hot spots view offers the option to include calls to filtered classes into the inherent time. Please see the article on hot spots and filters [p. 41] for a thorough discussion of this topic.

When you open a hot spot node, you see a reverse call tree. However, the times that are displayed in those **backtraces** do not have the same meaning as those in the call tree, since they do not express a time measurement for the corresponding node. Rather, the time displayed at each node indicates how much time that particular call tree contributes to the hot spot. If there is only one backtrace, you will see the hot spot time at each node.

Times in the call graph

The times that are shown for **nodes** (methods, classes, packages or Java EE components, depending on the selected aggregation level) in the call graph are the same as those in the hot spots view. The times that are associated with the **incoming arrows** are the same as those in the first level of the hot spot backtrace, since they show all calling nodes and the cumulated duration of their calls. The time on the **outgoing arrows** is a measurement that cannot be found in the call tree. It shows the cumulated duration of calls from this node, while the call tree shows the cumulated duration of calls from the current call stack.

A.4.2 The Influence Of Method Call Recording Filters On Hot Spots

Introduction

The notion of a performance hot spot is not absolute but relative to your point of view. The total execution time of a method is not the right measure, since in that case your main method or the `run()` methods of your threads would be the biggest hot spots in most cases. Such a definition of a hot spot would not be very useful. Clearly, we somehow must use the **inherent time of methods** to determine what a hot spot is.

As an extreme case, one could use the inherent time of all executed methods in the JVM for the ranking of hot spots. This would not be very useful either, since the biggest hot spots will most likely always be core methods in the JRE, like string manipulation, I/O classes or core drawing routines in obscure implementation classes of the AWT.

As the above considerations make clear, the definition of a hot spot is not trivial and must be carefully considered.

Definition of a hot spot

Only with method call recording filters [p. 24] is it possible to come up with a useful definition of a hot spot. Usually, your filter settings will exclude all library classes and framework classes by restricting the profiled classes to your top-level packages.

In order to be useful to you, a hot spot must be

- **a method in your own classes**

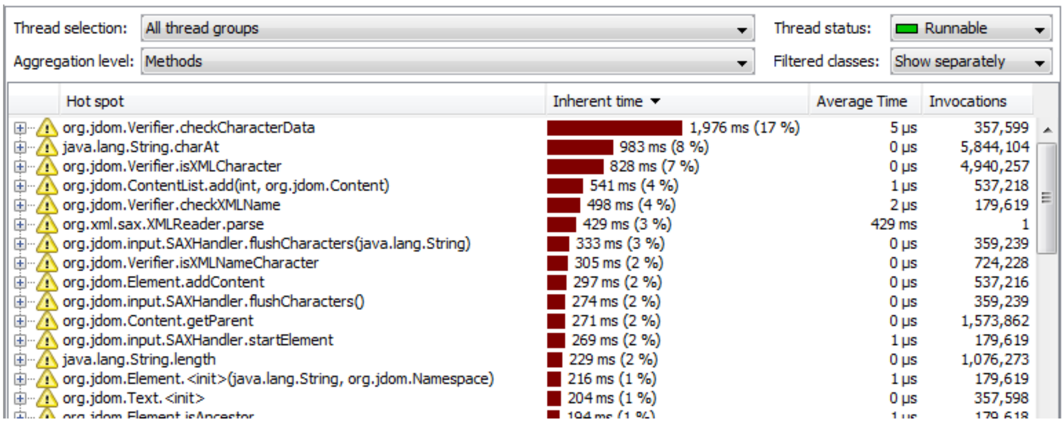
  These are the classes that you can actually modify to solve a performance problem.
- **a method in a library class that you call directly**

  This gives you a more fine-grained resolution of the activities of your own methods. While not directly under your control, you can sometimes choose to call libraries less frequently or in a different way.

Sometimes, you will want to eliminate hot spots in unprofiled classes by adding their time to the inherent time of the calling method, which is definitely in a profiled class. In that way, only profiled methods can appear as hot spots. JProfiler's hot spots view offers both modes with the "Filtered classes" drop-down list in the top-right corner. The allocation hot spots view also offers this mechanism of adjusting the definition of a hot spot.

Example

In the following example, a simple program with the main class `misc.JdomTest` is shown that reads an XML file with the help of the JDOM library. First, we set the filter settings to include `misc.` and `org.jdom.`.



Thread selection: All thread groups

Aggregation level: Methods

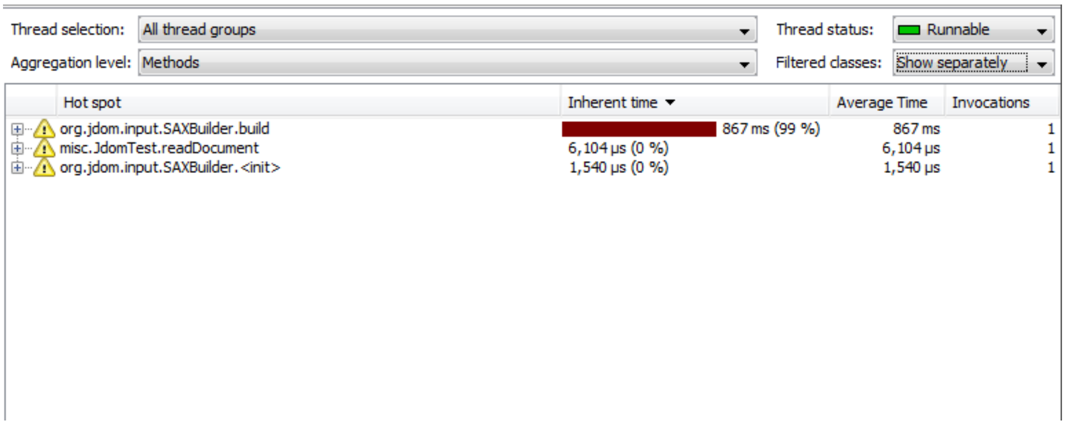
Thread status: 🟩 Runnable

Filtered classes: Show separately

Hot spot	Inherent time	Average Time	Invocations
org.jdom.Verifier.checkCharacterData	1,976 ms (17 %)	5 µs	357,599
java.lang.String.charAt	983 ms (8 %)	0 µs	5,844,104
org.jdom.Verifier.isXMLCharacter	828 ms (7 %)	0 µs	4,940,257
org.jdom.ContentList.add(int, org.jdom.Content)	541 ms (4 %)	1 µs	537,218
org.jdom.Verifier.checkXMLName	498 ms (4 %)	2 µs	179,619
org.xml.sax.XMLReader.parse	429 ms (3 %)	429 ms	1
org.jdom.input.SAXHandler.flushCharacters(java.lang.String)	333 ms (3 %)	0 µs	359,239
org.jdom.Verifier.isXMLNameCharacter	305 ms (2 %)	0 µs	724,228
org.jdom.Element.addContent	297 ms (2 %)	0 µs	537,216
org.jdom.input.SAXHandler.flushCharacters()	274 ms (2 %)	0 µs	359,239
org.jdom.Content.getParent	271 ms (2 %)	0 µs	1,573,862
org.jdom.input.SAXHandler.startElement	269 ms (2 %)	1 µs	179,619
java.lang.String.length	229 ms (2 %)	0 µs	1,076,273
org.jdom.Element.<init>(java.lang.String, org.jdom.Namespace)	216 ms (1 %)	1 µs	179,619
org.jdom.Text.<init>	204 ms (1 %)	0 µs	357,598
org.jdom.Element.isAncestor	194 ms (1 %)	1 µs	179,618

Since we profile the JDOM classes, all the hot spots are in the JDOM subsystem, and not in our own class. This may be useful if you are a JDOM developer, but otherwise you just see confusing and useless information. None of the listed `org.jdom.*` classes are ever called by our code. While we could open the back traces and check how they have been invoked, this is cumbersome and produces no insight into any performance problems that we might be able to solve.

In the next step, we change our filter settings so that only the `misc.` package is profiled.

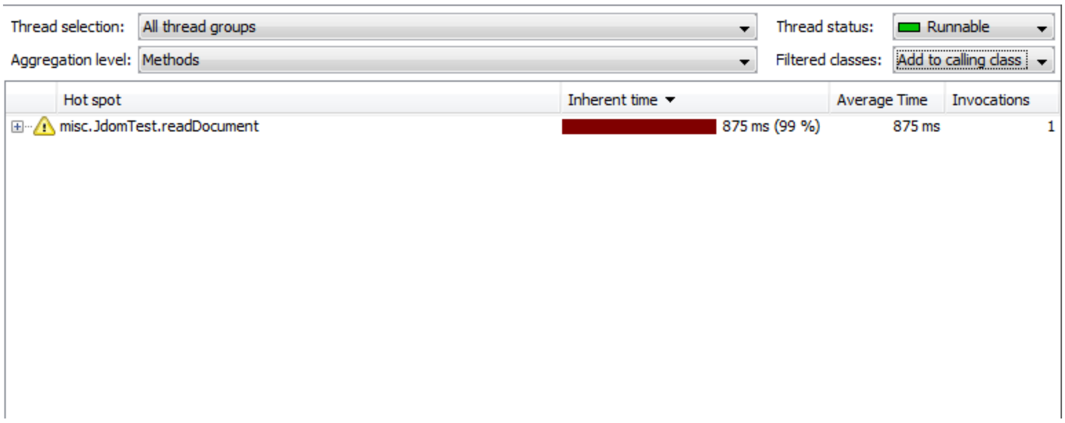


Thread selection: All thread groups
Thread status: Runnable
Aggregation level: Methods
Filtered classes: Show separately

Hot spot	Inherent time	Average Time	Invocations
org.jdom.input.SAXBuilder.build	867 ms (99 %)	867 ms	1
misc.JdomTest.readDocument	6,104 µs (0 %)	6,104 µs	1
org.jdom.input.SAXBuilder.<init>	1,540 µs (0 %)	1,540 µs	1

We see the `SAXBuilder` class in JDOM that is actually constructed and called by our code to read the XML file. No other internal JDOM classes are shown. The `readDocument` method that calls the JDOM library is not a significant hot spot.

If you want to fully concentrate on your own classes, the remaining JDOM hot spots might be unwanted. You can quickly change the hot spot definition by setting "Filtered classes handing" to "Add to calling class".



Thread selection: All thread groups
Thread status: Runnable
Aggregation level: Methods
Filtered classes: Add to calling class

Hot spot	Inherent time	Average Time	Invocations
misc.JdomTest.readDocument	875 ms (99 %)	875 ms	1

Now, the list of hot spots just includes the method that reads the XML file, as expected for our trivial example.

From the above example, you can see how important the filter settings and the filtered classes handling are for the actual results in the hot spots view. The same considerations apply to the allocation hot spots view.

A.4.3 Request Tracking

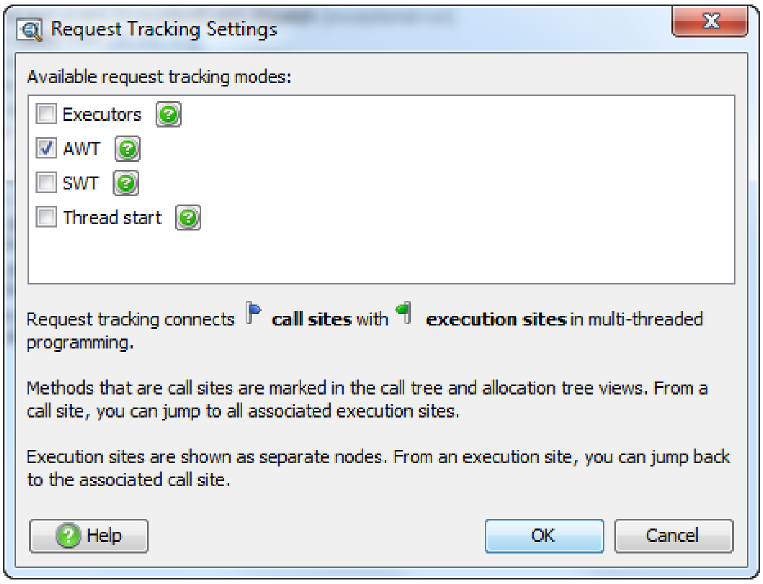
Introduction

It is a standard practice of most applications to handle certain tasks on dedicated threads. The execution may be asynchronous to avoid blocking on the calling thread or synchronous because certain operations may only be performed on one particular thread. For debugging and profiling, this thread change presents two problems: On the one hand, it is not clear how expensive an invoked operation is. On the other hand, an expensive operation cannot be traced to the code that caused its execution.

JProfiler's solution to this problem is **request tracking**: Call sites and execution sites in multi-threaded programming are hyperlinked in the call tree [p. 192] , so you can seamlessly navigate both ways.

Request Tracking Types

Inter-thread communication can be implemented in various ways and the semantics of starting tasks on a separate thread cannot be detected in a generic way. JProfiler explicitly supports several common asynchronous systems. You can enable or disable them in the request tracking settings [p. 211] . By default, request tracking is not enabled.



Available request tracking modes:

- ☐ Executors
- ☑ AWT
- ☐ SWT
- ☐ Thread start

Request tracking connects **call sites** with **execution sites** in multi-threaded programming.

Methods that are call sites are marked in the call tree and allocation tree views. From a call site, you can jump to all associated execution sites.

Execution sites are shown as separate nodes. From an execution site, you can jump back to the associated call site.

The simplest way to offload a task on another thread is to **start a new thread**. JProfiler supports this "Thread start" request tracking type. However, threads are heavy-weight objects and are usually reused for repeated invocations, so this request tracking type is more useful for debugging purposes.

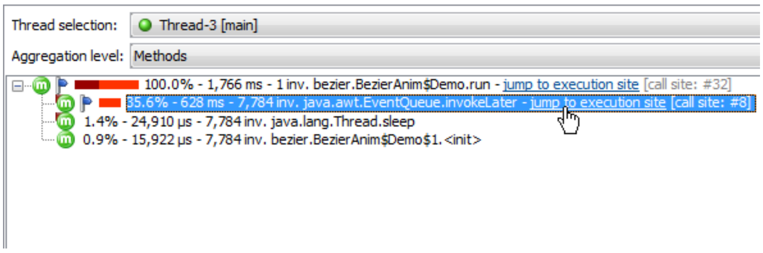
The most important and generic way to start tasks on other threads uses **executors** in the `java.util.concurrent` package. Executors are also the basis for many higher-level third party libraries that deal with asynchronous execution. By supporting executors, JProfiler supports a whole class of libraries that deal with multi-threaded and parallel programming.

Apart from the generic cases above, JProfiler also supports the two most popular **GUI toolkits** for the JVM: AWT and SWT. Both toolkits are single-threaded, which means that there is one special event dispatch thread that can manipulate GUI widgets and perform drawing operations. In order not to block the GUI, long-running tasks have to be performed on background threads. However, background threads often need to update the GUI to indicate progress or completion. This is done with special methods that schedule a `Runnable` to be executed on the event dispatch thread.

In GUI programming, you often have to follow multiple thread changes in order to connect cause and effect: The user initiates an action on the event dispatch thread, which in turn starts a background operation via an executor. After completion, that executor pushes an operation to the event dispatch thread. If that last operation creates a performance problem, it's two thread changes away from the originating event.

Call Sites

A **call site** in JProfiler is the last profiled method call before a recorded thread change is performed. It starts a task at an **execution site** which is located on a different thread. If request tracking is enabled for the appropriate request tracking type, JProfiler allows you to jump from a call site to an execution site by using hyperlinks that are shown in the call tree view.

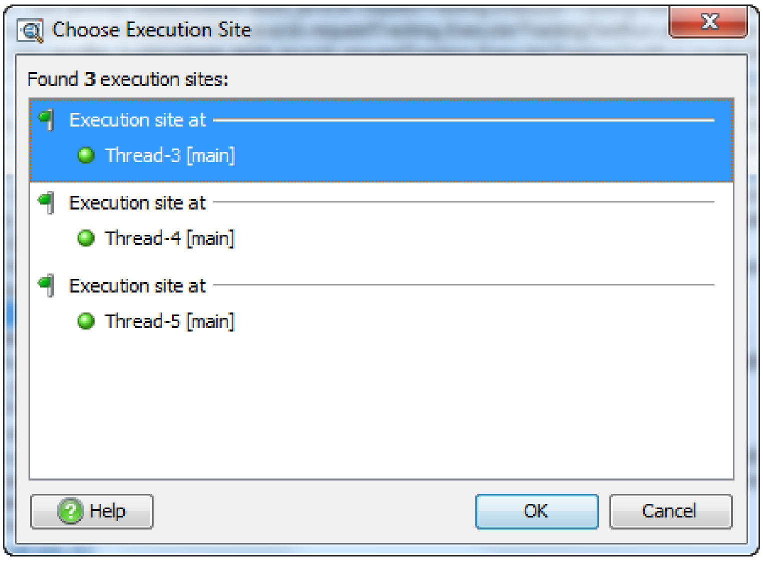


Thread selection: Thread-3 [main]

Aggregation level: Methods

```
100.0% - 1,766 ms - 1 inv. bezier.BezierAnim$Demo.run - jump to execution site [call site: #32]
  35.6% - 628 ms - 7,784 inv. java.awt.EventQueue.invokeLater - jump to execution site [call site: #8]
  1.4% - 24,910 µs - 7,784 inv. java.lang.Thread.sleep
  0.9% - 15,922 µs - 7,784 inv. bezier.BezierAnim$Demo$1.<init>
```

Call sites and execution sites are in a 1:n relationship. A call site can start tasks on several execution sites, such as different threads in a thread pool. If a call site calls more than one execution site, you can choose one of them in a dialog.



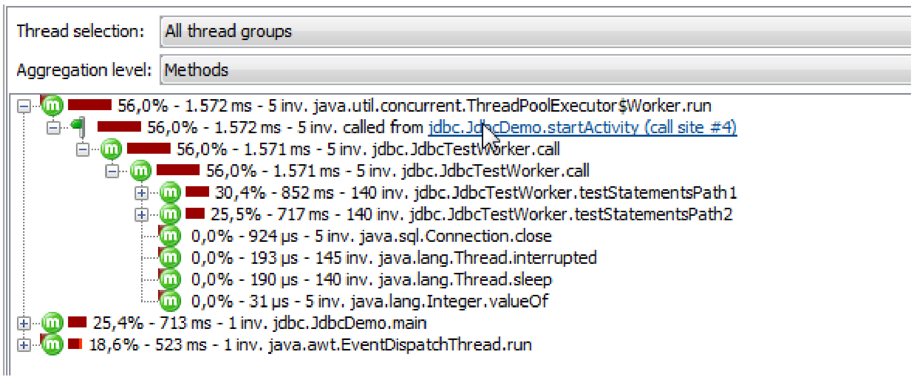
Choose Execution Site

Found **3** execution sites:

- Execution site at
  - Thread-3 [main]
- Execution site at
  - Thread-4 [main]
- Execution site at
  - Thread-5 [main]

Execution Sites

An execution site is a synthetic node in the call tree that contains all executions that were started by one particular call site. JProfiler allows you to jump back to the call site by using the hyperlink in the execution site node.



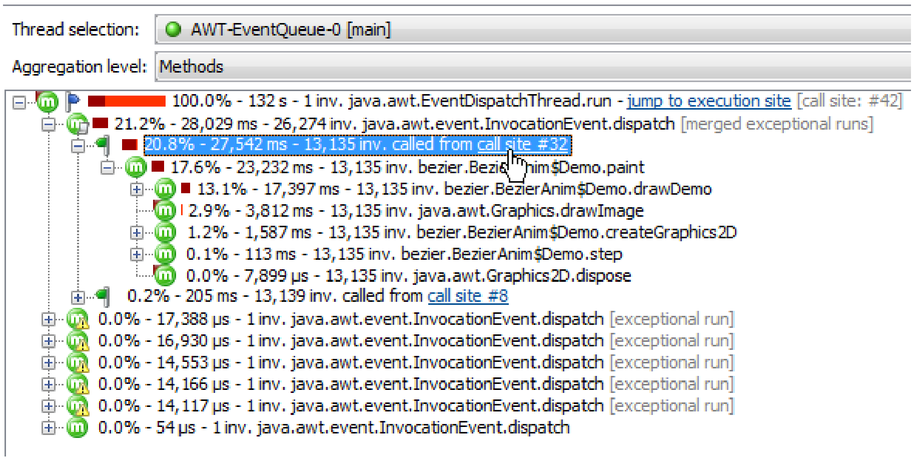
Thread selection: All thread groups

Aggregation level: Methods

```
56,0% - 1.572 ms - 5 inv. java.util.concurrent.ThreadPoolExecutor$Worker.run
  56,0% - 1.572 ms - 5 inv. called from jdbc.JdbcDemo.startActivity (call site #4)
    56,0% - 1.571 ms - 5 inv. jdbc.JdbcTestWorker.call
      56,0% - 1.571 ms - 5 inv. jdbc.JdbcTestWorker.call
        30,4% - 852 ms - 140 inv. jdbc.JdbcTestWorker.testStatementsPath1
        25,5% - 717 ms - 140 inv. jdbc.JdbcTestWorker.testStatementsPath2
        0,0% - 924 µs - 5 inv. java.sql.Connection.close
        0,0% - 193 µs - 145 inv. java.lang.Thread.interrupted
        0,0% - 190 µs - 140 inv. java.lang.Thread.sleep
        0,0% - 31 µs - 5 inv. java.lang.Integer.valueOf
25,4% - 713 ms - 1 inv. jdbc.JdbcDemo.main
18,6% - 523 ms - 1 inv. java.awt.EventDispatchThread.run
```

In principle, call sites and execution sites could be implemented in an n:m relationship. However, it is often important to separately analyze the execution site depending on the call site. For example, the same executor thread can handle tasks submitted from different methods, but they will probably be of a different nature and so merging them would not be advantageous. That's why JProfiler creates **a new execution site for every call site**.

However, if the same call site invokes the same execution site repeatedly, the execution site will show the merged call tree of all its invocations. If that is not desired, you can use the exceptional methods [p. 82] feature to split the call tree further, as shown in the screen shot below.



Thread selection: AWT-EventQueue-0 [main]

Aggregation level: Methods

```
100.0% - 132 s - 1 inv. java.awt.EventDispatchThread.run - jump to execution site [call site: #42]
  21.2% - 28,029 ms - 26,274 inv. java.awt.event.InvocationEvent.dispatch [merged exceptional runs]
    20.8% - 27,542 ms - 13,135 inv. called from call site #32
      17.6% - 23,232 ms - 13,135 inv. bezier.BezierAnim$Demo.paint
        13.1% - 17,397 ms - 13,135 inv. bezier.BezierAnim$Demo.drawDemo
        2.9% - 3,812 ms - 13,135 inv. java.awt.Graphics.drawImage
        1.2% - 1,587 ms - 13,135 inv. bezier.BezierAnim$Demo.createGraphics2D
        0.1% - 113 ms - 13,135 inv. bezier.BezierAnim$Demo.step
        0.0% - 7,899 µs - 13,135 inv. java.awt.Graphics2D.dispose
    0.2% - 205 ms - 13,139 inv. called from call site #8
  0.0% - 17,388 µs - 1 inv. java.awt.event.InvocationEvent.dispatch [exceptional run]
  0.0% - 16,930 µs - 1 inv. java.awt.event.InvocationEvent.dispatch [exceptional run]
  0.0% - 14,553 µs - 1 inv. java.awt.event.InvocationEvent.dispatch [exceptional run]
  0.0% - 14,166 µs - 1 inv. java.awt.event.InvocationEvent.dispatch [exceptional run]
  0.0% - 14,117 µs - 1 inv. java.awt.event.InvocationEvent.dispatch [exceptional run]
  0.0% - 54 µs - 1 inv. java.awt.event.InvocationEvent.dispatch
```

Because several execution sites can refer to the same call site, call sites have a numeric ID. In that way you can recognize the same call site if you see it referenced from different execution sites. Execution sites are only referenced from a single call site and so they do not need a separate ID.

A.4.4 Replacing Finalizers With Phantom References

Why finalizers are bad

Sometimes one must perform pre-garbage collection actions such as freeing resources. In a JDBC driver, for example, a database connection may be held by a connection object. Before the connection object is garbage collected, the actual database connection must be closed. In such a case, one typically cannot rely on the `close()` method being called by the user application code.

Most often, **finalizers** are used to solve this problem. A finalizer is created by overriding the `finalize()` method of `java.lang.Object`. In that case, before the object is garbage collected, this finalize method will be called. Unfortunately, there are severe problems with the design of this finalizer mechanism. Using finalizers has a negative impact on the performance of the garbage collector and can break data integrity of your application if you're not very careful since the "finalizer" is invoked in a random thread, at a random time. If you use a lot of finalizers, the finalizer system may be completely overwhelmed which can lead to `OutOfMemoryErrors`. In addition, you have no control about when a finalizer will be run, so it can create problems with locking, the shutdown of the JVM and other exceptional circumstances.

Because the random execution of the finalizers break the call tree, JProfiler eliminates them from the profiling results.

The solution for all these problems is to **eliminate finalizers** where they are not strictly required and **replace the necessary ones with phantom references**.

What are phantom references?

Phantom references can be used to perform actions before an object is garbage collected in a safe way. In the constructor of a `java.lang.ref.PhantomReference`, you specify a `java.lang.ref.ReferenceQueue` where the phantom reference will be enqueued once the referenced object becomes "phantom reachable". Phantom reachable means unreachable other than through the phantom reference. The initially confusing thing is that although the phantom reference continues to hold the referenced object in a private field (unlike soft or weak references), its `getReference()` method always returns `null`. This is so that you cannot make the object strongly reachable again.

From time to time, you can poll the reference queue and check if there are any new phantom references whose referenced objects have become phantom reachable. In order to be able to do anything useful, one can for example derive a class from `java.lang.ref.PhantomReference` that references resources that should be freed before garbage collection. The referenced object is only garbage collected once the phantom reference becomes unreachable itself.

How to replace finalizers with phantom references

Let's continue with the example of the JDBC driver above: Before a connection object is garbage collected, the actual database connection must be closed. The following steps are necessary to achieve this with phantom references:

- **Add data structure that holds phantom references**

  The JDBC driver class gets a data structure that holds phantom references to the connection objects. A private field

  ```
  private LinkedList phantomReferences = new LinkedList();
  ```

  would be appropriate. This is necessary to ensure that phantom references are not garbage collected as long as they have not been handled by the reference queue.

- **Create reference queue**

  Before a connection object will be garbage collected, its phantom reference will be enqueued into the associated reference queue. The JDBC driver thus gets an additional private field

```
private ReferenceQueue queue = new ReferenceQueue();
```

- **Derive a class from PhantomReference that references resources**

  You will not be able to access the original object from a phantom reference. Therefore, you have to add the resources that must be freed to the phantom reference itself. In our example JDBC driver this could be a class named `DatabaseConnection`. The phantom reference class will thus look like:

  ```
  public class ConnectionPhantomReference extends PhantomReference {
      private DatabaseConnection databaseConnection;

      public MyPhantomReference(ConnectionImpl connection, ReferenceQueue queue) {

          super(connection, queue);
          databaseConnection = connection.getDatabaseConnection();
      }

      public void cleanup() {
          databaseConnection.close();
      }
  }
  ```

  The custom phantom reference extracts the resource object from the implementation class of the connection and saves it in a private field. It additionally provides a `cleanup()` method that can be invoked once after the phantom reference is taken out of the reference queue.

- **Create and remember phantom references when objects are created**

  When a connection object is created, a corresponding `ConnectionPhantomReference` must be created as well and added to the `phantomReferences` list:

  ```
  phantomReferences.add(new ConnectionPhantomReference(connection, queue));
  ```

- **Create reference queue handler thread**

  When a phantom reference is added to the queue by the garbage collector, no further action is taken. You have to handle and empty the reference queue yourself. It's best to create a separate daemon thread that removes phantom references from the queue and invokes the cleanup method:

  ```
  Thread referenceThread = new Thread() {
      public void run() {
          while (true) {
              try {
                  ConnectionPhantomReference ref =
  (ConnectionPhantomReference)queue.remove();
                  ref.close();
                  phantomReferences.remove(ref);
              } catch (Exception ex) {
                // log exception, continue
              }
          }
      }
  };
  referenceThread.setDaemon(true);
  referenceThread.start();
  ```

  The phantom reference is removed from the `phantomReferences` list. Now the phantom reference is unreferenced itself and the referenced object can be garbage collected.

A.5 Probes

A.5.1 Probes Explained

Introduction

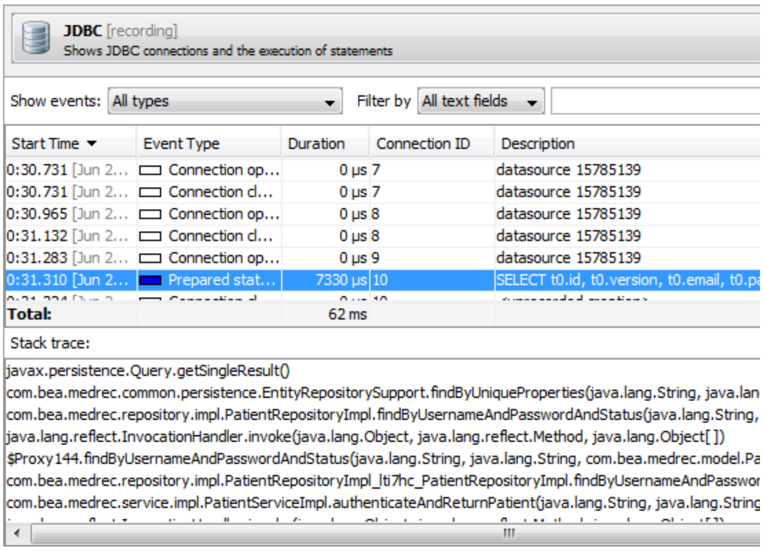
Most functionality in a Java profiler revolves around the basic operations in the JVM which mainly concern memory allocations, CPU usage and threading operations. In addition, JProfiler offers a higher-level analysis of common Java subsystems that are used by many applications. For JSE, they are file I/O, network I/O and process execution. For JEE, JProfiler can collect data on servlets as well as JDBC, JMS and JNDI. Each such subsystem is handled by a single "probe".

The probes facility in JProfiler is exposed through an API, so you can write your own custom probe [p. 53] to capture information on other subsystems as well. Because JProfiler allows you to enter scripts directly in the JProfiler GUI, custom probes can also be configured and deployed without using your IDE and without modifying the profiled application.

Events

Probes intercept selected methods to collect data. At method entry, a probe will usually extract semantic data from the method arguments and store it for later use. Some method invocations will be intercepted just for collecting information, other method invocations define time-consuming operations that are measured by the probe. When such methods exit (either via a return or through an exception), the probe will retrieve the stored data, determine how long the method execution has taken, and publish an **event**.

An event contains the following information: a start time, an optional duration, the associated thread and a description that is constructed by the probe to describe the event. Also, an event has an **event type** that distinguishes various classes of events. For example, the JDBC probe publishes different events for statement, prepared statement and batch execution. In addition, an event can have an associated stack trace.


JDBC [recording]
Shows JDBC connections and the execution of statements

Show events: All types
Filter by All text fields

Start Time	Event Type	Duration	Connection ID	Description
0:30.731 [Jun 2...	▭ Connection op...	0 µs	7	datasource 15785139
0:30.731 [Jun 2...	▭ Connection cl...	0 µs	7	datasource 15785139
0:30.965 [Jun 2...	▭ Connection op...	0 µs	8	datasource 15785139
0:31.132 [Jun 2...	▭ Connection cl...	0 µs	8	datasource 15785139
0:31.283 [Jun 2...	▭ Connection op...	0 µs	9	datasource 15785139
0:31.310 [Jun 2...	■ Prepared stat...	7330 µs	10	SELECT t0.id, t0.version, t0.email, t0.p
Total:		62 ms		

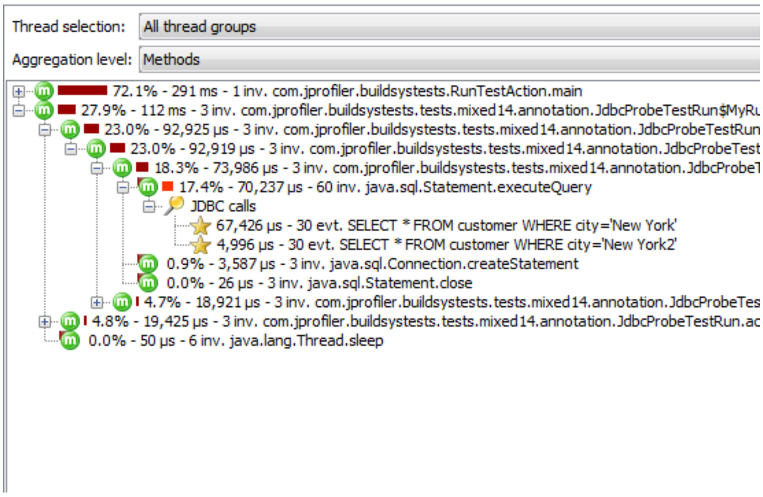
Stack trace:

```
javax.persistence.Query.getSingleResult()
com.bea.medrec.common.persistence.EntityRepositorySupport.findByUniqueProperties(java.lang.String, java.lan
com.bea.medrec.repository.impl.PatientRepositoryImpl.findByUsernameAndPasswordAndStatus(java.lang.String,
java.lang.reflect.InvocationHandler.invoke(java.lang.Object, java.lang.reflect.Method, java.lang.Object[])
$Proxy144.findByUsernameAndPasswordAndStatus(java.lang.String, java.lang.String, com.bea.medrec.model.Pa
com.bea.medrec.repository.impl.PatientRepositoryImpl_lti7hc_PatientRepositoryImpl.findByUsernameAndPasswor
com.bea.medrec.service.impl.PatientServiceImpl.authenticateAndReturnPatient(java.lang.String, java.lang.String
```

From these basic events, JProfiler calculates more aggregated data as explained below. After an event has been processed, it can either be discarded or retained for inspection in the probe events view [p. 237] . You can make this decision yourself in the probe settings [p. 99] by choosing whether or not to record single events. By default, only the JEE probes are configured to record single events. In other probes, a lot of events can be generated very quickly. File I/O, for example produces a lot of events. To prevent excessive memory usage when single events are recorded, JProfiler **consolidates events**. The event cap is configured in the profiling settings [p. 88] and applies to all probes. Only the most recent events are retained, older events are discarded. This consolidation does not affect the higher-level views.

Payload

For events that have an associated stack trace, the probe can publish the event description as **payload** into the recorded call tree. The event description then becomes the **payload name**. If you record CPU data, you can open the call tree view in the CPU section and locate a call trace where a probe intercepts data, for example, a database connection executing JDBC statements. You will see a **payload container node** that contains the payload names that have been published, in our example the SQL strings.



Thread selection: All thread groups

Aggregation level: Methods

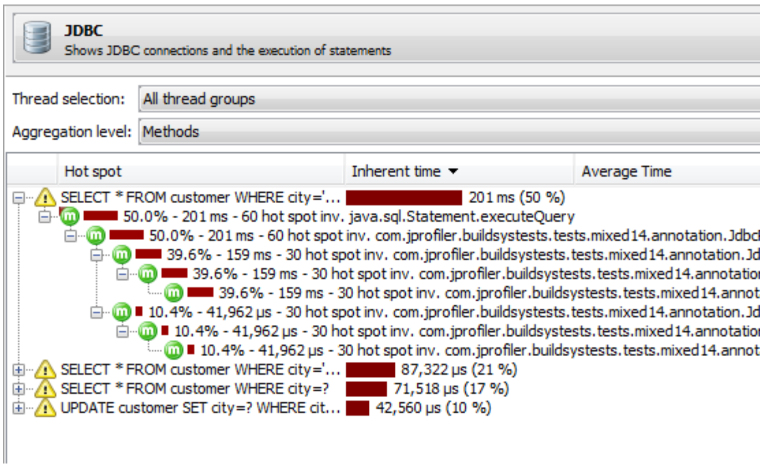
```
72.1% - 291 ms - 1 inv. com.jprofiler.buildsystests.RunTestAction.main
27.9% - 112 ms - 3 inv. com.jprofiler.buildsystests.tests.mixed14.annotation.JdbcProbeTestRun$MyRu
  23.0% - 92,925 µs - 3 inv. com.jprofiler.buildsystests.tests.mixed14.annotation.JdbcProbeTestRun
    23.0% - 92,919 µs - 3 inv. com.jprofiler.buildsystests.tests.mixed14.annotation.JdbcProbeTest
      18.3% - 73,986 µs - 3 inv. com.jprofiler.buildsystests.tests.mixed14.annotation.JdbcProbeT
        17.4% - 70,237 µs - 60 inv. java.sql.Statement.executeQuery
          JDBC calls
            67,426 µs - 30 evt. SELECT * FROM customer WHERE city='New York'
            4,996 µs - 30 evt. SELECT * FROM customer WHERE city='New York2'
        0.9% - 3,587 µs - 3 inv. java.sql.Connection.createStatement
        0.0% - 26 µs - 3 inv. java.sql.Statement.close
      4.7% - 18,921 µs - 3 inv. com.jprofiler.buildsystests.tests.mixed14.annotation.JdbcProbeTes
  4.8% - 19,425 µs - 3 inv. com.jprofiler.buildsystests.tests.mixed14.annotation.JdbcProbeTestRun.ac
  0.0% - 50 µs - 6 inv. java.lang.Thread.sleep
```

In the call tree, events with the same payload names and stack traces are aggregated. This means that at each stack trace, a particular payload name can occur only once. The number of invocations and the total times are displayed. Payload names are **consolidated on a per-call stack basis**, with oldest entries being aggregated into an "Earlier calls" node. By default, the maximum number of recorded payload names per call stack is 50.

If CPU data is not being recorded, payload information is still collected, just without the associated stack trace. Often you will use the "Sampling" mode for CPU profiling to reduce the overhead. This works fine for performance problems, but for probes you usually need exact stack trace information. This is why JProfiler by default determines the exact stack traces even if "Sampling" is chosen.

Hot Spots

From the payload information, JProfiler calculates payload hot spots, similar to the CPU hot spots. Payload names are aggregated over the entire call tree and sorted by their execution times. JProfiler calculates a tree of back traces that show you which call stacks have contributed how much time and how many invocations to the hot spot.



Thread selection: All thread groups

Aggregation level: Methods

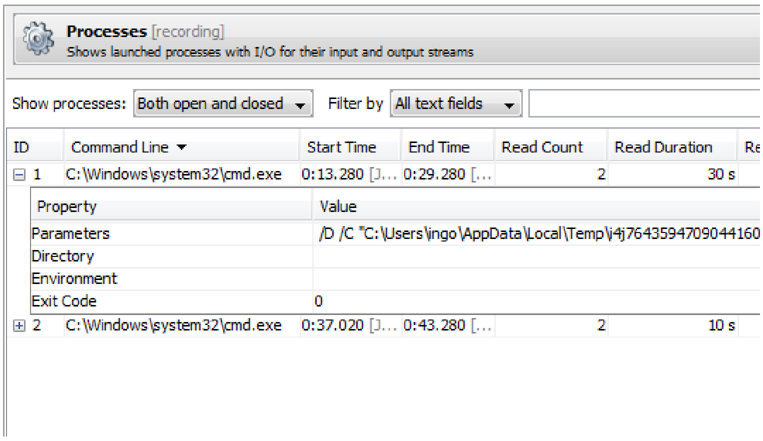
```
Hot spot                                    Inherent time ▼          Average Time
⊟ SELECT * FROM customer WHERE city='...   201 ms (50 %)
  ⊟ 50.0% - 201 ms - 60 hot spot inv. java.sql.Statement.executeQuery
    ⊟ 50.0% - 201 ms - 60 hot spot inv. com.jprofiler.buildsystests.tests.mixed14.annotation.Jdbc
      ⊟ 39.6% - 159 ms - 30 hot spot inv. com.jprofiler.buildsystests.tests.mixed14.annotation.Jd
        ⊟ 39.6% - 159 ms - 30 hot spot inv. com.jprofiler.buildsystests.tests.mixed14.annotatio
            39.6% - 159 ms - 30 hot spot inv. com.jprofiler.buildsystests.tests.mixed14.annot
      ⊟ 10.4% - 41,962 µs - 30 hot spot inv. com.jprofiler.buildsystests.tests.mixed14.annotation.Jd
        ⊟ 10.4% - 41,962 µs - 30 hot spot inv. com.jprofiler.buildsystests.tests.mixed14.annotatio
            10.4% - 41,962 µs - 30 hot spot inv. com.jprofiler.buildsystests.tests.mixed14.annot
⊞ SELECT * FROM customer WHERE city='...   87,322 µs (21 %)
⊞ SELECT * FROM customer WHERE city=?      71,518 µs (17 %)
⊞ UPDATE customer SET city=? WHERE cit...  42,560 µs (10 %)
```

If no CPU data is recorded, the back traces will only contain a "No CPU data was recorded" node. If CPU data was only partially recorded, there may be a mixture of these nodes with actual back traces.

Control Objects

An important concept in JProfiler's probes are **control objects**. Events are often bound to particular long-lived Java objects. For example, JDBC statements are associated with a JDBC connection and file I/O is associated with instances of `java.io.File`. These probe-specific control objects can be opened and closed via special event types.

Control objects are displayed in a separate view together with aggregated information from the associated events. For each event type, control objects show the aggregated event count and event duration. For events that measure throughput in bytes, the aggregated throughput is displayed as well. Furthermore, the probe can publish additional data for control objects that will help you with identifying and debugging control objects. For example, the processes probe publishes the command line parameters, the working directory, the special environment variables and the exit code of the process.


Processes [recording]
Shows launched processes with I/O for their input and output streams

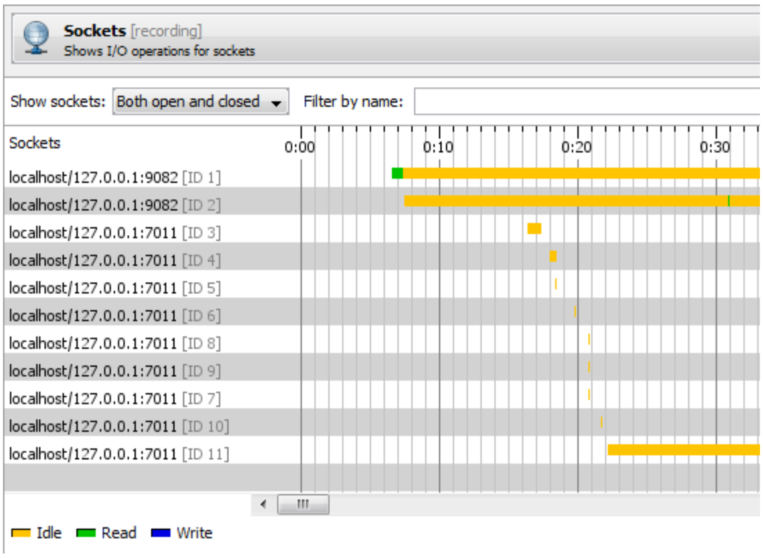
Show processes: Both open and closed

Filter by: All text fields

ID	Command Line ▼	Start Time	End Time	Read Count	Read Duration	Re
⊟ 1	C:\Windows\system32\cmd.exe	0:13.280 [J...	0:29.280 [...	2	30 s	
⊞ 2	C:\Windows\system32\cmd.exe	0:37.020 [J...	0:43.280 [...	2	10 s	

Property	Value
Parameters	/D /C "C:\Users\ingo\AppData\Local\Temp\i4j764359470904416O
Directory	
Environment	
Exit Code	0

Since control objects have a start and an end time, JProfiler shows them on a **time line** as horizontal bars. The events that are associated with a control object are shown in different colors on the bar in the time line. For example, read and write events in the socket probe are shown as different colors. If no event has taken place at a particular time, the probe is shown as idle. For example, a JDBC connection is idle, unless a JDBC statement is being executed. This status data is not taken from the list of events, which may be consolidated or not even available, but it is sampled every 100 ms from the last status.

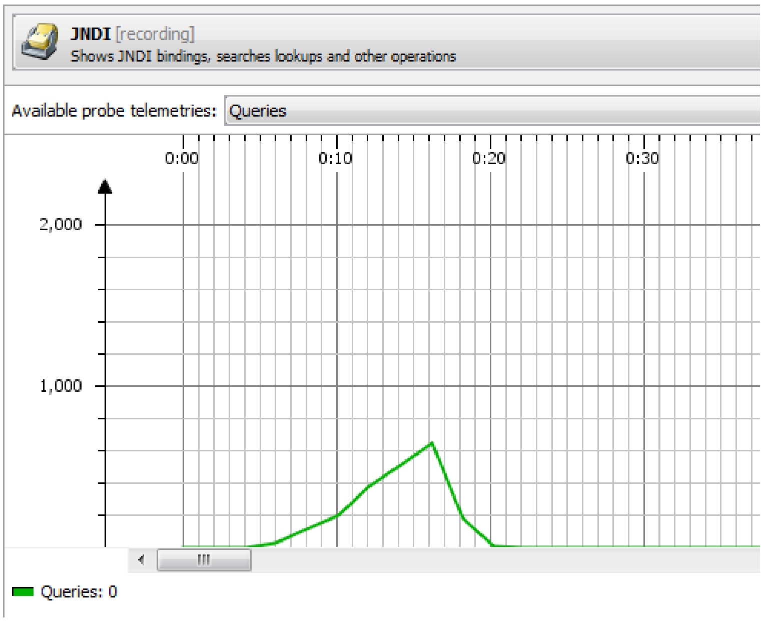


Show sockets: Both open and closed

localhost/127.0.0.1:9082 [ID 1]
localhost/127.0.0.1:9082 [ID 2]
localhost/127.0.0.1:7011 [ID 3]
localhost/127.0.0.1:7011 [ID 4]
localhost/127.0.0.1:7011 [ID 5]
localhost/127.0.0.1:7011 [ID 6]
localhost/127.0.0.1:7011 [ID 8]
localhost/127.0.0.1:7011 [ID 9]
localhost/127.0.0.1:7011 [ID 7]
localhost/127.0.0.1:7011 [ID 10]
localhost/127.0.0.1:7011 [ID 11]

Telemetries

As an even more aggregated form of data, probes can publish telemetries that show graphs of arbitrary measurements on a time axis. Telemetry data is determined once per second.

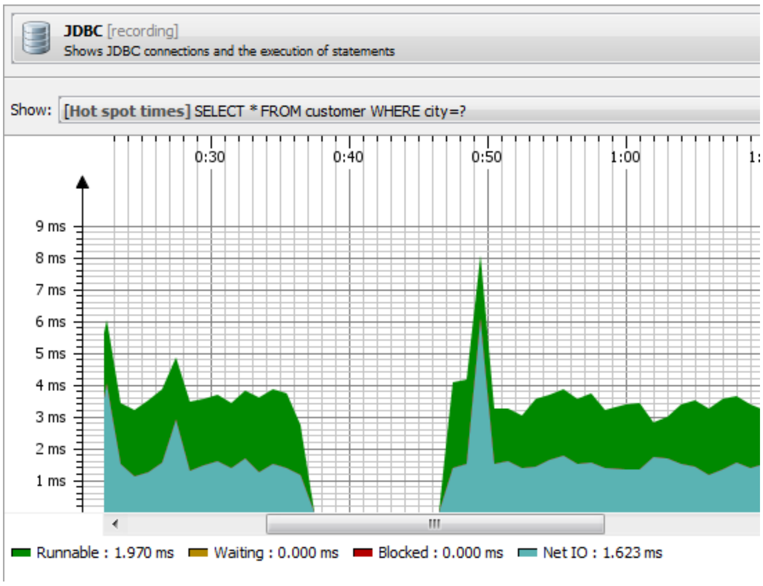


Available probe telemetries: Queries

Most telemetries of built-in probes in JProfiler are canonical aggregations, such as the number of open control objects, event counts per second or throughputs per second. Some telemetries are probe-specific such as the "Average statement execution time" telemetry of the JDBC probe.

Tracking

Telemetries concern the summed up state of everything that is measured by a probe. More fine-grained telemetries for selected control objects or hot spots are available in the probe tracker.



JDBC [recording]
Shows JDBC connections and the execution of statements

Show: **[Hot spot times]** SELECT * FROM customer WHERE city=?

Depending on the capabilities of the probe, you can track different measurements for different elements. For selected control objects, you can track event durations, event counts and event throughputs, for selected hot spots you can track execution times split into thread states and invocation counts.

A.5.2 Custom Probes

Introduction

If you want to collect information on a subsystem that is not covered by the built-in probes, JProfiler offers an API to write your own custom probes. There are two ways to develop and deploy a custom probe into the profiled application. You can write your custom probe in your IDE, add the compiled classes to the classpath, and add a special VM parameter to the invocation of the profiled application. Alternatively, you can create the probe directly in the JProfiler GUI by configuring the scripts in the custom probe wizard. In the latter case, no modification of the profiled application is necessary.

For an overview of the basic probe concepts, please see the corresponding help topic [p. 48] . An example of a custom probe is given in the *api/samples/probe* directory.

Probe Configuration

A probe is a Java class that implements one or both of the interfaces `com.jprofiler.api.agent.probe.InterceptorProbe` and `com.jprofiler.api.agent.probe.TelemetryProbe`. Both interfaces extend the base `com.jprofiler.api.agent.probe.Probe` interface which in itself is not sufficient to develop a useful probe.

Each probe is configured at startup when its `getMetaData()` method is called by the profiling agent. To get a meta data instance, call `com.jprofiler.api.agent.probe.ProbeMetaData#create(String name)` and continue calling configuration methods on the returned object. ProbeMetaData is a fluent interface, so you can append calls to its methods on the same line. The information you provide at **configuration time** via the ProbeMetaData is relevant when using the `com.jprofiler.api.agent.probe.ProbeContext` that is passed to you during **data-collection time**.

Several configuration methods determine the capabilities of the probe. For example, `metaData.payload(true).telemetry(true).events(true).controlObjectsView(true)` configures a probe that publishes data for all available views.

An easy way to configure an automatic telemetry is to call `ProbeMetaData#addOpenControlObjectTelemetry(String name)`. Custom telemetries can be configured with `ProbeMetaData#addCustomTelemetry(String name, Unit unit, float factor)`.

Importantly for the time line and events views, you can configure custom event types with `ProbeMetaData#customTypeNames(String[] names)` and assign custom colors to them with `ProbeMetaData#customColors(String[] names)`.

Events and control objects can receive additional data, which is configured with `ProbeMetaData#addAdditionalData(String name, DataType dataType)` for events and `ProbeMetaData#addAdditionalControlObjectData(String name, DataType dataType, boolean nested)` for control objects.

Interceptor Probes

An interceptor probe gets the opportunity to intercept selected methods. It is queried at startup for the methods that should be instrumented and notified each time one of those methods is called. To the interception methods an instance of `com.jprofiler.api.agent.probe.InterceptorContext` is passed which contains methods for publishing payload information and creating events.

Because methods can be intercepted recursively, you should use `InterceptorContext#push(PayloadInfo)` to save a payload at method entry and `InterceptorContext#pop()` to retrieve it at method exit. The payload stack is thread-local, so it also works in multi-threaded situations. Finally you can call `calculateTime()` on the payload info object and publish it with `InterceptorContext#addPayloadInfo(PayloadInfo)`.

Control objects are registered by creating an open event with `ProbeContext#createOpenEvent(String description, Object controlObject)` and are closed by creating a close event with `ProbeContext#createCloseEvent(String description, Object controlObject)`. If you have configured additional data for control objects, you create the open event with `ProbeContext#createOpenEvent(String description, Object controlObject, Object[] controlObjectData)` instead.

Custom events for particular control objects are created with `ProbeContext#createCustomEvent(String description, int type, Object controlObject)`. If you do not use control objects, just pass `null` as the last parameter of this method. The type ID is the index in the array argument that was passed to `ProbeMetaData#customTypeNames(String[] names)` at configuration time. If you have configured additional data for events, you supply it by calling `ProbeEvent#additionalData(Object[] additionalData)` on the event.

Note that all created events have to be published by calling `ProbeContext#addEvent(ProbeEvent)`.

Telemetry Probes

A telemetry probe is called via its `fillTelemetryData(ProbeContext probeContext, int[] data, int duration)` method and thus periodically gets a chance to publish its telemetry data. The indices in the data array correspond to the invocations of `ProbeMetaData#addCustomTelemetry(String name, Unit unit, float factor)` in the meta-data configuration.

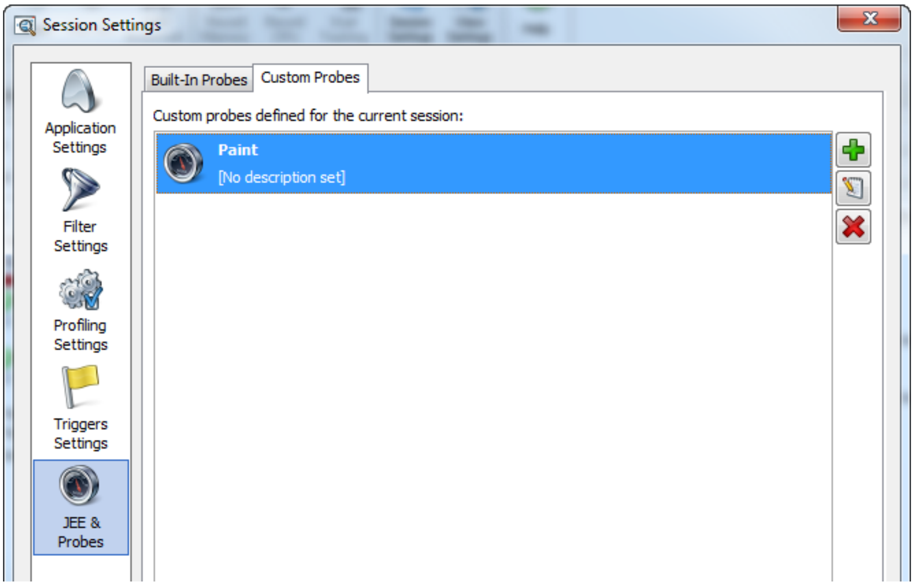
Since telemetry information is not related to payloads, to telemetry probes an instance of `com.jprofiler.api.agent.probe.ProbeContext` is passed rather than an instance of the derived `com.jprofiler.api.agent.probe.InterceptorContext` that is passed to the interception methods of telemetry probes. A probe can take both roles and implement both the interface for an interceptor probe and the interface for a telemetry probe.

Manual Probe Registration

To manually register a probe in the profiled application, you have to create a class that implements `com.jprofiler.api.agent.probe.ProbeProvider`. Its `getProbes()` method can return one or several probes. Then, you have to pass the VM parameter `-Djprofiler.probeProvider=[fully-qualified-class]` to the profiled JVM. The probe provider is instantiated at startup.

Custom Probe Wizard

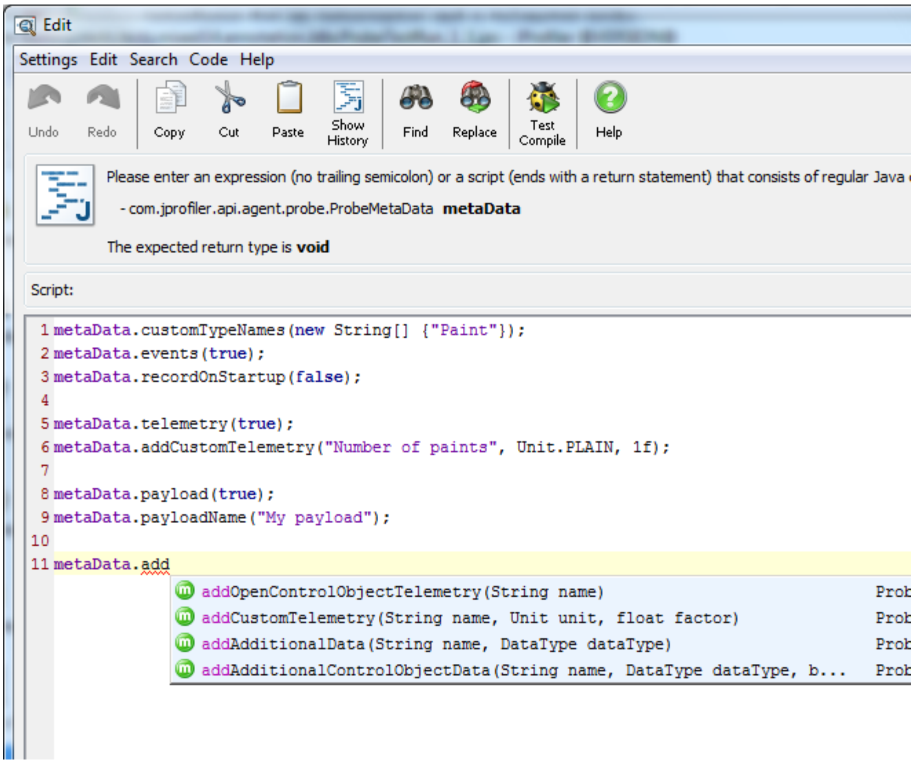
Developing probes in an IDE, compiling them against the JProfiler API and deploying them to the profiled application together with the modification of the java command can be quite inconvenient. JProfiler offers an easier way to quickly develop and deploy custom probes without the need to use an IDE or modify the profiled application. The custom probe wizard [p. 101] leads you step by step through the creation of a custom probe.



Custom probes defined for the current session:

Paint
[No description set]

First, you define the meta data script, to which an instance of `com.jprofiler.api.agent.probe.ProbeMetaData` is already passed. The script editor in JProfiler offers code analysis, code completion and context-sensitive Javadoc.



Please enter an expression (no trailing semicolon) or a script (ends with a return statement) that consists of regular Java

- com.jprofiler.api.agent.probe.ProbeMetaData **metaData**

The expected return type is **void**

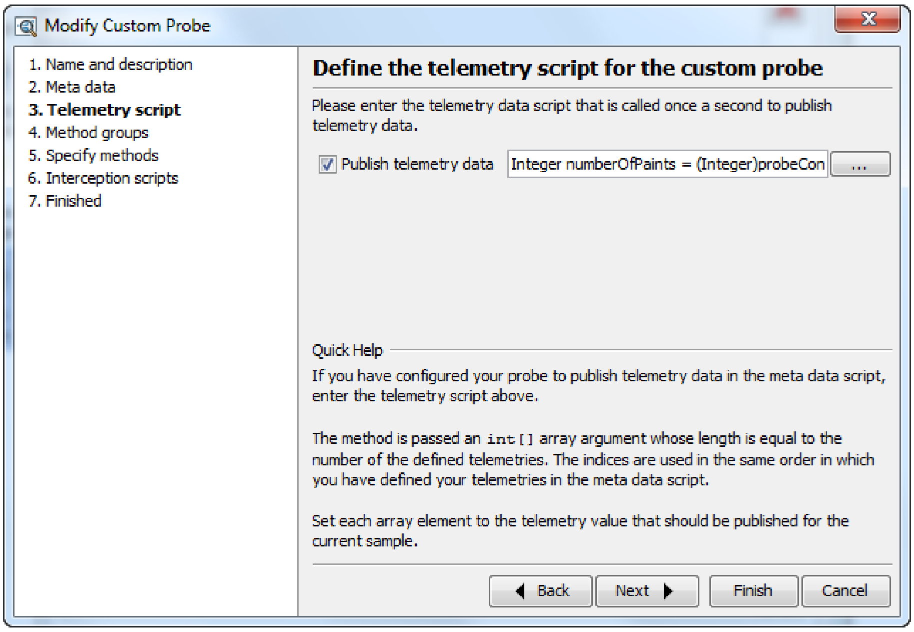
```
metaData.customTypeNames(new String[] {"Paint"});
metaData.events(true);
metaData.recordOnStartup(false);

metaData.telemetry(true);
metaData.addCustomTelemetry("Number of paints", Unit.PLAIN, 1f);

metaData.payload(true);
metaData.payloadName("My payload");

metaData.add
                 addOpenControlObjectTelemetry(String name)                              Prob
                 addCustomTelemetry(String name, Unit unit, float factor)                Prob
                 addAdditionalData(String name, DataType dataType)                       Prob
                 addAdditionalControlObjectData(String name, DataType dataType, b...     Prob
```

Custom probes defined in the JProfiler GUI are both interceptor and telemetry probes. You can optionally define a telemetry script in the custom probe wizard that will be called every second.



Define the telemetry script for the custom probe

Please enter the telemetry data script that is called once a second to publish telemetry data.

☑ Publish telemetry data: `Integer numberOfPaints = (Integer)probeCon`

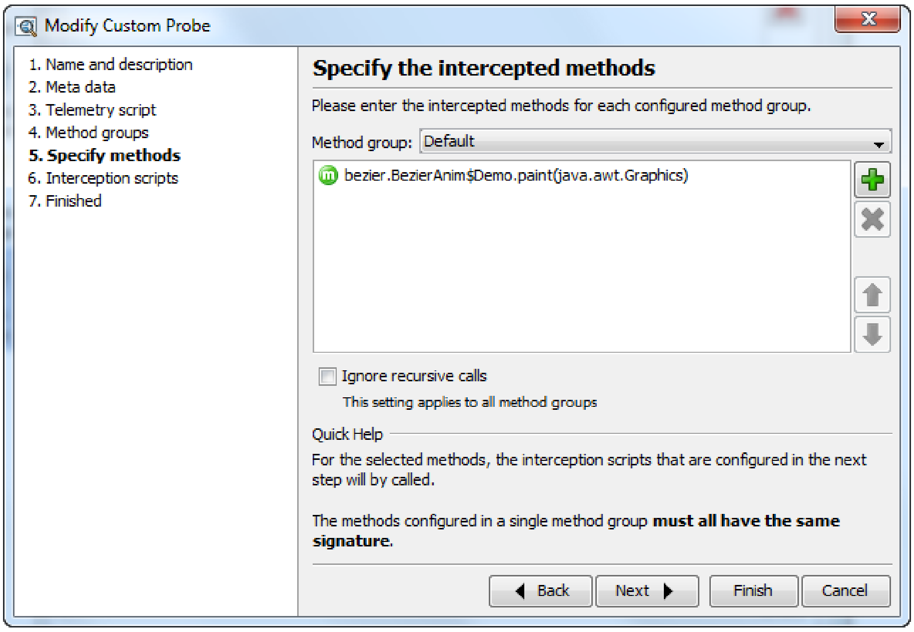
Quick Help

If you have configured your probe to publish telemetry data in the meta data script, enter the telemetry script above.

The method is passed an `int[]` array argument whose length is equal to the number of the defined telemetries. The indices are used in the same order in which you have defined your telemetries in the meta data script.

Set each array element to the telemetry value that should be published for the current sample.

Selecting methods for interception is also much easier in the JProfiler GUI compared to writing probes manually. You just choose the methods from a list of all methods found in the profiled JVM.



Specify the intercepted methods

Please enter the intercepted methods for each configured method group.

Method group: Default

bezier.BezierAnim$Demo.paint(java.awt.Graphics)

☐ Ignore recursive calls

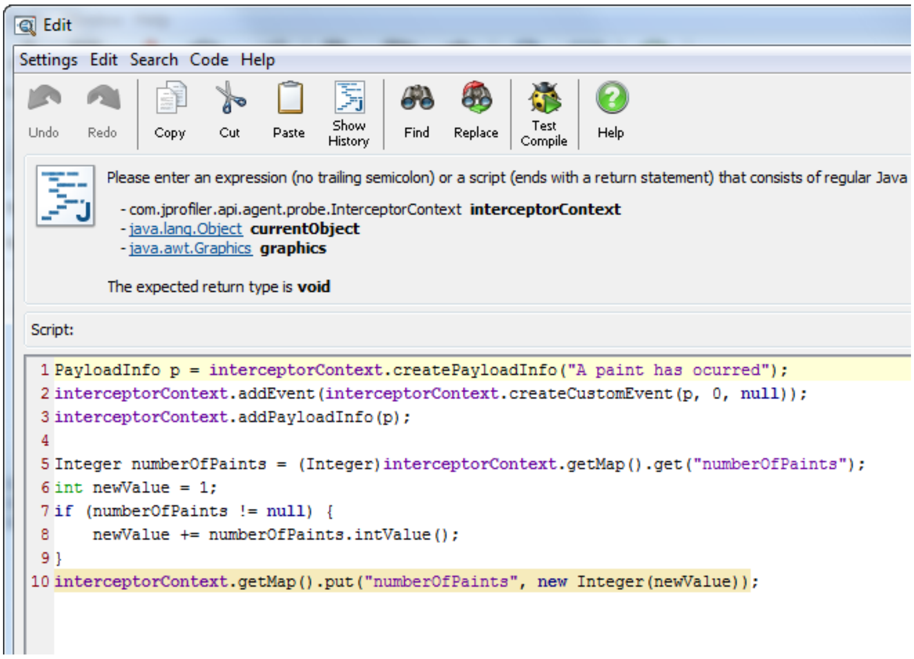
This setting applies to all method groups

Quick Help

For the selected methods, the interception scripts that are configured in the next step will by called.

The methods configured in a single method group **must all have the same signature**.

There are three interception scripts for method entry, exit and exception exit. You configure them for different groups of methods with the same signature. The method arguments of the intercepted method are passed to the method entry script together with the interceptor context and the current object.



Please enter an expression (no trailing semicolon) or a script (ends with a return statement) that consists of regular Java

- com.jprofiler.api.agent.probe.InterceptorContext **interceptorContext**
- java.lang.Object **currentObject**
- java.awt.Graphics **graphics**

The expected return type is **void**

Script:

```java
PayloadInfo p = interceptorContext.createPayloadInfo("A paint has ocurred");
interceptorContext.addEvent(interceptorContext.createCustomEvent(p, 0, null));
interceptorContext.addPayloadInfo(p);

Integer numberOfPaints = (Integer)interceptorContext.getMap().get("numberOfPaints");
int newValue = 1;
if (numberOfPaints != null) {
    newValue += numberOfPaints.intValue();
}
interceptorContext.getMap().put("numberOfPaints", new Integer(newValue));
```

Custom Probe Vs. Trigger

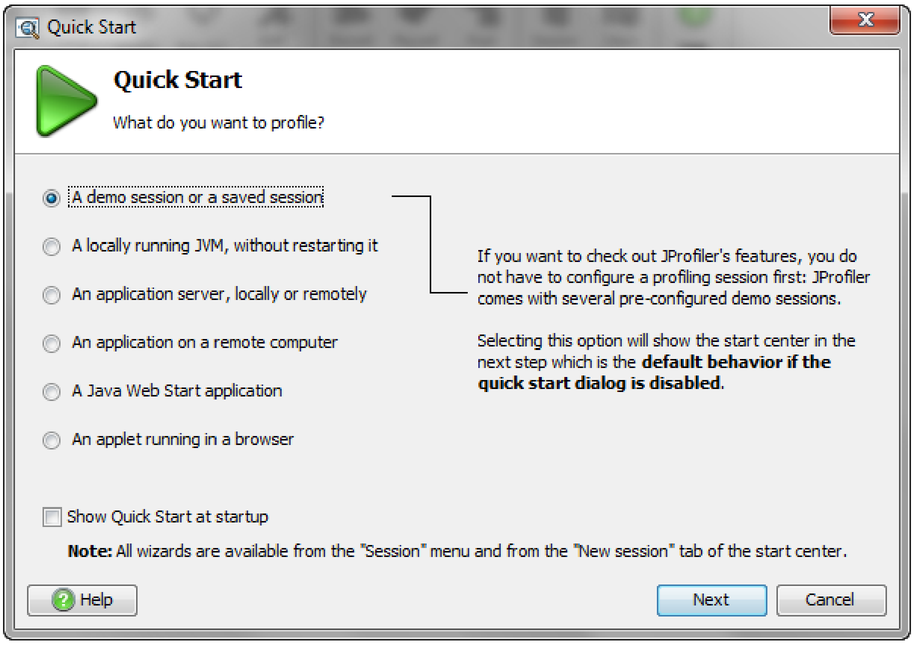
If you just want to intercept a method and invoke your own code there without collecting any data, it is recommended to use a method trigger [p. 92] with a "Run interceptor script" action. In this way you do not have to provide the probe meta data. Also, method triggers can be added conveniently via the context menu in the call tree view.

B Reference

B.1 Getting Started

B.1.1 Quickstart Dialog

By default, the quickstart dialog is shown when JProfiler is started. It contains a number of shortcuts that help to to get started with profiling your application. The manual configuration dialog as well as all integration wizards are also available on the "New session" tab of the start center [p. 60] . Once you're familiar with JProfiler you can turn off the quickstart dialog by deselecting the check box `show quickstart at startup` at the bottom.



Quick Start

Quick Start

What do you want to profile?

● A demo session or a saved session
○ A locally running JVM, without restarting it
○ An application server, locally or remotely
○ An application on a remote computer
○ A Java Web Start application
○ An applet running in a browser

If you want to check out JProfiler's features, you do not have to configure a profiling session first: JProfiler comes with several pre-configured demo sessions.

Selecting this option will show the start center in the next step which is the **default behavior if the quick start dialog is disabled**.

☐ Show Quick Start at startup

Note: All wizards are available from the "Session" menu and from the "New session" tab of the start center.

You can access the quickstart dialog at at any later time by pressing `SHIFT-F1` or by choosing *Help->Show quickstart dialog* from JProfiler's main menu.

B.1.2 Running The Demo Sessions

For a quick tour of JProfiler's features, please run the **demo sessions**:

1. Start up JProfiler and wait for the start center [p. 60] to appear.
2. Choose one of the demo sessions from the list of available sessions.
3. Click **[OK]**.
4. The profiling settings dialog appears. To accept the default settings, just click **[OK]**.
5. A terminal window is opened for the demo process and the main window of JProfiler starts displaying profiling information [p. 127] .

The Java source code for the demo sessions can be found in *`"{JProfiler install directory}/demo/"`*>

B.1.3 Overview Of Features

JProfiler's features are ordered into view sections. A view section can be made visible by selecting in JProfiler's sidebar. JProfiler offers the following view sections:

- Memory profiling [p. 140]

  Keep track of your objects and find out where the problem spots are.
- The heap walker [p. 158]

  Use the drill down capabilities of JProfiler's unique heap walker to find memory leaks.
- CPU profiling [p. 190]

  Find out where your CPU time is going and zero in on performance bottlenecks.
- Thread profiling [p. 213]

  Check the activity of your threads, resolve deadlocks and get detailed information on your application's monitor usage.
- VM telemetry information [p. 227]

  Unfold the statistical history of your application with JProfiler's virtual machine telemetry monitors.
- JEE & probes [p. 229]

  Measure higher-level subsystems of the JVM, like JDBC calls or file I/O, as well as own subsystems with custom probes.

In order to help you find JProfiler's features which are most important to you, we present a situational overview. There are two types of uses for a profiler which arise from different motivations:

- **Problem solving**

  If you turn to a profiler with a problem in your application, it most likely falls into one of the following three categories:

  - **Performance problem**

    To find performance related problem spots in your application, turn to JProfiler's CPU section [p. 190] . Often, performance problems are caused by excessive creation of temporary objects. For that case, the recorded objects views [p. 143] with its view mode set to "garbage collected objects" will show you where efforts to reduce allocations make sense.

    For I/O or any other subsystem that is measured by a probe, the probe views [p. 229] show you higher-level information on what operations take a lot of time.
  - **Excessive memory consumption**

    If your application consumes too much memory, the memory views [p. 140] will show you where the memory consumption comes from. With the reference views [p. 169] in the heap walker [p. 158] you can find out which objects are unnecessarily kept alive in the heap.
  - **Memory leak**

    If your application's memory consumption goes up linearly with time, you likely have a memory leak which is show stopper especially for application servers. The "mark current values and show differences" feature in the memory section [p. 140] and the heap walker [p. 158] will help you to find the cause.
  - **Deadlock**

    If you experience a deadlock, JProfiler's current monitor graph [p. 221] will help you to find the cause even for complex locking situations.
  - **Hard to find bug**

    A often overlooked but highly profitable use of a profiler is that of debugging. Many kinds of bugs are exceptionally hard to find by hand or by using a traditional debugger. Some bugs revolve around complex call stack scenarios (have a look at the CPU section [p. 190]), others around entangled object reference graphs (have a look at the heap walker section [p. 158]), both of which are not easy to keep track of.

  Particularly JProfiler's thread views [p. 213] are of great help in multi-threaded situations, where race-conditions and deadlocks are hard to track down.

- **Quality assurance**

  During a development process, it's a good idea to regularly run a profiler on your application to assess potential problem spots. Even though an application may prove to be "good enough" in test cases, an awareness for performance and memory bottlenecks enables you adapt your design decisions as the project evolves. In this way you avoid costly re-engineering when real-world needs are not met. Use the information presented in JProfiler's telemetry section [p. 227] to keep an eye on the evolution of your application. The ability to save profiling snapshots [p. 115] enables you to keep track of your project's evolution. The offline profiling [p. 259] capability allows you to perform automated profiling runs on your application.

B.1.4 JProfiler's Start Center

When JProfiler is started, the **start center** window appears. The start center is composed of three tabs:

- **Open session**

  All sessions configured by you or the preconfigured demo sessions can be started by double clicking on a session or by selecting a session and clicking **[OK]** at the bottom of the start center. In addition, sessions can be edited [p. 74] , copied or deleted by using the buttons on the right hand side of the dialog or by invoking the context menu.
- **New session**

  Sessions can be created in one of two ways:

  - **By manual configuration**

    Use the **[New session]** button to manually configure [p. 75] a new session. After you finish configuring your session, it will be started.
  - **Through an integration wizard**

    Use the **[New server integration]** button to invoke the integration wizard [p. 61] selector. The **[New remote integration]** and **[New applet integration]** buttons are convenience shortcuts. After you finish configuring your session, you can either start the session immediately or the "open session" tab will be displayed with the new session selected.

- **Convert session**

  Here, you can convert existing launched application sessions to remote sessions or offline profiling sessions [p. 259] or prepare a launched application session for redistribution to other computers. The latter will also collect all files for the agent that are necessary to get the agent running on remote machines. The existing launched application session that is chosen for conversion will not be modified.
- **Open snapshot**

  Previously saved sessions [p. 115] can be opened from this tab by selecting `Open a single saved snapshot` and selecting the desired *`*.jps`* file. Also, you can select "Compare multiple snapshots" to create snapshot comparisons [p. 240] .

When you choose not to open a profiling session for an empty window and exit the start center by clicking the **[Cancel]** button, all of JProfiler's views are disabled and only the general settings (*Session->General settings*) and the *Session* and *Help* menus are enabled.

The start center can be invoked at any later time

- by choosing *Session->Start center* or clicking on the corresponding toolbar button.

  If a session is currently active upon opening a session, it will be stopped after a confirmation dialog and the new session will replace all profiling data of the old session.
- by choosing *Session->Start center in new window*. A new main window of JProfiler will be opened, other active sessions will not be affected.

B.1.5 Application Server Integration

JProfiler's application server integration wizard makes profiling application servers especially easy. It can be invoked in one of two ways:

- from the start center [p. 60] on the "new session" tab.
- by selecting *Session->New server integration* from JProfiler's main menu.

During the first step of the wizard you are asked to specify the product which is to be integrated. The second step asks you whether the profiled application or application server is running on the local computer or on a remote machine. In the third step you choose the desired startup mode which is one of "Wait for connection", "Startup immediately" and "Offline profiling". The "Wait for connection" is recommended at first. Only choose the other modes later on once you are familiar with JProfiler.

The subsequent steps depend on this choice. Please follow the instructions presented by the wizard.

If you miss support for a particular product, please don't hesitate to contact us through the support request form

If no GUI is available on the remote machine you can use the `jpintegrate` executable in the *`bin`* directory for the **console integration wizard**.

The console integration wizard will create a config file that can be imported [p. 117] in a JProfiler GUI installation to connect zo the profiled application server without any further configuration.

B.1.6 IDE Integration

JProfiler integrates seamlessly into several popular IDEs [p. 63] . To bring up the integration dialog, please select *Session->IDE integrations* from JProfiler's main menu.

Select the desired IDE from the drop down list and click on **[Integrate]**. After completing the instructions, you can invoke JProfiler from the integrated IDE without having to specify class path, main class, working directory, used JVM and other options again. Also, source code navigation will be performed in the IDE where possible.

See here [p. 63] for specific explanations regarding each IDE integration.

B.1.7 JProfiler Licensing

Without a valid license, JProfiler cannot be started. If you don't have a key, visit www.jprofiler.com; to get an evaluation key or to buy a license. If you have already obtained an evaluation key and were not able to evaluate JProfiler, please write to sales@ej-technologies.com to request a new key. JProfiler 5 does not work with license keys for lower versions. Please upgrade your license on our website.

You can enter your license key in one of two ways:

- In JProfiler's setup wizard
- Through JProfiler's main menu: *Help->Enter license key*

Together with your license key, you are asked for your name and - if applicable - for the name of your company.

Please read the included file *`license.html`* to learn about the scope of the license.

To make it easier for you to enter the license key, you can use the **[Paste from clipboard]** button, after copying any text fragment which contains the license key to your system clipboard. If a valid license key can be found in the clipboard content, it is extracted and displayed in the dialog.

B.2 IDE Integrations

B.2.1 JProfiler IDE Integrations

JProfiler can be integrated into the IDEs listed here [p. 63] . Installation is done either

- **Automatically (recommended)**

  Select *Session->IDE integrations* from JProfiler's main menu or go to the IDE integrations tab [p. 121] in the general settings dialog [p. 118] . Now select the desired IDE from the drop down list, click on **[Integrate]** and follow the instructions [p. 121] .
- **Manually**

  The directory *`integrations`* in the JProfiler install directory holds a number of archives which can be used for manually integrating JProfiler with any of the supported IDEs. See the file *`README.txt`* in the above directory for detailed instructions.

After completing the instructions, you can invoke JProfiler from the integrated IDE without having to specify class path, main class, working directory, used JVM and other options again.

All integrations insert toolbar buttons and menu entries into the respective IDE that run the application in the IDE with profiling enabled. On Windows and Mac OS X, the IDE reuses an already running instance of JProfiler to present profiling data. If JProfiler is not running, it will be started automatically.

Navigation to source code from JProfiler will be performed in the IDE, i.e. if you choose the "Show source" action for a class or a method, it will be displayed in the IDE and not in JProfiler's integrated source code viewer.

B.2.2 JProfiler As An IntelliJ IDEA Plugin

With JProfiler integrated into JetBrain's IntelliJ IDEA, JProfiler can be invoked from within the IDE without any further need for session configuration.

Requirements: IDEA 6.x, 7.x., 8.x, 9.x or 10.x

The installation of the IntelliJ IDEA plugin is started by selecting "IntelliJ IDEA [your version]" on the

- IDE integration tab of JProfiler's setup wizard
- miscellaneous options tab [p. 121] of JProfiler's general settings [p. 118] (use *Session->IDE integrations* in JProfiler's main menu as a shortcut).

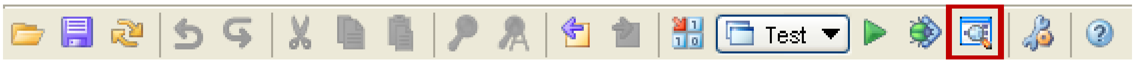
and clicking on **[Integrate]**

Reminder: Please close IntelliJ IDEA while performing the plugin installation. If you are performing the installation from JProfiler's setup wizard, please complete the entire setup first before starting IntelliJ IDEA.

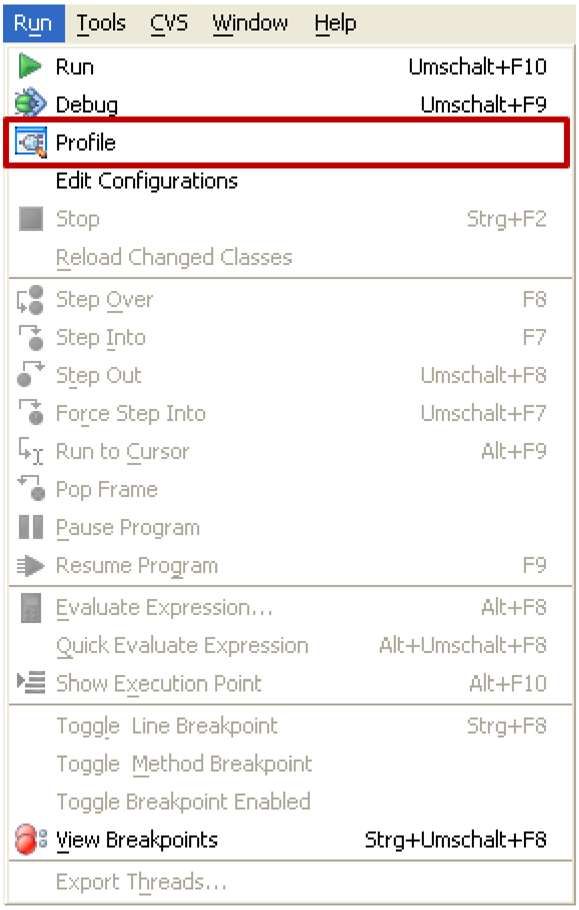
A file selector will then prompt you to locate the installation directory of IntelliJ IDEA.

After acknowledging the completion message, you can start IntelliJ IDEA and check whether the installation was successful. You should now see a menu entry *Run->Profile* in IDEA's main menu.

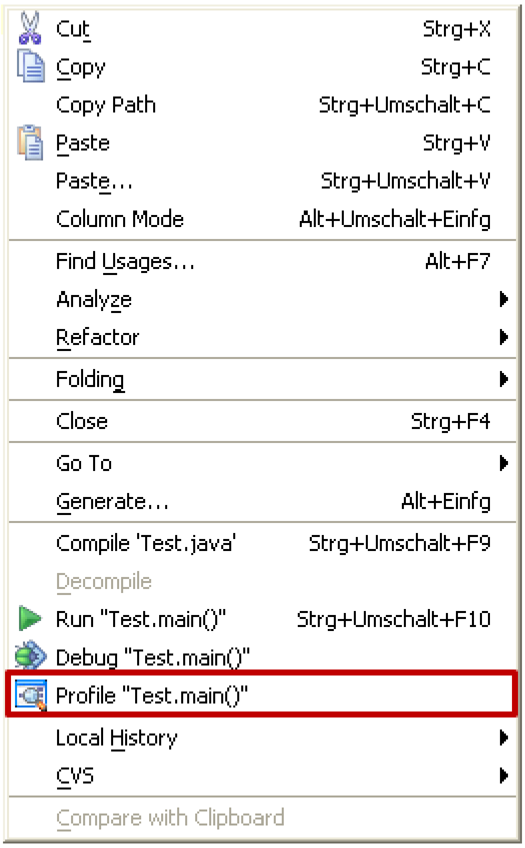
To profile your application from IntelliJ IDEA, choose one of the profiling commands in the *Run* menu, the context menu in the editor, or click on the corresponding toolbar button.



Main toolbar with "Profile" button

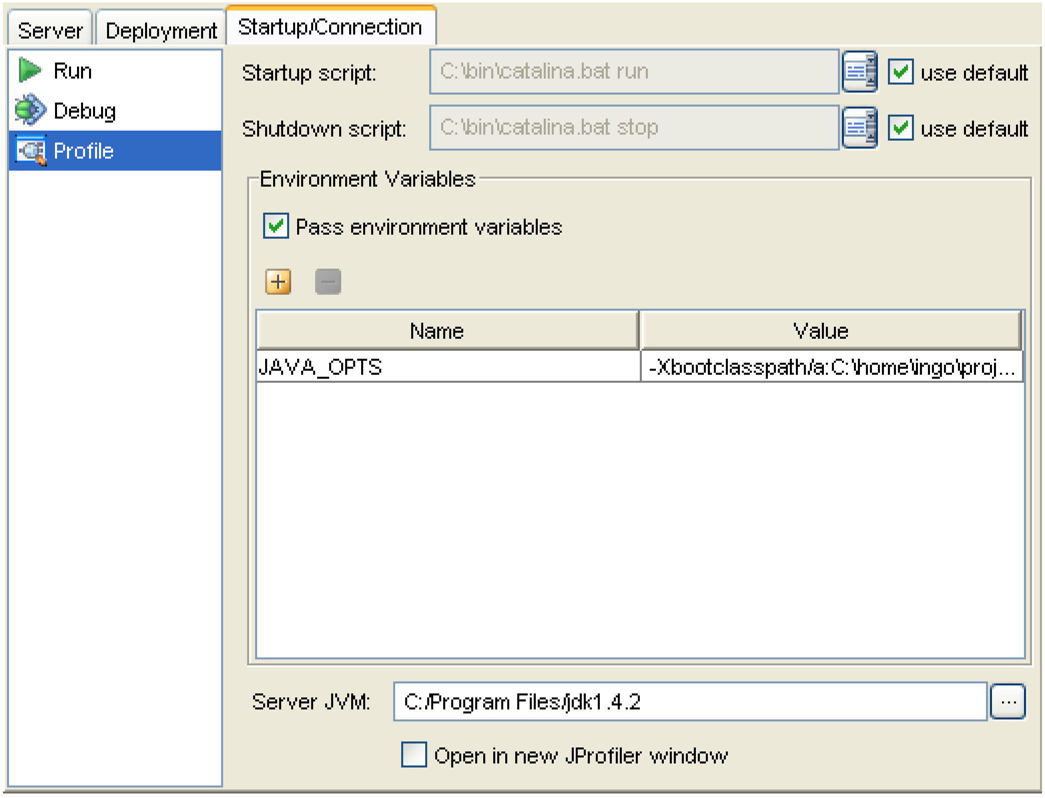


"Run" menu with "Profile" action



Editor context menu with "Profile" action

JProfiler can profile all run configuration types from IDEA, also applications servers. To configure further settings, please edit the run configuration, choose the "Startup/Connection" tab, and select the "Profile" entry. The screen shot below shows the startup settings for a local server configuration. Depending on the run configuration type, you can adjust JVM options or retrieve profiling parameters for remote profiling.



Startup script: C:\bin\catalina.bat run ☑ use default

Shutdown script: C:\bin\catalina.bat stop ☑ use default

Environment Variables

☑ Pass environment variables

Name	Value
JAVA_OPTS	-Xbootclasspath/a:C:\home\ingo\proj...

Server JVM: C:/Program Files/jdk1.4.2

☐ Open in new JProfiler window

Startup settings for profiling of a local server configuration

For all run configuration types you can decide whether you want to open a new window in JProfiler for the profiling session or if you wish to reuse the last window to accommodate the profiling session.

The profiled application is then started just as with the usual "Run" commands. If no instance of JProfiler is currently running, JProfiler is also started, otherwise the running instance of JProfiler will be used for presenting profiling data.

When JProfiler is started from IntelliJ IDEA, the "Show source" action for a class or a method in one of JProfiler's view will show the source element in IDEA and not in JProfiler's integrated source code viewer.

You can also open JProfiler snapshots from IDEA, either from the project window or the open file dialog in order to get source code navigation into IDEA.

With the *Run->Attach JProfiler to JVM* menu item, you can **attach JProfiler to any locally started JVM** and get source code navigation in the IDE. Please see the help on attaching to JVMs [p. 104] for more information on attach mode.

In order to change the used JProfiler installation from IntelliJ IDEA, please do the following:

1. Select "Edit Configurations" from the "Run" drop down menu
2. Select "Application" under "Defaults" in the dialog box (or any existing run configuration)
3. Select the "Startup/Connection" tab
4. Select "JProfiler" in the list
5. Click on the "Select JProfiler Executable" button
6. Choose the JProfiler executable, which is

   - [JProfiler installation directory]\bin\jprofiler.exe on Windows

- [JProfiler installation directory]/bin/jprofiler on Linux/Unix
- [JProfiler installation directory]/bin/macos/jprofiler.sh on Mac OS X

B.2.3 JProfiler As An Eclipse 3.x Plugin

When JProfiler is integrated into the eclipse 3.x IDE, JProfiler can be invoked from within the IDE without any further need for session configuration. Profiling **WTP run configurations** is supported by the JProfiler plugin.

Requirements: . eclipse 3.3, 3.4, 3.5, 3.6, or 3.7. The eclipse 3.x plugins work with **the full SDKs for** eclipse 3.x. The JProfiler integration does not work with partial installations of the eclipse framework.

The installation of the eclipse plugin is started by selecting "eclipse [your version]; on the

- IDE integration tab of JProfiler's setup wizard
- miscellaneous options tab [p. 121] of JProfiler's general settings [p. 118] (use *Session->IDE integrations* in JProfiler's main menu as a shortcut).

and clicking on **[Integrate]**

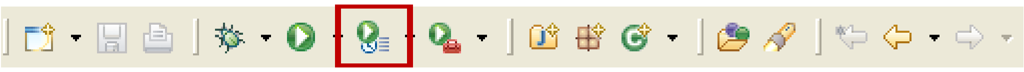
Reminder: Please close eclipse while performing the plugin installation. If you are performing the installation from JProfiler's setup wizard, please complete the entire setup first before starting eclipse.

A file selector will then prompt you to locate the **installation directory** of eclipse.

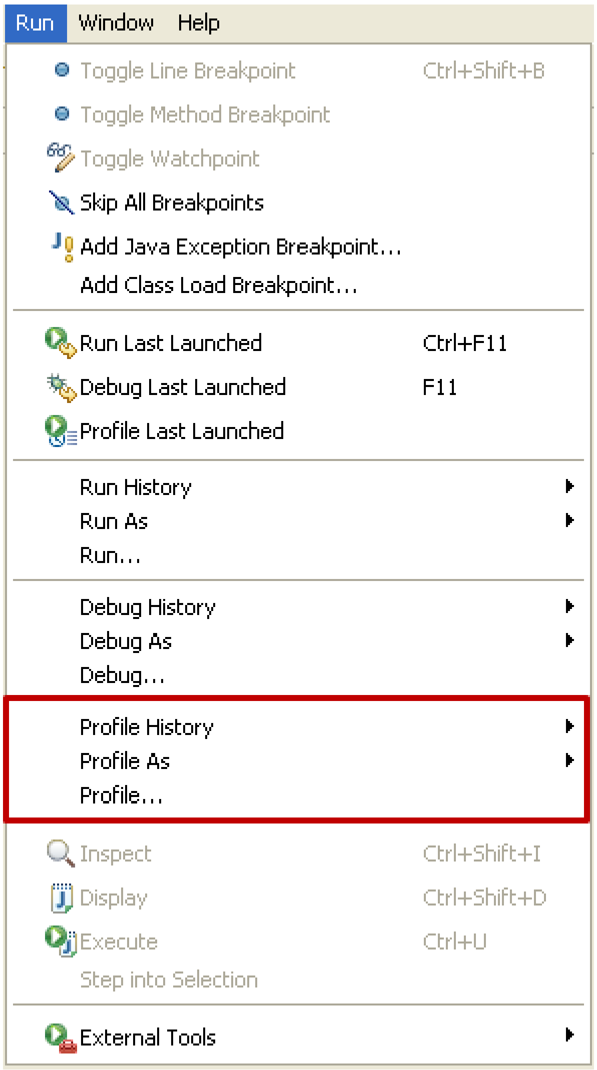
After acknowledging the completion message, you can start eclipse and check whether the installation was successful. If the menu item *Run->Profile ...* does not exist in the **Java perspective**, please enable the "Profile" actions for this perspective under *Window->Customize perspective* by bringing the **Command** tab to front and selecting the "Profile" checkbox.

eclipse provides shared infrastructure for profiling plugins that allows only one active profiler at a time. If another profiler has registered itself in eclipse, JProfiler will show a collision message dialog at startup. Please go to the `plugin` directory in your eclipse installation and delete the plugins that are specified in the warning message in order to guarantee that JProfiler will be used when you click on one of the profiling actions.

To profile your application from eclipse, choose one of the profiling commands in the *Run* menu or click on the corresponding toolbar button. The profile commands are equivalent to the debug and run commands in eclipse and are part of eclipse's infrastructure.



Main eclipse toolbar with "Profile" button



eclipse "Run" menu with "Profile" actions

The profiled application is then started just as with the usual "Run" commands. If no instance of JProfiler is currently running, JProfiler is also started, otherwise the running instance of JProfiler will be used for presenting profiling data.

Every time a run configuration is profiled, a dialog box is brought up that asks you whether a new window should be opened in JProfiler. To get rid of this dialog, you can select the "Don't ask me again" checkbox. The window policy can subsequently be configured in the JProfiler settings in eclipse (see below).

All profiling settings and view settings changes are persistent across session restarts.

When JProfiler is used with the eclipse integration, the "Show source" action for a class or a method in one of JProfiler's view will show the source element in eclipse and not in JProfiler's integrated source code viewer.

You can also open JProfiler snapshots from eclipse, either from the project window or the open file dialog in order to get source code navigation into eclipse.

With the *Run->Attach JProfiler to JVM* menu item, you can **attach JProfiler to any locally started JVM** and get source code navigation in the IDE. Please see the help on attaching to JVMs [p. 104] for more information on attach mode.

Several JProfiler-related settings can be adjusted in eclipse under *Window->Preferences->JProfiler*:

- The used **JProfiler installation** can be changed by repeating the integration from JProfiler or by adjusting the JProfiler executable in the corresponding text field. When you upgrade to a newer version of JProfiler, make sure to repeat the integration, since the plugin has to be updated, too.
- The **window policy** can be configured as
  - **Ask each time**

    Every time you profile a run configuration, a dialog box will ask you whether a new window should be opened in JProfiler. This is the default setting.
  - **Always new window**

    Every time you profile a run configuration, a new window will be opened in JProfiler.
  - **Reuse last window**

    Every time you profile a run configuration, the last window will be reused in JProfiler.
- You can manually repeat the **collision detection** that is performed at startup. With the corresponding checkbox, you can also switch off collision detection at startup.
- You can ask JProfiler to always use **interpreted mode** for profiling. A separate checkbox tells JProfiler to use the **deprecated JVMPI interface** when profiling with a 1.5 JRE. Both these settings are trouble-shooting options and should normally not be selected.

B.2.4 JProfiler As A JDeveloper Addin

With JProfiler integrated into Oracle's JDeveloper, JProfiler can be invoked from within the IDE without any further need for session configuration.

Requirements: JProfiler requires JDeveloper 10.1.3 or JDeveloper 11g.

The installation of the JDeveloper addin is started by selecting "JDeveloper [your version]" on the

- IDE integration tab of JProfiler's setup wizard
- miscellaneous options tab [p. 121] of JProfiler's general settings [p. 118] (use *Session->IDE integrations* in JProfiler's main menu as a shortcut).

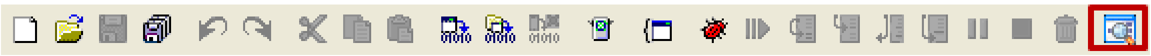
and clicking on **[Integrate]**

Reminder: Please close JDeveloper while performing the addin installation. If you are performing the installation from JProfiler's setup wizard, please complete the entire setup first before starting JDeveloper.

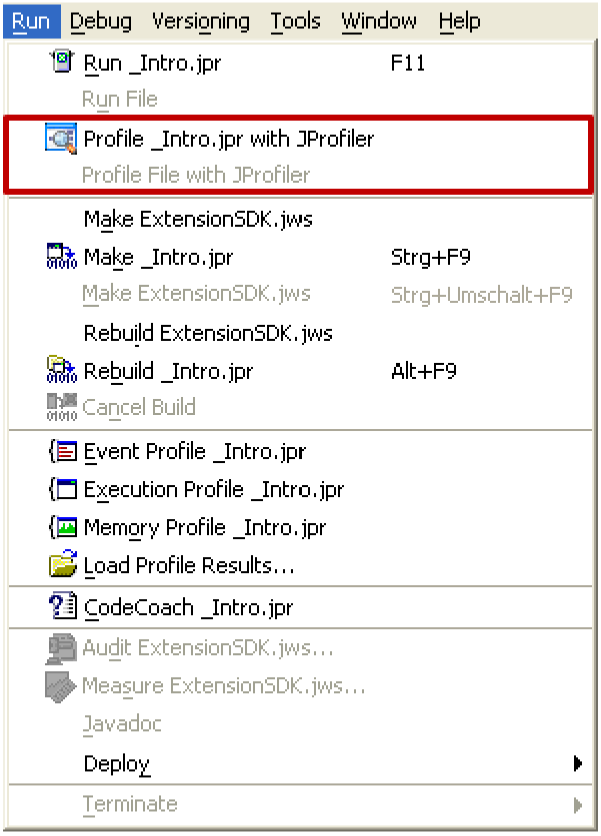
A file selection box will then prompt you to locate the installation directory of JDeveloper.

After acknowledging the completion message, you can start JDeveloper and check whether the installation was successful. You should now see a menu entry *Run->Profile with JProfiler* in JDeveloper's main menu.

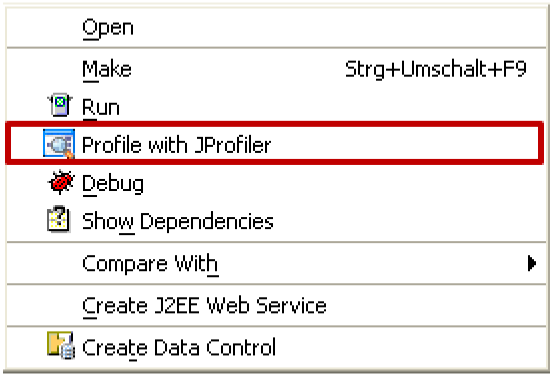
To profile your application from JDeveloper, choose one of the profiling commands in the *Run* menu or click on the corresponding toolbar button.



Main toolbar with "JProfiler" button


Run
Debug
Versioning
Tools
Window
Help
Run _Intro.jpr F11
Run File
Profile _Intro.jpr with JProfiler
Profile File with JProfiler
Make ExtensionSDK.jws
Make _Intro.jpr Strg+F9
Make ExtensionSDK.jws Strg+Umschalt+F9
Rebuild ExtensionSDK.jws
Rebuild _Intro.jpr Alt+F9
Cancel Build
Event Profile _Intro.jpr
Execution Profile _Intro.jpr
Memory Profile _Intro.jpr
Load Profile Results...
CodeCoach _Intro.jpr
Audit ExtensionSDK.jws...
Measure ExtensionSDK.jws...
Javadoc
Deploy
Terminate

"Run" menu with "JProfiler" actions



Project explorer context menu with "JProfiler" action

The profiled application is then started just as with the usual "Run" commands. If no instance of JProfiler is currently running, JProfiler is also started, otherwise the running instance of JProfiler will be used for presenting profiling data.

Every time a run configuration is profiled, a dialog box is brought up that asks you whether a new window should be opened in JProfiler. To get rid of this dialog, you can select the "Don't ask me again" checkbox. The window policy can subsequently be configured in the "JProfiler" node in the settings dialog of JDeveloper (see below).

All profiling settings and view settings changes are persistent across session restarts.

When JProfiler is started from JDeveloper, the "Show source" action for a class or a method in one of JProfiler's view will show the source element in JDeveloper and not in JProfiler's integrated source code viewer.

Several JProfiler-related settings can be adjusted in JDeveloper under *Tools->Preferences->JProfiler*:

- The used **JProfiler installation** can be changed by repeating the integration from JProfiler or by adjusting the JProfiler executable in the corresponding text field. When you upgrade to a newer version of JProfiler, make sure to repeat the integration, since the addin has to be updated, too.
- The **window policy** can be configured as
  - **Ask each time**

    Every time you profile a run configuration, a dialog box will ask you whether a new window should be opened in JProfiler. This is the default setting.
  - **Always new window**

    Every time you profile a run configuration, a new window will be opened in JProfiler.
  - **Reuse last window**

    Every time you profile a run configuration, the last window will be reused in JProfiler.
- You can ask JProfiler to always use **interpreted mode** for profiling. A separate checkbox tells JProfiler to use the **deprecated JVMPI interface** when profiling with a 1.5 JRE. Both these settings are trouble-shooting options and should normally not be selected.

B.2.5 JProfiler As A Netbeans Module

With JProfiler integrated into Oracle's Netbeans(TM), JProfiler can be invoked from within the IDE without any further need for session configuration.

Requirements: Netbeans 6.x or 7.x.

The installation of the Netbeans module is started by selecting "Netbeans IDE [your version]" on the

- IDE integration tab of JProfiler's setup wizard
- miscellaneous options tab [p. 121] of JProfiler's general settings [p. 118] (use *Session->IDE integrations* in JProfiler's main menu as a shortcut).

and clicking on **[Integrate]**

Reminder: Please close Netbeans while performing the module installation. If you are performing the installation from JProfiler's setup wizard, please complete the entire setup first before starting Netbeans.

A file selection box will then prompt you to locate the installation directory of Netbeans. In the next step, you are asked whether the installation should be performed globally, or for a single user only. A single user installation is mostly of interest in network installations where the user cannot write to the Netbeans installation directory. If you decide for a single user installation, another file selection box will then prompt you to locate your Netbeans user directory. This is a version-specific directory under `.netbeans` in your user home directory.

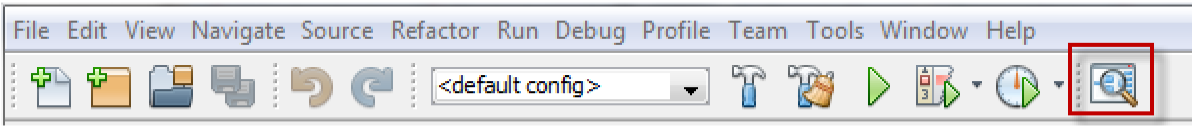
The Netbeans updater is then invoked and the module is installed. After acknowledging the completion message, you can start Netbeans and check whether the installation was successful. You should now see a menu entry *Profile->Profile Main Project With JProfiler* in Netbeans' main menu.

You can profile **standard and free form projects** in Netbeans. For free form projects, you have to debug your application once before trying to profile it, since the required file `nbproject/ide-targets.xml` is set up by the debug action. JProfiler will add a target named "profile-jprofiler" to it with the same contents as the debug target and will try to modify the VM parameters as needed. If you have problems profiling a free form project, please check the implementation of this target.

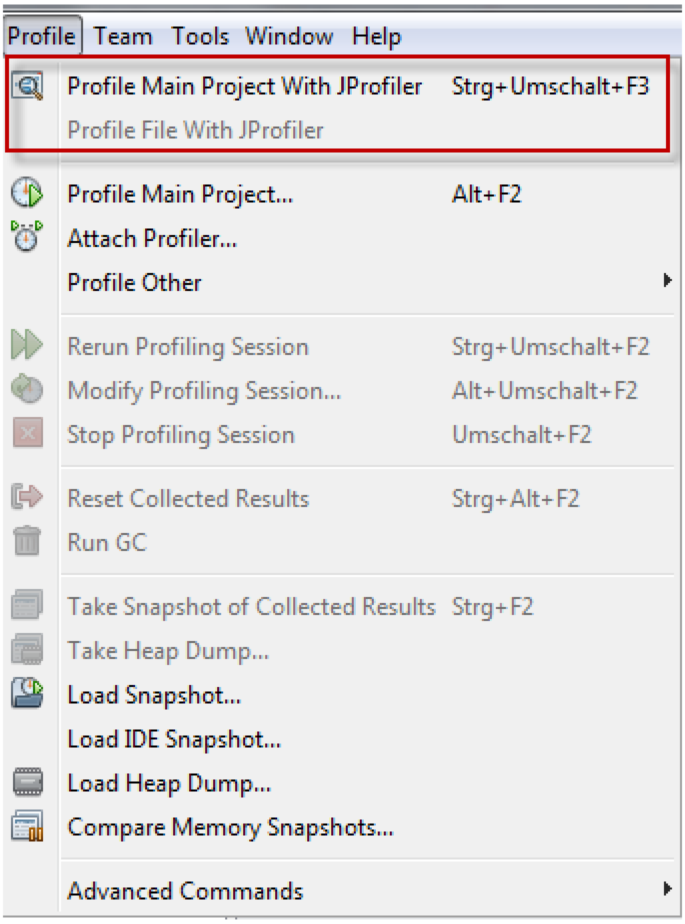
You can profile **web applications** with the integrated Tomcat or with any other Tomcat server configured in Netbeans. When your main project is a web project, selecting "Profile main project with JProfiler" (see below) starts the Tomcat server with profiling enabled. Please make sure to stop the Tomcat server before trying to profile it.

If you use Netbeans with the **bundled GlassFish Server**, you can transparently profile Java EE applications with it. When your main project is set up to use GlassFish Server, selecting "Profile main project with JProfiler" (see below) starts the application server with profiling enabled. Please make sure to stop the application server before trying to profile it.

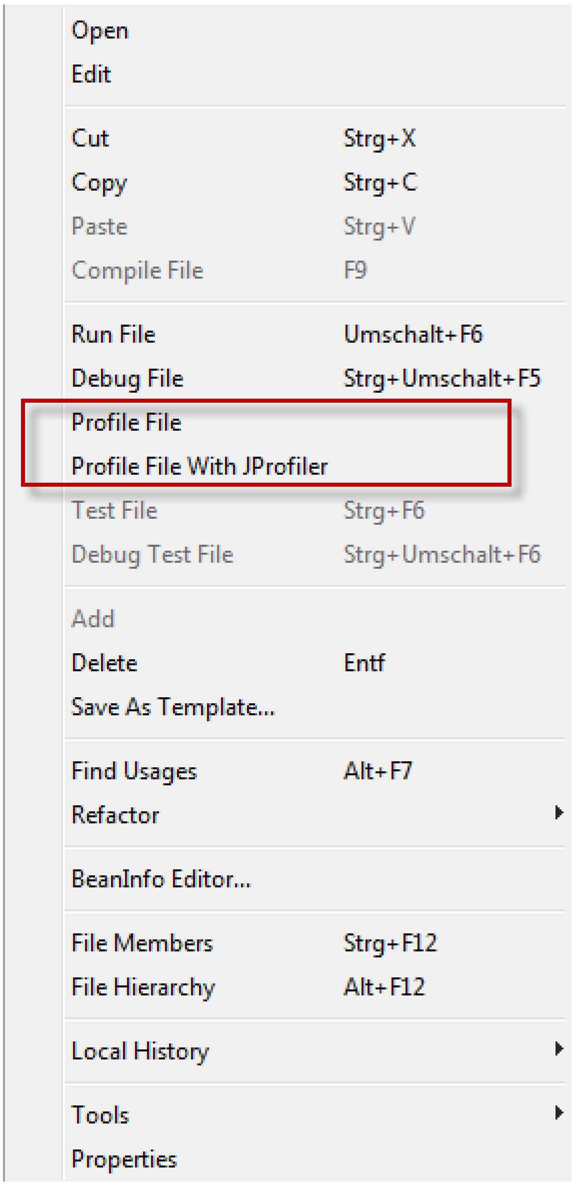
To profile your application from Netbeans, choose one of the profiling commands in the *Run* menu or click on the corresponding toolbar button.


File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help
<default config>

Main toolbar with "JProfiler" button


Profile Team Tools Window Help
Profile Main Project With JProfiler Strg+Umschalt+F3
Profile File With JProfiler
Profile Main Project... Alt+F2
Attach Profiler...
Profile Other
Rerun Profiling Session Strg+Umschalt+F2
Modify Profiling Session... Alt+Umschalt+F2
Stop Profiling Session Umschalt+F2
Reset Collected Results Strg+Alt+F2
Run GC
Take Snapshot of Collected Results Strg+F2
Take Heap Dump...
Load Snapshot...
Load IDE Snapshot...
Load Heap Dump...
Compare Memory Snapshots...
Advanced Commands

"JProfiler" menu



Explorer context menu with "JProfiler" action

The profiled application is then started just as with the usual "Run" commands. If no instance of JProfiler is currently running, JProfiler is also started, otherwise the running instance of JProfiler will be used for presenting profiling data.

When JProfiler is used with the Netbeans integration, the "Show source" action for a class or a method in one of JProfiler's view will show the source element in Netbeans and not in JProfiler's integrated source code viewer.

You can also open JProfiler snapshots from Netbeans, either from the project window or the open file dialog in order to get source code navigation into Netbeans.

B.3 Managing Sessions

B.3.1 Sessions Overview

The information required to start a profiling run is called a **session**. Sessions are saved in the file *`{User home directory}/.jprofiler7/config.xml`* and can be easily migrated to a different computer by importing this file in the setup wizard. When upgrading JProfiler, your settings of older installations are imported automatically.

Sessions are created

- on the "New Session" tab of JProfiler's start center [p. 60] .
- by selecting *Session->New session* from JProfiler's main menu.
- automatically by JProfiler's application server integration wizard [p. 61] .
- by importing them [p. 61] . from an external config file.
- closing a session that was created by invoking quick attach [p. 104] with *Session->Quick attach*. In that case, you will be asked whether to save a new session or not.

Sessions are edited, deleted and opened

- in JProfiler's start center [p. 60] .
- through the open session dialog [p. 103] which is accessible from JProfiler's main menu via *Session->Open session*.

The session settings dialog can be invoked from

- the open session dialog [p. 103] or the start center [p. 60] .
- the the session startup dialog [p. 103] that is displayed just before a session is started.
- JProfiler's main menu and the toolbar. The 📋 toolbar button and the menu item *Session->Session settings* open the session settings dialog.

The session settings dialog is divided into 5 sections:

- **Application settings**

  The application settings section [p. 75] collects all information that is required to start your application with profiling enabled or to connect to a running JVM. If you use an IDE integration [p. 63] , this information will be provided by the IDE.

  This section also includes the code editor & compilation settings [p. 80] which are important for code completion [p. 123] and compilation of scripts.
- **Filter settings**

  In the filter settings section [p. 80] , you define which classes should be considered when recording call-stack information. Defining appropriate filters will help you to reduce data overload and minimizing CPU profiling overhead. By default, JProfiler adds an exclusion list
- **Profiling settings**

  In the profiling settings section [p. 85] you can configure the way your application is profiled and change the focus of a profiling run toward performance or accuracy, CPU or memory profiling.
- **Trigger settings**

  In the trigger settings section [p. 80] you can optionally define a list of triggers. With triggers, you can tell the profiling agent to execute specific actions when certain events occur in the JVM. The actions are also executed during offline profiling [p. 259] .

- **JEE & probes**

  In the JEE & probes section [p. 99] you can configure built-in probes and optionally define a list of custom probes. Probes capture higher-level information on specific subsystems such as JDBC, file I/O or launcher processes.

If you change filter, profiling or trigger settings for an active session, the new settings **can be applied immediately if you profile a 1.6+ JRE**. Apart from telemetry data, all recorded data including the heap dump in the heap walker will be discarded in that case. When profiling settings are updated, a bookmark [p. 135] will be added to views with a time-line, such as the telemetry views. The application of the new profiling settings may take some time, especially if filter settings are changed and the method call recording type is set to dynamic instrumentation. In this case, changes in the instrumentation requires that classes have to be retransformed to reflect the new filter settings.

If you profile a **pre-1.6 JRE**, you have to restart the session.

View settings on the other hand, are always adjustable during a running session and are saved separately for each session.

B.3.2 Application Settings

B.3.2.1 Application Settings

The application settings section of the session settings dialog [p. 74] collects all information that is required to start your application with profiling enabled. If you use an IDE integration [p. 63] , this information will be provided by the IDE.

- **Session name**

  Every session has a unique name that is presented in the "Open session" pane of the start center [p. 60] and in the open session dialog [p. 103] . It is also used for the title of the main window and the terminal window. Next to the name text field you see an ID which is used for choosing the session in offline profiling [p. 259] or for remote profiling with the "nowait" option [p. 108] (in the latter case only relevant if the profiled JVM has a version of 1.5 or earlier).

- **Session type**

  There are five different session types. Depending on this choice, the middle part of the tab will display different options. The available sessions are grouped into two categories: **attach sessions** that attach to a JVM that is already running and **launch sessions** that launch a new JVM for profiling.

  - Attach to local JVM session [p. 77]

    An attach to local JVM session can connect to any locally started JVM with a minimum version of Java 1.6. The profiling agent is loaded on the fly. This is the easiest and most convenient way to profile.

  - Attach to profiled JVM session [p. 77]

    An attach to profiled JVM session connects to a running application which has been started with JProfiler's profiling agent [p. 105] . The profiling agent listens on the default port of 8849 which can be changed in the agent's initialization parameters. Remote sessions are most convenient for profiling server applications on remote machines and application servers.

  - Launched application session [p. 78]

    A launched application session starts your application when the session is opened. You have to specify the virtual machine, as well as your application's class path, main class, parameters and working directory. Your application will be started in a separate terminal window. Application sessions are most convenient for profiling GUI and console applications where you have written the main class yourself.

  - Launched applet session [p. 79]

    Applet sessions are used for profiling applets with Sun's applet viewer which is shipped with every JDK. You only have to supply the URL to a HTML page containing the applet.

    Note: If the applet viewer is too restrictive for your applet, please use the **Java plugin integration wizard** available on the `New session` tab of the start center [p. 60] to profile the applet directly in the browser.

  - Launched Java Web Start session [p. 79]

    JProfiler can profile Java Web Start applications. You only have to supply the URL for the JNLP file or select a cached application.

- **Java file path**

  With the radio buttons on the left you can switch between the

  - **Class path**

    The class path consists of directories and jar files that are used for the -classpath VM argument. The class path is also used by the bytecode viewer [p. 137] to find class files for display.

  - **Source path**

    The source path optionally lists archives and directories that contain source code for some or all of the entries in the class path. Note that the sources of the selected JDK contained in *`src.jar`* or *`src.zip`* will be automatically appended if they are installed. The source path is is used by the source code viewer [p. 137] to display Java sources.

  - **Native library path**

    The native library path consists of directories that are added to the native library envrironment variable. The name of the native library envrironment variable depends on the operating system. You only have to specify the native library path when you load native libraries by calling `java.lang.System.loadLibrary()` or for resolving dependent libraries that have to be dynamically loaded by your native libraries.

  When clicking the ✚ add button you can select multiple path entries to the path list in one go from the file chooser. Alternatively, to quickly add a list of path entries defined elsewhere, you can **copy a path from the system clipboard** by clicking copy button. The path must consist of either

  - a single path entry
  - or multiple path entries separated by the standard path separator (";" on Windows, ":" on UNIX) or by line breaks.

  Each path entry can be

  - **absolute**

    The path entry is added as it is.

  - **relative**

On the first occurrence of a relative path, JProfiler brings up a directory chooser and asks for the root directory against which relative paths should be interpreted. All subsequent relative paths will be interpreted against this root directory.

JProfiler will only add unique path entries into the list. If no new path entry could be found, a corresponding error message is displayed.

Note: Adjusting the class and source path during an active session is effective for the source code and bytecode viewer [p. 137] only.

B.3.2.2 Attach To Local JVM Session

If the session type in the application settings [p. 75] is set to "Select from all local JVMs", the middle part of the dialog allows you to configure filter settings for the dialog that shows all local JVMs.

When the session is started, a dialog with all locally running JVMs with a minimum version of 1.6 is displayed. Some JVMs are marked with special backgrounds, either as

- **Profiled**

  if the profiling agent has already been loaded. This may be because the profiling agent was specified on the command line or because you have already attached to that JVM before.
- **Offline**

  if the application is already profiled in offline mode. To start and stop recording as well as save snapshots in offline profiling mode, use the jpcontroller [p. 262] command line executable.
- **Connected**

  if the JVM is already connected to by another JProfiler GUI.

You can select any JVM that is not marked as offline or connected and start profiling.

Above the list of JVMs, you find a selector that allows you to modify the filter settings for the displayed JVMs. The list of JVMs supports quick search (just type into it), alternatively you can use the filter field at the bottom to restrict the displayed JVMs.

On Windows, only JVMs that are started by the currently logged in users are shown by default. Often it is required to profile a service that is started by the "Local System" account. In that case, you have to select the toggle button in the upper right corner to add the service JVMs to the list. On Windows Vista and higher, a UAC dialog will be shown to elevate permissions (unless UAC has been disabled). This is required because otherwise those JVMs cannot be discovered and profiled.

Please see the help on attaching to JVMs [p. 104] for more information.

B.3.2.3 Attach To Profiled JVM Session

If the session type in the application settings [p. 75] is set to "Attach to profiled JVM (local or remote)", the following settings are displayed in the middle part of the dialog:

- **Host**

  Enter the host on which the application you want to profile is running either as a DNS name or as an IP address. If this is your local computer, you may enter `localhost`.
- **Port**

  Choose the port on which the profiling agent is listening. If you have not supplied a port parameter [p. 108] , the default port 8849 is the correct choice. This default can be restored by clicking the **[Default]** button on the right side of the text field.
- **Timeout**

Choose the timeout in seconds after which JProfiler will give up trying to connect to the profiled application.

- **Start command**

  If you enable the "start command" checkbox and enter the path to an executable in the text field to the right, JProfiler will execute this command before trying to connect to the profiled application. The output of that command will be displayed in a terminal window similar to the "local" session type [p. 75] . In this case JProfiler has full control over the life cycle of the profiled application. If the terminal window is closed, the stop button is clicked or JProfiler is exited, the process will be killed if it is still alive.

  The application server integration wizard uses start commands to make it easy to profile application servers. should you want to take control of the launching of the application server you can temporarily uncheck the "start command" checkbox while preserving the suitable start command.

- **Stop command**

  If you enable the "stop command" checkbox and enter the path to an executable in the text field to the right, JProfiler will execute this command when disconnecting from the profiled application, i.e. when the terminal window is closed, the stop button is clicked or JProfiler is exited.

  The application server integration wizard uses stop commands where possible.

- **Open browser with URL**

  If you would like to open a browser window along with the session, please select this checkbox and enter the URL in the adjacent text field. JProfiler polls this URL until it becomes available, only then is the browser opened. Please set the browser start command [p. 121] if you're working on a UNIX platform.

The **[config synchronization options]** button brings up the config synchronization options dialog [p. 116] .

B.3.2.4 Launched Application Session

If the session type in the application settings [p. 75] is set to "Application", the following settings are displayed in the middle part of the dialog:

- **Java VM**

  Choose the Java VM to run your application. Java VMs are configured on the "Java VMs" tab [p. 118] of JProfiler's general settings [p. 118] which are accessible by clicking the **[General settings]** button on the bottom of the dialog.

- **Working directory**

  Choose the directory in which your **java** process will be started either manually or by clicking on the **[...]** button to bring up a file chooser. As long as you have not selected a particular directory, this option is set to `[startup directory]` which means that JProfiler's startup directory will also be your application's working directory.

- **VM arguments**

  If your application needs virtual machine arguments of the form `-Dproperty=value`, you can enter them here. Parameters that contain spaces must be surrounded with double quotes (like `"-Dparam=a parameter with spaces"`).

- **Main class or executable JAR**

  Enter the fully qualified name of your main class or the path to an executable JAR file here. If you enter a main class, it has to be contained in class path (see above).

  Clicking on the **[...]** button brings up menu that lets you

    - **Search the classpath**

      If you have already configured your classpath, this option will search for classes with a main method and present them in the main class selection dialog.
    - **Browse for an executable JAR file**

      This brings up a file chooser where you can select an executable JAR file. If the JAR file has a Class-Path manifest entry, you will be asked whether the class path should be replaced with the contents of that attribute. Also, the working directory will be set to the parent directory of the executable JAR file after a confirmation.
    - **Browser for a .class file**

      This brings up a file chooser where you can select the *`*.class`* file of the desired main class. A dialog box will ask you whether to add the associated class path root directory to the class path.

- **Arguments**

  This is the place to enter any arguments you want to supply to the main class of your application. Arguments that contain spaces must be surrounded with double quotes (like `"a parameter with spaces"`).
- **Open browser with URL**

  If you would like to open a browser window along with the session, please select this checkbox and enter the URL in the adjacent text field. JProfiler polls this URL until it becomes available, only then is the browser opened. Please set the browser start command [p. 121] if you're working on a UNIX platform.

B.3.2.5 Launched Applet Session

If the session type in the application settings [p. 75] is set to "Applet", the following settings are displayed in the middle part of the dialog:

- **Java VM**

  Choose the Java VM to run your applet. The main class `sun.applet.AppletViewer` from the *`tools.jar`* of the selected JVM will be used to show the applet. Java VMs are configured on the "Java VMs" tab [p. 118] of JProfiler's general settings [p. 118] which are accessible by clicking the **[General settings]** button on the bottom of the dialog.
- **URL**

  Enter a URL pointing to an HTML page which contains the applet. By clicking on the **[...]** button you can bring up a file chooser to select an HTML file on your file system.

Note: If the applet view is too restrictive for your applet, please use the **Java plugin integration wizard** available on the `New session` tab of the start center [p. 60] to profile the applet directly in the browser.

B.3.2.6 Launched Java Web Start Session

If the session type in the application settings [p. 75] is set to "Web Start", the following settings are displayed in the middle part of the dialog:

- **URL of the JNLP file**

  Every Web Start application is launched by means of a launch descriptor called a JNLP file. Enter the URL of the JNLP file in the text field. By clicking on the **[...]** button you can bring up a dialog which shows the JNLP URLs of all applications which have already been downloaded by Java Web Start. Choose one in the list and press **[OK]** to transfer the URL to the text field.

- **Java VM**

  Choose the Java VM to run Java Web Start and the profiled web start application.

Note: Java VMs are configured on the "Java VMs" tab [p. 118] of JProfiler's general settings [p. 118] which are accessible by clicking the **[General settings]** button on the bottom of the dialog.

B.3.2.7 Code Editor & Compilation Settings

The choice of a JDK can be changed on a per session basis. By default, the JDK that you configure in the general settings [p. 118] is used. You can select a different JDK on this tab that will only be used for this session.

The selected JDK will be used for **code completion** in the script editor [p. 123] and scripts will be **compiled against this JDK**. It is recommended that the JDK is compatible with the JRE of the profiled application, otherwise you might accidentally use methods that are not available in the profiled application.

When you profile a JVM with the JProfiler GUI, JProfiler compiles scripts on the fly according to the auto-detected Java version in the profiled JVM.

For scripts in the session settings, such as the custom probe configuration [p. 101] , scripts are compiled when you save the session. In that case, the version of the selected JDK configuration is taken.

Here, a problem arises if the configured JDK has a **different version than the actually profiled JRE**. Apart from selecting a wrong JDK for the session, this may also be the case in remote profiling, when you do not have a suitable JDK at hand. Once you connect to the profiled JVM, the scripts will be recompiled in the appropriate class file format. This recompilation is not necessary if you adjust the target JRE version explicitly on this tab.

An accurate selection is **critical for offline profiling**, where no recompilation can be performed in the case of a mismatch between the class file format of the pre-compiled script classes and the version of the profiled JVM.

B.3.3 Filter Settings

B.3.3.1 Filter Settings

The filter settings section of the session settings dialog [p. 74] allows you to define the filters that will be used for recording method calls. For background information on filters, please see the help topic on method call recording filters [p. 24] .

One exception where the filters configured in this section will **not** be used is if the "Disable all filters for sampling" setting is activated on the method call recording [p. 86] tab of the profiling settings dialog [p. 85] .

The filter settings section is grouped into several tabs:

- Define filters [p. 81]

  Define exclusive and inclusive filter rules for packages and classes.
- Exceptional methods [p. 82]

  Configure methods whose slow invocations are shown separately in the call tree.
- Ignored methods [p. 84]

  Displays methods with excessive instrumentation overhead that were removed by auto-tuning.

B.3.3.2 Define Filters For Method Recording

On this tab of the filter settings [p. 80] , you define filter rules for packages and classes that will be applied to method call recording [p. 86] .

There are two types of filter rules:

- **Included** packages or classes are profiled and **will** be shown in the call tree. If the first filter is inclusive, no classes are profiled by default.
- **Excluded** packages or classes are not profiled and **will not** be shown in the call tree. If the first filter is exclusive, all other classes are profiled by default.

All calls **from** profiled classes are shown in the call tree regardless of whether the called class is profiled or not. For example, if you only have one inclusive filter for the `com.mycorp.` packages, and if your class `com.mycorp.MyClass` calls a method in java core classes, all those calls will be measured, but their internal call structure will not be resolved. In the call tree view [p. 192] , such method calls are opaque and will be labeled with a red corner.

Package filters include all sub-packages. For example, if you have one inclusive filter with the name `com.mycorp.`, it includes all classes directly in the `com.mycorp.` package as well as the `com.mycorp.test` and the `com.mycorp.test.detail` packages.

Filter rules are evaluated from top to bottom, the last matching rule is applied. For example, if you add an exclusive filter for the `com.mycorp.` packages, but further down add an inclusive filter for the `com.mycorp.test` package, the `com.mycorp.test` package is profiled while other classes in the `com.mycorp.` packages are not.

When clicking on the **[Add]** button, you also get the option to select filters in a package browser. The package browser shows packages for

- **Classes from the configured class path**

  if the application is not running yet. Since the class path may not be configured for some session types, the package tree may be empty.
- **Loaded classes that can be instrumented**

  if the application is already running. This includes attach sessions where the profiling agent is not waiting for a connection on startup.

Next to each package node, the cumulated number of contained classes is displayed. The total number of classes that will be included or excluded through your selection is indicated at the bottom of the dialog.

Adjacent filter rules of the same type can be **grouped** together. Just select all filters that you wish to group and select the appropriate action from the context menu. You are then prompted to name the group. The name of a filter group is only informational. The context menu also offers an action to ungroup selected groups. Filter rules in filter groups are sorted alphabetically, have a gray background and cannot be moved. However,they can be deleted from the filter group. To add a new filter rule to an existing filter group, you first have to ungroup the group and group it again.

By default, the filter rules are configured to exclude a list of common framework classes. All other classes are included. Whenever you find that the default list is not suitable, or if you would like to profile classes that are in that list, you should delete the entire exclude group and add your own inclusive filters. Alternatively, you can delete parts of the default exclude group.

If, at any later point, you wish to restore these default exludes, you can use the reset filters to default button on the right side. All current filter settings will be lost in that case.

To analyze the overall filter configuration, you can click on **[Show filter tree]** and bring up a dialog [p. 82] that shows you all filter rules in a read-only package hierarchy.

Filter configurations can be saved to filter templates [p. 82] with the 💾 save button, the 📂 open button lets you replace the current filter configuration with a filter template.

On the session defaults [p. 120] tab of the general settings dialog [p. 118] you can change the default filter template used for new sessions.

You can quickly bring up this tab by clicking on the **[Global filters]** button that is shown in the bottom right corner of views that show call trees or time measurements of method calls.

B.3.3.3 View Filter Tree

In this dialog, you can inspect the filters for method call recording [p. 86] in a package hierarchy. This dialog can be shown by clicking **[Show filter tree]** on the Define Filters [p. 81] tab of the filter settings [p. 80] .

The tree shows

- **excluded packages**

  ⊘ these packages or classes will not be profiled, they are only shown if they are called directly from profiled classes.
- **included packages**

  ✓ these packages will be profiled.
- **bridge packages**

  📂 these packages are only shown because there's a filter rule for a descendant package. If the first node in the tree is an "all other packages" inclusive node, they will be profiled, otherwise not.

If the first filter rule on the Define Filters [p. 81] tab is exclusive, an "all other packages" inclusive node is added as the first node in the tree. If the first filter rule is inclusive, there is no automatic addition to the package tree.

Please note that this is a read-only representation of the filter configuration. For defining filter rules, please return to the Define Filters [p. 81] tab.

B.3.3.4 Filters Templates

Filter templates can be saved from the Define Filters [p. 81] tab of the filter settings [p. 80]

A filter template captures all configured filter rules from a session configuration. When saving a filter template, you have to assign a unique name to it. The filter template dialog allows you to reorder, rename and remove existing filter templates.

The filter template dialog can also be invoked from the session defaults [p. 120] tab of the general settings dialog [p. 118] where you can change the default filter template used for new sessions.

B.3.3.5 Exceptional Methods

On this tab of the filter settings [p. 80] , you define methods whose exceptionally slow invocations will be shown separately in the call tree view [p. 192] .

By default, JProfiler splits invocation events on the AWT thread in that way. If you click on on the ↺ Reset button, the default entries will be restored.

Exceptional methods can be used to **investigate outliers in the performance of selected methods**. Often, certain methods are supposed to complete quickly, but occasionally an invocation will take much longer than the median time. In the call tree view, you cannot analyze those outliers, since all calls are cumulated.

When you register a method for exceptional method recording, a few of the slowest invocations will be retained separately in the call tree. The other invocations will be merged into a single method node as usual. The number of separately retained invocations can be configured in the profiling settings [p. 87] , by default it is set to 5.

When discriminating slow method invocations, a certain thread state can be used for the time measurement. By default, the wall clock time (all thread states) is used, but a different thread status can be configured in the profiling settings [p. 87] . Note that the thread status selection in the CPU views [p. 190] is not used in this case, but the separate setting in the profiling settings is used.

Exceptional method runs are displayed differently in the call tree view [p. 192] . For the concerned method nodes, icons are changed and text is appended:

- **[exceptional run]**

  Such a node contains an exceptionally slow method run. By definition, it will have an invocation count of one. If many other method runs are slower later on, this node may vanish and be added to the "merged exceptional runs" node depending on the configured maximum number of separately recorded method runs [p. 87] .
- **[merged exceptional runs]**

  Method invocations which do not qualify as exceptionally slow are merged into this node. For any call stack, there can only be one such node per exceptional method.
- **[current exceptional run]**

  If an invocation was in progress while the call tree view was transmitted to the JProfiler GUI, it was not yet known whether the invocation was exceptionally slow or not. The "current exceptional run" shows the separately maintained tree for the current invocation. After the invocation completes, it will either be maintained as a separate "exceptional run" node or be merged into the "merged exceptional runs" node.

To check the **statistical properties** of the distribution of call times of certain methods of interest, please start with the method statistics view [p. 206] . It can show you the outlier coefficient and a graph of call times versus frequency. This analysis allows you to assess whether an outlier is significant or not. From the method statistics view you can use the *Add as exceptional method* action in the context menu to add the method to the list of exceptional methods. The same context action is available in the call tree view [p. 192] .

Apart from removing previously configured exceptional methods, you can also add exceptional methods directly on this tab of the filter settings. The following ways for selecting methods are available:

- **Search in configured classpath**

  A class chooser will be shown that shows all classes in the classpath configured in the application settings [p. 75] . Finally you have to select a method from the selected class.
- **Search in other JAR or class files**

  First, you can select a JAR or class file. If the selection is a JRE file, you then have to select a class in a class chooser. After the selection you will be asked whether to expand the classpath with the current selection. For remote sessions, the classpath is often not configured, so this is a shortcut to make your selection permanent. Finally, you can select a method from the selected class.
- **Search in profiled classes**

If the session is being profiled, a class chooser is displayed that shows all classes in the profiled JVM. There may be classes in the classpath that have not been loaded. Those classes will not be shown in the class chooser. Finally, you can to select a method from the selected class.

- **Enter manually (advanced)**

  This option displays a dialog that allows you to enter class name, method name and method signature in JNI format. The JNI format of the method signature is explained in the javadoc of `com.jprofiler.api.agent.probe.InterceptionMethod`.

  The context menu for the list of methods offers the option to edit existing entries.

B.3.3.6 Ignored Methods

On this tab of the filter settings [p. 80] , you see methods an classes that should be completely ignored by JProfiler. The two main use cases for this feature are call site mechanisms of dynamic languages such as Groovy, and methods that have been identified as overhead hot spots and that you have accepted into the list of ignored methods.

By default, JProfiler ignores the call site mechanism of Groovy. If you click on on the Reset button, the default entries will be restored.

If the method call recording type [p. 86] is set to `Dynamic instrumentation`, all methods of profiled classes [p. 81] are instrumented. This creates some overhead which is significant for methods that have very short execution times. If such methods are called very frequently, the measured time of those method will be far to high. Also, due to the instrumentation, the hot spot compiler might be prevented from optimizing them. In extreme cases, such methods become the dominant hot spots although this is not true for an uninstrumented run. An example is the method of an XML parser that reads the next character. This method returns very quickly, but may be invoked millions of times in a short time span.

This problem is not present when the method call recording type [p. 86] is set to `Sampling`. However, sampling does not provide invocations counts, shows only longer method calls and several view such as the method statistics view [p. 206] and the call tracer [p. 208] do not work when sampling is used.

To alleviate the problem with dynamic instrumentation, JProfiler has a mechanism called **auto-tuning**. From time to time, the profiling agent checks for such methods and transmits them to the JProfiler GUI. In the status bar, an entry such as `3 overhead hot spots` will be shown. You can click on that status bar entry to review the detected overhead hot spots and choose to accept them into the list of ignored methods. These ignored methods will then not be instrumented. When a session is terminated, the same dialog is shown.

All ignored methods will be missing in the call tree. Their execution time will be added to the inherent time of the calling method. If you find later on, that some ignored methods are indispensable in the profiling views, you can activate this tab in the filter settings and delete those methods.

In case that you do not want to see messages about auto-tuning, you can disable it in the profiling settings [p. 87] . Also, several parameters can be adjusted to broaden or narrow the scope of the methods that are considered as overhead hot spots.

You can also add ignored methods directly on this tab of the filter settings. The following ways for selecting methods are available:

- **Search in configured classpath**

  A class chooser will be shown that shows all classes in the classpath configured in the application settings [p. 75] . Finally you have to select a method from the selected class.

- **Search in other JAR or class files**

First, you can select a JAR or class file. If the selection is a JRE file, you then have to select a class in a class chooser. After the selection you will be asked whether to expand the classpath with the current selection. For remote sessions, the classpath is often not configured, so this is a shortcut to make your selection permanent. Finally, you can select a method from the selected class.

Alternatively, you can choose all methods from the selected class by selecting the "All methods" radio button at the top of the dialog.

- **Search in profiled classes**

  If the session is being profiled, a class chooser is displayed that shows all classes in the profiled JVM. There may be classes in the classpath that have not been loaded. Those classes will not be shown in the class chooser. Finally, you can to select a method from the selected class.

  Alternatively, you can choose all methods from the selected class by selecting the "All methods" radio button at the top of the dialog.

- **Enter manually (advanced)**

  This option displays a dialog that allows you to enter class name, method name and method signature in JNI format. The JNI format of the method signature is explained in the javadoc of `com.jprofiler.api.agent.probe.InterceptionMethod`.

  The context menu for the list of methods offers the option to edit existing entries.

  To select all methods from a class, enter * for the method name and the empty string for the signature.

B.3.4 Profiling Settings

B.3.4.1 Profiling Settings

In the profiling settings section of the session settings dialog [p. 74] you can adjust a number of settings that impact profiling detail and overhead. Please see the detailed discussion in the help topic on profiling settings [p. 20] to get a background understanding of the various available settings.

The profiling settings section displays a list of pre-configured **profiling settings templates** that are targeted at a variety of situations. As different templates in the drop down list are selected, the description box and the performance indicators below it are updated accordingly. Both description and performance indicators should help you choose the best template for your task at hand. If you click on the **[Customize profiling settings]** button below the drop down list, the **profiling settings dialog** is opened.

If you customize the profiling settings, the text in the drop down list changes to "[Customized]". You can save new profiling settings templates with the **[Save as template]** button. The profiling settings template dialog [p. 91] is then displayed.

On the session defaults [p. 120] tab of the general settings dialog [p. 118] you can change the default profiling settings template used for new sessions.

The profiling settings dialog is grouped into several tabs:

- Method call recording [p. 86]

  Configure method call recording options for the session. These settings affect CPU views and memory views with allocation information.

- CPU profiling [p. 87]

  Configure options regarding CPU profiling. These settings affect CPU views only.

- Probes [p. 88]

  Configure recording options for probes.

- Memory profiling [p. 88]

  Configure options regarding memory profiling. These settings affect all memory views.
- Thread profiling [p. 89]

  Configure options regarding thread profiling. These settings affect all views in the thread section.
- Miscellaneous [p. 89]

  Configure miscellaneous options for profiling.

Other settings, which concern the presentation of profiling data are called **view settings** and are accessible from the main toolbar as well as from context sensitive menus in each view. View settings are persistent as well and are saved automatically for each session.

B.3.4.2 Adjusting Method Call Recording Options

On this tab of the profiling settings dialog [p. 85] , you can adjust all options related to method call recording. These settings influence the detail level of CPU profiling data and the profiling overhead.

The following options are available:

- **Enable method call recording**

  When you record CPU data or allocations, JProfiler collects information about the call tree. You might want to record allocations without the overhead of recording the allocation call stacks: If you don't need the allocation view [p. 165] in the heap walker, the allocation call tree [p. 146] and the stack trace information in the monitor usage views [p. 224] , you can switch off method call recording. This will speed up profiling considerably and reduce memory usage.
- **Method call recording type**

  Select the method call recording type for CPU profiling as one of

  - **Dynamic instrumentation**

    When dynamic instrumentation is enabled, JProfiler modifies filtered classes on the fly as they are loaded by the JVM to include profiling hooks. **Accuracy of non-timing related stack information** (like allocation information) is high, **invocation counts** are available and **Java EE payloads** can be annotated in the call tree, but calls from Java core classes are not resolved. The overhead and timing accuracy varies depending on what classes are instrumented.

    Java core classes (`java.*`) cannot be profiled this way and are filtered automatically.
  - **Sampling**

    When sampling is enabled, JProfiler inspects the call stacks of all threads periodically. Sampling has **extremely low overhead** even without any filters. Accuracy of non-timing related stack information (like allocation information) is low and invocation counts are not available. Only methods that take longer than the sampling period or methods called frequently are captured by sampling.

    Sampling is ideally suited for use without any method call filters. To temporarily switch off all filters, you can use the `Disable all filters for sampling` setting instead of deleting all filters in your configuration. In that way you can create a profiling settings template that ignores your filter configuration and alternate between using filters and using no filters at all.

    If sampling is enabled, the **sampling frequency** can be adjusted. The default value is 5 ms. A lower sampling frequency incurs a slightly higher CPU overhead when profiling.

    Note: allocations will be reported according to the call traces recorded by the sampling procedure. This may lead to incorrect allocation spots.

- **Line numbers**

  By default, JProfiler does not resolve line numbers in call trees. If you enable `show line numbers for sampling and dynamic instrumentation`, line numbers will be recorded and shown.

  If the aggregation level is set to "methods" and a method calls another method multiple times in different lines of code, line number resolution will show these invocations as separate method nodes in the call tree [p. 192] and the allocation call tree [p. 146] . Backtraces in the hot spots views will also show line numbers.

  Note that a line number can only be shown if the call to a method originates in an unfiltered class.

B.3.4.3 Adjusting CPU Profiling Options

On this tab of the profiling settings dialog [p. 85] , you can adjust all options related to CPU profiling. These settings influence the detail level of CPU profiling data and the profiling overhead. They only apply to the views in the CPU view section [p. 190] .

The following options are available:

- **Auto-tuning settings**

  Here, you can disable auto-tuning [p. 84] . Furthermore you can configure the criteria for determining an overhead hot spot. A method is considered an overhead hot spot if both of the following conditions are met:

  - the total time of all its invocations exceeds a threshold in per mille of the entire total time in the thread
  - its average time is lower than an absolute threshold in microseconds

- **Time settings**

  Select whether you want times shown in the CPU view section [p. 190] to be measured in

  - **elapsed time**

    With elapsed time selected, the clock time difference between method entry and method exit will be shown. Note that if the thread state selector [p. 190] is set to its standard setting (Runnable). Waiting, blocking and Net IO thread states are not included in the displayed times.
  - **estimated CPU time**

    With estimated CPU time selected, the CPU time used between method entry and method exit will be shown. On Windows and Mac OS the system supplies CPU times with a 10 ms resolution which are used to calculate the estimated CPU times. On Linux and Solaris the VM does not supply a CPU time and the estimated CPU times are roughly estimated by looking at the number of runnable threads.

- **Settings for exceptional method run recording**

  Exceptional method run recording [p. 82] has the following configurable parameters:

  - **Maximum number of separately recorded method runs**

    The maximum number of the slowest invocations that are shown separately in the call tree view [p. 192] . Increasing this value can increase memory overhead and visual clutter in the call tree.
  - **Time type for determining exceptional method runs**

    The time measurement that is used for finding the slowest method invocations. Note that this setting is not linked to the thread state selector in the CPU views [p. 190] .

B.3.4.4 Probes & JEE

On this tab of the profiling settings dialog [p. 85] , you can edit advanced options regarding Java EE and probes.

The following options are available:

- **Maximum recorded number of payloads per call stack**

  Probes [p. 99] can publish information into the call tree [p. 192] . For each call stack and payload type, JProfiler keeps track of the invocation count and total execution times for each thread status. To avoid excessive memory consumption, there is a cap on the number of different retained payload names. If the maximum number is exceeded, the oldest payload is merged into an "[earlier calls]" node. By default, this maximum value is set to 50. If you require more detail, you can increase the value in the text field as needed.

- **Record exact payload call stacks in sampling mode**

  If sampling is enabled, JProfiler still records the exact call stack of payloads in order to generate useful back traces in the probe hot spots views [p. 235] . If you are not interested in these back traces, you can deselect this option in order to reduce overhead.

- **Maximum number of recorded events**

  Probes [p. 99] can record single events and show them in the probe events view [p. 237] . To avoid excessive memory consumption, there is a cap on the maximum number of retained events. If the maximum number is exceeded, the oldest events are discarded. By default, this maximum value is set to 20000. if you require more history, you can increase the value in the text field as needed.

- **Detect Java EE components**

  JProfiler can detect the following Java EE component types:

  servlets

  JSPs

  EJBs

  The corresponding methods have a separate icon in the call tree. For JSPs, the name of the JSP source file is displayed instead of the generated class and for EJBs the name of the interface is displayed instead of the generated stub or proxy classes. In the "method" and the "class" aggregation levels, the real class names are displayed in square brackets, too.

  Based on this component information, JProfiler offers the **Java EE components aggregation level** in all views with an aggregation level selector. If you would like to disable Java EE component detection, you can deselect the checkbox labeled **Detect Java EE components**.

- **Show request URLs without a recorded call stack**

  The servlet probe splits the call tree for each recorded request URL. Request URLs that do not have an associated call stack are not shown by default. To display these request URLs at the top level of the call tree you can select this option.

B.3.4.5 Memory Profiling Options

On this tab of the profiling settings dialog [p. 85] , you can adjust all options related to memory profiling. These settings influence the detail level of memory profiling data and the profiling overhead.

The following options are available:

- **Recording type**

The information depth of the allocation call tree [p. 146] and the allocation hot spots view [p. 150] is governed by this setting.

  - **Live objects**

    By default, only live objects can be displayed by the allocation views. Class-resolution is enabled.
  - **Live and GCed objects without class resolution**

    Live and garbage collected objects can be displayed by the allocation views, depending on the selection in the allocation options dialog [p. 156] . Class-resolution is disabled, i.e. class selection [p. 156] in the allocation options dialog [p. 156] will not work in this setting, only the cumulated allocations of all classes and array types can be displayed. This setting consumes more memory than the first setting and adds a considerable performance overhead.
  - **Live and GCed objects**

    Live and garbage collected objects can be displayed by the allocation views, depending on the selection in the allocation options dialog [p. 156] . Class-resolution is enabled. This setting consumes more memory than the other settings and adds adds a considerable performance overhead.

- **Allocation times**

  Select the `Record object allocation time` check box if you would like to be able to

  - use the time view in the heap walker [p. 178]
  - see allocation times in the references view [p. 169] of the heap walker and sort by those times.

  This setting leads to an increased memory consumption when recording objects.

B.3.4.6 Thread Profiling Options

On this tab of the profiling settings dialog [p. 85] , you can adjust all options related to thread profiling. These settings influence the detail level of thread profiling data and the profiling overhead.

The following options are available:

- **Monitors**

  if you are not interested in monitor contention events, you can switch data collection off by deselecting the `Enable monitor recording` check box. This lowers the memory consumption of the profiled application. If monitor contention views are **enabled**, the following settings govern the level of detail for the monitor contention views:

  - **Record java.util.concurrent events**

    JProfiler can insert itself into the locking facility in the **java.util.concurrent** package which does not use monitors of objects but a different natively implemented mechanism. If you do not wish to see this information, you can deselect this check box.

- **Thread filter**

  By default, JProfiler does not show system threads where no user code can ever run. If you would like to see all threads, please select the `Show system threads` check box.

B.3.4.7 Miscellaneous Options

On this tab of the profiling settings dialog [p. 85] , you can adjust uncategorized options for profiling.

The following options are available:

- **VM life cycle control**

  If you select the `Keep VM alive` check box, JProfiler keeps the VM alive until the JProfiler GUI disconnects. This option allows you to profile code sections which are close to a forced termination of the virtual machine.

  Note: with the classic VM (e.g. IBM JVMs), this option installs a security manager which intercepts your application's calls to `System.exit()` and executes them after JProfiler's GUI front end disconnects. This can be a problem when you profile an application server which installs its own security manager. If you use a classic VM and get security related exceptions when profiling your applications, try unchecking this option.
- **Dynamic views**

  Many views in JProfiler update their data automatically. There are several options for configuring the update behavior of those dynamic views:

  - **Transmission periods**

    Based on the varying degree of computing expenses required for the different views, the transmission periods for the dynamic views have been split into two separate settings:

    - **CPU views**

      This setting influences the update interval of the dynamic views in the CPU view section [p. 190] .
    - **Tables and graphs**

      This setting influences the update interval of the

      - all objects view [p. 141]
      - recorded objects view [p. 143]
      - dynamic views in the thread section [p. 213]
      - VM telemetry view section [p. 227]

      Note: The update frequency of the all objects view [p. 141] is adjusted automatically according to the total number of objects on the heap.

    To update any dynamic view in between two regular updates, you can click on the refresh icon in the status bar.

- **Console Settings**

  JProfiler displays a console for locally launched programs. This includes application sessions, applets, web start applications and remote sessions with a configured start command.

  JProfiler offers two types of consoles:

  - **Java Console**

    This is a cross-platform console, that supports text input, sending CTRL-C to the profiled application, text selection and clipboard operations. For the Java console you can set the following options:

    - **Buffer size**

      The number of most recent lines of output that are held by the console. Default is 1000.

    - **Window size**

      The initial size (width x height) of the console in characters. Note that the console does not wrap text. Default is 80 x 25.

    This console integrates with JProfiler's *Window* menu.

  - **Native Console**

    On Microsoft Windows, you also have the option to use the native console. This console does not integrate with JProfiler's *Window* menu.

- **Profiling agent debug parameters**

  Here you can enter debugging parameters [p. 108] that can be passed to the profiling agent on the command line. This text box is not visible for remote sessions, since you have to add those parameters to the start script yourself in that case.

B.3.4.8 Profiling Settings Template Dialog

Profiling settings templates can be saved on the profiling settings [p. 85] section of the session settings dialog [p. 74] .

A profiling template contains all profiling settings that can be configured in the profiling settings dialog. When saving a profiling settings template, you have to assign a unique name to it. The profiling settings template dialog allows you to reorder, rename and remove existing profiling settings templates.

The profiling setting template dialog can also be invoked from the session defaults [p. 120] tab of the general settings dialog [p. 118] where you can change the default profiling settings template used for new sessions.

B.3.5 Trigger Settings

B.3.5.1 Trigger Settings

In the trigger settings section of the session settings dialog [p. 74] you can configure triggers that allow you to respond to certain events in the JVM with a list of actions. For further background information, please see the help topic on triggers and offline profiling [p. 28] .

The trigger settings section is grouped into several tabs:

- **Triggers**

  Here, you define the list of triggers for your session. By default, no triggers are defined. To add new triggers, click on the add button to display the trigger wizard [p. 92] . The trigger wizard is also used to edit existing triggers.

  Some triggers are only required occasionally, especially when the set of actions incurs a considerable overhead, such as saving snapshots. JProfiler allows you to **disable and enable triggers** so you do not lose their configuration for the next time you need them. The corresponding actions are also available from the context menu.

  Note that you can select multiple triggers to quickly disable, enable or delete many triggers.

  Trigger configurations can be saved to trigger sets [p. 98] with the save button, with the open button you can add a trigger set to the current list of triggers.

  On the session defaults [p. 120] tab of the general settings dialog [p. 118] you can change the default trigger set used for new sessions. By default, no triggers are added to a new session.

- **Output options**

The following actions print information when they are executed:

- Print message
- Print method invocation

On this tab you define where this output should be printed. The available options are:

- **Print to stdout**
- **Print to stderr**
- **Print to file**

  For this option you have to enter a file name. The file will be saved relative to the working directory of the profiled JVM on the machine where the profiled JVM is running.

B.3.5.2 Trigger Wizard

The trigger wizard is shown when you add a new trigger or when you edit an existing trigger in the trigger section [p. 91] of the session settings [p. 74] .

The trigger wizard is also shown, when adding or editing triggers in the trigger settings [p. 91] or when adding a trigger from a view that displays single methods [p. 98] .

The first step of the trigger wizard lets you choose the event type from the list of available trigger event types [p. 92] .

The following steps in the wizard depend on this selection. Note that you can click with the mouse on the index to quickly jump to a different step. This is especially useful when editing triggers.

After the event-specific steps in the wizard, you can configure the actions that should take place when the trigger event occurs. JProfiler offers a fixed set of available actions [p. 95] . The actions are configured directly in the list, the options associated with an action are shown when the action is selected.

Actions are executed when the event occurs. For events that have a **duration**, such as the method invocation event or the threshold events, you can use the "Wait for the event to finish" action to separate actions that should be executed when the events starts from actions that should be executed when the event finishes.

In the list of configured triggers [p. 91] , each trigger is represented by the trigger type and a short summary of its most important parameters. If you have multiple triggers of the same type, this might not be distinctive enough. On the "Description" step, you can configure a name that is displayed in the list of triggers instead of the parameter summary.

You can enable and disable groups of triggers [p. 99] in a live session. To group triggers for this feature, the "Group ID" step allows you to optionally assign a group ID to each trigger.

B.3.5.3 Trigger Event Types

The following trigger types are available in the trigger wizard [p. 92] for configuring triggers [p. 91] :

- **Method invocation**

  Symbol:

  This event occurs when a method is called. Several methods can be configured for the same action sequence. Besides the standard actions, there are several special actions for this trigger type.

  The second step of the trigger wizard will then be the "Specify methods" step. Here you can edit the list of methods for which this trigger will be activated. There are several ways to enter new methods:

  - **Search in configured classpath**

    A class chooser will be shown that shows all classes in the classpath configured in the application settings [p. 75] . Finally you have to select a method from the selected class.
  - **Search in other JAR or class files**

    First, you can select a JAR or class file. If the selection is a JRE file, you then have to select a class in a class chooser. After the selection you will be asked whether to expand the classpath with the current selection. For remote sessions, the classpath is often not configured, so this is a shortcut to make your selection permanent. Finally, you can select a method from the selected class.
  - **Search in profiled classes**

    If the session is being profiled, a class chooser is displayed that shows all classes in the profiled JVM. There may be classes in the classpath that have not been loaded. Those classes will not be shown in the class chooser. Finally, you can to select a method from the selected class.
  - **Enter manually (advanced)**

    This option displays a dialog that allows you to enter class name, method name and method signature in JNI format. The JNI format of the method signature is explained in the javadoc of `com.jprofiler.api.agent.probe.InterceptionMethod`.

    The context menu for the list of methods offers the option to edit existing entries.

  In addition, all views with call trees [p. 98] offer the possibility to select methods for a method trigger in the context menu.

  By default, the method trigger event is not fired for recursive calls. This means that if a method M is being called and later on in the call stack method M is called again, the event is only fired for the first invocation of method M. If you deselect the check box `Ignore recursive calls`, the event will be fired for all invocations of a method.

- **Heap usage threshold**

  Symbol: ⚠

  Requirements: Java 1.4+

  This event occurs when the heap usage exceeds a certain threshold in percent of the maximum heap size for a minimum period of time.

  The second step of the trigger wizard will then be the "Threshold" step. Here you can configure the

  - **Threshold**

    The trigger will be activated each time when the used heap size exceed the configured percentage of the maximum heap size.
  - **Activation time**

    To avoid spurious trigger events, the activation time sets a minimum amount of time during which the threshold must be exceeded. Only after the activation time has passed will the trigger be activated.
  - **Deactivation time**

    Similar to the activation time, the trigger will only be deactivated after heap usage falls below the threshold for a minimum amount of time. By default, the deactivation time is the same as the activation time, however, you can configure a different time for it. Activation and deactivation times determine the sensitivity of the trigger to the threshold value.

  - **Inhibition time**

    To avoid that too many trigger events are fired, you can set an inhibition time. After the trigger has been deactivated, the trigger will not be activated again for the duration of the inhibition time.

- **CPU load threshold**

  Symbol: ⚠

  Requirements: Java 1.5+

  This event occurs when the CPU load exceeds a certain threshold in percent for a minimum period of time.

  The second step of the trigger wizard will then be the "Threshold" step which is explained above for the "Heap usage threshold" trigger with the only difference that the threshold value is the CPU load in percent.

- **Out of memory exception**

  Symbol: ⊘

  Requirements: Java 1.6+

  This event occurs when an OutOfMemoryException is thrown. You can only save an HPROF snapshot in this case since the trigger works by adding -XX:+HeapDumpOnOutOfMemoryError to the VM options. Also, this trigger only works with a Java 6+ JVM. For 1.5.0_07+ and 1.4.2_12+, this VM option is also supported, however, it cannot be added by the profiling agent, so you have to add it manually to the VM options of the profiled application.

- **Timer**

  Symbol: ⏱

  With a timer trigger, you can periodically execute a certain set of actions, such as saving a snapshot.

  The second step of the trigger wizard will then be the "Timer" step where you can configure the following properties of the timer:

  - **Timer type**

    A timer can either periodically either and unlimited number of times of a limited number of times.

  - **Interval**

    The interval defines the period of time between two subsequent timer invocations.

  - **Offset**

    With the offset, you can specify how much time should pass between the start of the JVM and the first invocation of the timer.

- **JVM startup**

  Symbol: ▶

  With a JVM startup trigger, you can execute a certain set of actions right after the JVM is started for profiling. The actual execution is performed right after the trigger subsystem has been initialized in the profiling agent.

- **JVM exit**

  Symbol: 🟥

  With a JVM exit trigger, you can execute a certain set of actions right before the JVM is shut down. This is implemented with a standard shutdown hook, so code in other shutdown hooks may be executed after the associated actions.

B.3.5.4 Trigger Action Types

The following trigger action types are available in the trigger wizard [p. 92] for configuring triggers [p. 91] :

- **Start recording**

  Symbol: ▶

  Starts recording any of

  - CPU data [p. 190]

    With the "Reset" check box, you can choose whether the previously recorded CPU data should be cleared or not.
  - Allocation data [p. 140]

    With the "Reset" check box, you can choose whether the previously recorded allocation data should be cleared or not.
  - Thread data [p. 213]
  - VM telemetry data [p. 227]
  - Method statistics [p. 206]

  With the "Reset" check boxes for CPU data and allocation data, you can choose whether the previously recorded data should be cleared or not.
- **Stop recording**

  Symbol: 🟦

  Stops recording any of

  - CPU data [p. 190]
  - Allocation data [p. 140]
  - Thread data [p. 213]
  - VM telemetry data [p. 227]
  - Method statistics [p. 206]

- **Start monitor recording**

  Symbol: 🔒

  Starts recording monitor data. The monitor views [p. 219] that show historical data receive new data when this action is executed. Please note that monitor recording adds a memory overhead that grows linearly in time. You should execute the "stop monitor recording" action at some point.

  In the configuration, you can define blocking and waiting thresholds for monitor recording. These settings are the same as those in the monitor history view settings dialog [p. 225] .

- **Stop monitor recording**

  Symbol:

  Stops recording monitor data.
- **Start call tracer**

  Symbol:

  Starts recording call traces. The call tracer view [p. 208] will receive new data once the "stop call tracer" action is executed. Please note that call traces use a lot of memory. You should execute the "stop call tracer" action after a short time.

  In the configuration, you can define a cap on the number of recorded call traces and determine if calls into filtered classes should be traced as well. These settings are the same as those in the call tracer view settings dialog [p. 209] .

  In addition, you can specify if previously recorded call traces should be reset or not. If you do not clear previously recorded call traces, you can build up call traces over several trigger events.
- **Stop call tracer**

  Symbol:

  Stops recording call traces. The call tracer view [p. 208] will be updated with the recorded data as soon as this action is executed.
- **Trigger heap dump**

  Symbol:

  With this action you can trigger a heap dump as in the heap walker [p. 158] . Accordingly, you can select whether to

  - **Select recorded objects only**

    Note that if you select this option and have not recorded any allocations, the heap walker will show the empty object set.
  - **Remove unreferenced and weakly referenced objects**

    This is effectively like a full GC before taking the snapshots, just that the GC is performed in the internal data structures of the profiling agent.
  - **Calculate retained sizes**

    To reduce the memory overhead and the time for heap snapshot processing you can deselect this option. Retained sizes can only be calculated if the "Remove unreferenced and weakly referenced objects" option is selected.
  - **Record primitive data**

    This has no effect with Java 1.5 and JVMTI where primitive data cannot be recorded. Java 1.2-1.4 and Java 1.6+ fully support this option.

- **Trigger thread dump**

  Symbol:

  With this action you can trigger a thread dump as in the thread dumps view [p. 218] . Please note that frequently taking thread dumps will cause a linear growth in memory overhead.
- **Start probe recording**

  Symbol:

With this action you can start probe recording [p. 229] for a single selected built-in probe. Probes that do not have the "record at startup" option selected in the session settings can be started this way

- **Stop probe recording**

  Symbol:

  With this action you can stop probe recording [p. 229] for a single selected built-in probe. If probe recording should only be done for a specific use case, you can use this action to switch off recording.

- **Start probe tracking**

  Symbol:

  With this action you can start probe tracking [p. 238] for a single selected built-in probe and one or more control objects or hot spots.

- **Stop probe tracking**

  Symbol:

  With this action you can stop probe tracking [p. 238] for a single selected built-in probe and one or more control objects or hot spots. This only has an effect if you have executed the Start probe tracking" action first.

- **Save snapshot**

  Symbol:

  With this action you can save a JProfiler snapshot [p. 115] of all profiling data to disk.

  In addition to the name of the snapshot file you can specify whether a number should be appended to the file name to prevent old snapshot files from being overwritten. Note that the path is relative to the working directory of the profiled JVM and that the snapshot is saved on the remote machine if you profile remotely.

- **Create an HPROF heap dump**

  Symbol:

  Requirements: Java 1.6+

  With this action you can save an HPROF heap snapshot [p. 115] of all profiling data to disk. For the "Out of memory exception" [p. 92] event type, this is the only supported action.

  In addition to the name of the snapshot file you can specify whether a number should be appended to the file name to prevent old snapshot files from being overwritten. Note that the path is relative to the working directory of the profiled JVM and that the snapshot is saved on the remote machine if you profile remotely.

  HPROF heap dumps also offer the option to only save referenced objects.

- **Wait for the event to finish**

  Symbol:

  For event types [p. 92] that have a duration, such as the method invocation event or the threshold events, you can use this action to execute some actions not at the start of the event but rather after the event is finished.

- **Override thread status for current method**

  Symbol:

This action is only available for the method invocation [p. 92] event type and allows you to change the thread status [p. 214] for the duration of the methods that are associated the the trigger. The thread status is configurable.

- **Print method invocation**

  Symbol:

  This action is only available for the method invocation [p. 92] event type and allows you print details about the current method invocation including parameters and return value to the output stream configured in the trigger output options [p. 91] .

- **Invoke interceptor**

  Symbol:

  This action is only available for the method invocation [p. 92] event type and allows you to invoke an interceptor when the methods associated the the trigger are invoked. Interceptors can be developed with the JProfiler API and can also be added with VM parameters. Please see the *`api`* directory for documentation and samples. The advantage of adding the interceptor with a trigger is that you do not have to specify the methods and signatures in the interceptor class.

  You can enter the interceptor class manually or use the **[...]** button to scan the class path configured in the application settings [p. 75] for all classes extending `com.jprofiler.api.agent.interceptor.Interceptor`.

- **Add bookmark**

  Symbol:

  With this action you can add a boookmark [p. 135] to the time-resolved views. You have to enter a description for the bookmark.

- **Sleep**

  Symbol:

  With this action, you can sleep a specified amount of time until the next action in the list is executed. Please note that this does not block the current thread in the JVM. For example, you can use this action to start CPU recording, record 10 minutes, stop CPU recording and save a snapshot.

- **Print message**

  Symbol:

  With his action you can print an arbitrary message to the output stream configured in the trigger output options [p. 91] .

B.3.5.5 Trigger Sets

Trigger sets can be saved on the trigger settings [p. 91] section of the session settings dialog [p. 74] .

A trigger set contains all triggers that are currently defined for the session being edited. When saving a trigger set, you have to assign a unique name to it. The trigger set dialog allows you to reorder, rename and remove existing trigger sets.

The trigger set dialog can also be invoked from the session defaults [p. 120] tab of the general settings dialog [p. 118] where you can change the default trigger set that is added to new sessions.

B.3.5.6 Method Selection For Triggers

Several views in JProfiler display call trees and back traces, such as the call tree [p. 192] , the hot spots view [p. 197] , the allocation call tree [p. 146] and the allocation hot spots view [p. 150] .

In all these views, the context menu shows an add method trigger action if the currently selected node is a method. That action displays this dialog where you can choose whether to add the method interception to an existing method trigger or whether to create a new method trigger.

If you select "Add to existing method trigger", the list below which displays all existing method triggers is enabled and you have to choose one of them. The select method is added to the selected trigger and the trigger wizard [p. 92] is opened at the "Actions" step, so you can review or modify the existing list of actions.

If you select "Create new method trigger", a new method trigger is created and the trigger wizard [p. 92] is shown at the action step.

B.3.5.7 Enabling And Disabling Triggers

By default, triggers are active when the JVM is started for profiling. There are two ways to disable triggers at startup:

- **disable individually on startup**

  In the trigger configuration [p. 91] you can select single triggers and disable them. Those triggers will be shown in gray.
- **disable all on startup**

  In the session startup dialog [p. 103] there is a check box `Enable triggers on startup`. If you deselect this check box, all triggers will be disabled when the JVM is started for profiling.

During a live session, you can enable or disable all triggers by choosing *Profiling->(Enable|Disable) triggers* from JProfiler's main menu. Bookmarks [p. 135] will be added when triggers are enabled or disabled manually.

The trigger recording state is shown in the status bar with a flag icon which is shown in gray when triggers are not enabled. Clicking on the flag icon will toggle trigger recording.

Sometimes, you need to toggle trigger recording for **groups of triggers** at the same time. This is possible by assigning the same group ID [p. 92] to the triggers of interest and invoking *Profiling->Enable triggers groups* from JProfiler's main menu.

A dialog will be shown where you can select one or more group IDs. Furthermore, there are radio buttons to control whether the selected trigger groups should be enabled or disabled.

Enabling or disabling trigger groups overrides the global trigger recording status as well as the initial disabling of individual triggers.

B.3.6 Probe Settings

B.3.6.1 Probe Settings

The configuration of Probes [p. 48] is divided into two sections:

- Built-in probes [p. 100]

  These are probes that are provided by JProfiler.
- Custom probes [p. 101]

  These are probes that you define yourself directly in the JProfiler GUI.

Changing the configuration of probes requires that the new profiling settings are applied to the profiled JVM. All previous recorded data will be cleared in that case.

B.3.6.2 Built-in Probes

All built-in probes are described on the help page of the probes view [p. 229] . Here, only configuration aspects of built-in probes are discussed. For general information on the concepts behind probes, see the corresponding help topic [p. 48] .

Click on a probe to display the configuration panel. The following common configuration options are available for each probe:

- **Enabled or disabled**

  If a probe is disabled, the bytecode instrumentation required by that particular probe will not be performed. Disabling a probe may be useful for trouble-shooting or minimization of overhead. Note that the overhead of a probe that is enabled but not recording is very small.

- **Record on startup**

  If you would like to record probe data right after connecting to the profiled JVM, you can select this option. Otherwise you can start recording data for selected probes manually in the probes view [p. 229] .

- **Record single events**

  Data in the probe events view [p. 237] is only available if this option is selected. Recording single events may add noticeable overhead depending on the activities of the profiled application. Other probe views are not affected by this setting.

- **Annotate into call tree**

  Select this option, if you would like to see payload data from the probe hot spots view [p. 235] in the call tree view [p. 192] . In this way, you get additional information in-place when analyzing performance problems in the call tree view. You can deselect this option in order to minimize overhead.

  This option is not available for the "Servlets" probe.

The following built-in probes have particular configuration options:

- **JDBC**

  If required, you can choose to resolve parameters of prepared statements. By default, those parameters are shown as question marks in the hot spots view [p. 235] and the event view [p. 237] . Resolving these parameters makes the hot spots view more cluttered, but can be useful for debugging purposes.

- **JPA/Hibernate**

  The JPA/Hibernate probe supports a number of providers, like Hibernate 3.x, Hibernate 4.x and eclipselink 2.3. You can deselect providers in the probe configuration.

- **JMS**

  Since messages are custom objects, JProfiler does not know how to optimally display messages in the hot spots and event views. By default, a message is only identified via the `toString()` value of the destination returned by `javax.jms.Message#getJMSDestination()`.

  With the "message resolver script" you can display customized information on your messages. The script [p. 123] receives a parameter "message" which is of type `java.lang.Object`. This is because the JMS classes may not be available in the profiled JVM, so the JMS probe cannot depend on them. You can cast the message to a subtype of `javax.jms.Message`, extract the relevant information and return a string that will be displayed in the JProfiler GUI. That string is the basis for the hot spots calculation in the hot spots view [p. 235] .

- **Servlets**

The servlet probe splits the call tree for different URL invocations, so you can analyze different requests separately. What constitutes a "different" request is governed by the "URL splitting" setting of the servlet probe. By default, only the request path is retained, and all parameters are discarded.

In reality, there may be certain request parameters that should be retained for URL splitting, such as parameters that do not identify user input, but determine the type of the request. For example, you may have a dispatcher servlet and a parameter "controller" that determines the type of the request. In that case, you would probably like to retain the parameter "controller". In the text field after the "Retain request parameters" radio button, a comma-separated list of such parameters can be specified.

However, the structure of the URLs may be more complex than that. Maybe you want to discard parts of the request path or conditionally retain request parameters. In that case, you can use the "Resolve with script" option and define a script [p. 123] that returns the string defining the URL displayed by JProfiler. The script is passed two parameters: `uri` for the request path and `queryString` for the query parameters. Just returning `uri` would correspond to the default "Request path only" setting.

B.3.6.3 Custom Probes

For more information on custom probes, please see the corresponding help topic [p. 53] . Here, only the configuration of custom probes in the JProfiler GUI is discussed.

If you add or edit a custom probe, the **custom probe wizard** is displayed. In several steps, it leads you through the creation of a custom probe. You can directly jump to another step of the wizard by clicking on the step in the index. The wizard is partitioned into the following steps:

- **Name and description**

  Here, you provide a name and a description for the probe. The name is used in the call to `ProbeMetaData#create(String)` and the description is set with `ProbeMetaData#description(String)`. This could be set in the meta data script in the next step, but since JProfiler needs to display this information in the custom probe configuration, it is entered separately outside the script and applied to the `ProbeMetaData` object before it is passed to the meta data script.

- **Meta data**

  The meta data of the probe is configured with a single script. The script [p. 123] is passed a single parameter `metaData` of type `ProbeMetaData` and does not return anything. New probes contain a non-functional example script that gives you a starting point for your own configuration.

- **Telemetry script**

  If the probe publishes telemetries, a telemetry script is called once a second and gives you the chance to publish telemetry data. The script is passed a `ProbeContext` and an int-array with the data to be filled. To retrieve data that was collected during interceptions, you have to use the map returned by `probeContext.getMap()`. The n-th index in the int-array corresponds to the n-th telemetry that was defined in the meta-data script.

- **Method groups**

  The interception scripts later on operate on several methods of the same signature. If you have to deal with methods of different signatures (which is common for more complex probes), you have to define different method groups. Each method group can only contain methods with the same signature. In subsequent steps, the method group can be selected from a drop-down list in order to configure different method groups.

- **Specify methods**

If you want to intercept method to collect data (which most probes do), you can add those methods in this step. Remember that all methods in a single method group must have the same signature. There are several ways to enter new methods:

  - **Search in configured classpath**

    A class chooser will be shown that shows all classes in the classpath configured in the application settings [p. 75] . Finally you have to select a method from the selected class.
  - **Search in other JAR or class files**

    First, you can select a JAR or class file. If the selection is a JRE file, you then have to select a class in a class chooser. After the selection you will be asked whether to expand the classpath with the current selection. For remote sessions, the classpath is often not configured, so this is a shortcut to make your selection permanent. Finally, you can select a method from the selected class.
  - **Search in profiled classes**

    If the session is being profiled, a class chooser is displayed that shows all classes in the profiled JVM. There may be classes in the classpath that have not been loaded. Those classes will not be shown in the class chooser. Finally, you can to select a method from the selected class.
  - **Enter manually (advanced)**

    This option displays a dialog that allows you to enter class name, method name and method signature in JNI format. The JNI format of the method signature is explained in the javadoc of `com.jprofiler.api.agent.probe.InterceptionMethod`.

    The context menu for the list of methods offers the option to edit existing entries.

- **Interception scripts**

  The first two parameters passed to an interception script are the `InterceptorContext` (which is an extension of `ProbeContext`) and the current object `currentObject` (which is `null` for static method interceptions).

  There are interception scripts for three points in the execution flow:

  - **Method entry**

    Called immediately after the intercepted method is entered. In addition to the common parameters, all arguments of the intercepted method are passed to the script. As long as the types of the arguments are in the configured class path of the session, method completion is available in the script dialog.
  - **Method exit**

    Called just before the intercepted method is exited via a return call. No method arguments are passed. If creating payload information, use the payload stack methods in the interceptor context to retrieve information from the entry script.
  - **Exception exit**

    Called just before the intercepted method is exited after an exception has been thrown. In addition to the common parameters, the Throwable `t` is passed as a parameter. The method exit script will not be called in this case.

  Interception scripts must be defined separately for each method group.

Custom probes can be organized into **custom probe sets**. You can add a saved custom probe set to the current list of custom probes or save the current list of custom probes to a set. This makes it easy to share custom probes between different sessions.

To automatically add a set of custom probe to new sessions, configure a saved custom probe set on the session defaults tab [p. 120] of the general settings [p. 118] dialog.

To share a set of custom probes with a colleague, or to copy it to another JProfiler installation, use the import/export feature [p. 117] .

B.3.7 Open Session Dialog

The open session dialog serves two functions:

- To open profiling sessions [p. 74] . Double click on an existing session or choose a session and click **[Open]** to start a profiling session.
- To edit [p. 75] , copy and delete existing sessions.

The list of available session configurations displays the session name which can be changed when editing [p. 75] a session. In addition, the associated icon to the left of the session name show whether the session is an "Attach to local JVM" session an "Attach to profiled JVM (local or remote)" session a launched application session, a launched applet session or a launched Java Web Start session

The facility to open sessions is also embedded in JProfiler's start center [p. 60] .

B.3.8 Session Startup Dialog

Before a session is started, the session startup dialog is displayed. This dialog displays short summaries for the

- Filter settings [p. 80]
- Profiling settings [p. 85]
- Trigger settings [p. 91]

of the profiled session as well as **[Edit]** buttons that lead to the corresponding sections of the session settings dialog [p. 74] .

When profiling, there is a general trade-off between profiling overhead and information depth. Most likely your personal requirements will change from profiling run to profiling run, so these settings are displayed every time before your application is started.

For **IDE integration users**, this is the dialog where session settings can be accessed and modified. Session settings are persistent and are associated with the project name in the IDE.

In the `Startup` section dialog you can choose whether recording of CPU or allocation data should be started immediately. For many profiling use cases the startup phase of an application is not of interest. For large applications servers, you can save a lot of memory and speed up the startup phase by not recording allocations from the beginning.

- **Record CPU data on startup**

  Both the invocations view [p. 192] and the hot spots view [p. 197] will display data immediately.
- **Record allocations on startup**

  The recorded objects view [p. 143] will display data immediately.
- **Enable triggers on startup**

By default, this option is selected. If you deselect this check box, triggers will not be enabled when the JVM is started for profiling. You can enable triggers manually [p. 99] later on.

In addition, request tracking settings [p. 211] can be adjusted in the startup dialog.

The performance indicators are set according to the selected profiling settings [p. 85] . Please note that these values are only approximate and the the filter settings influence overhead as well.

When you click on **[OK]**, the session will be started.

B.3.9 Attaching To JVMs

JProfiler has the capability to profile any JVM that has a minimum version of 1.6, even if that JVM was not started with the VM parameters for profiling [p. 108] . Through the use of the attach API that is present in Oracle/Sun JVMs, JProfiler can load the profiling agent on the fly. There are two scenarios for attaching to JVMs:

- **Locally running JVMs**

  In this case, invoke *Session->Quick Attach* from the main menu and select the JVM from a list of discovered JVMs [p. 77] .

  When you close the session, you can save the session settings (filter, profiling and triggers settings) so that you can reuse them for future use. When you attach to the same application again, start the saved session [p. 103] instead of using "Quick attach". Of course you can also start out by creating such a dedicated session in the first place.
- **JVMs running on remote machines**

  In this case, extract a JProfiler archive from the download page on the remote machine. You do not have to enter a license key there. Run the `bin/jpenable` command line application on the remote machine. You will be able to select a JVM and load the profiling agent into it so that is listens on a specific profiling port.

  In your local JProfiler GUI, create an "Attach to profiled JVM (local or remote)" session [p. 77] and enter the host name and the same profiling port that you specified in `jpenable` on the remote machine.

  When you start the session, it connects to the remote JVM and you can start profiling.

When the profiling agent is loaded for an attach session (either by the JProfiler GUI or by `jpenable`, the profiling agent did not have the chance to instrument classes when they were loaded. Instead, it has to reload them which puts a burden on the PermGem space of the heap. Classes are not easily garbage collected and so the PermGem space has to support both old and new versions of all reloaded classes. If the PermGen space is to small for a particular application, you can increase it with the VM parameter `-XX:MaxPermSize=128m`.

When you choose "Dynamic instrumentation" as the method call recording type, it is important to choose inclusive filters that focus on the classes of interest. In that way, relatively few classes are instrumented. Alternatively, you can choose Sampling [p. 86] in the profiling settings.

If JProfiler detects that the PermGen space would be overloaded with the current filter settings, it will warn you in the session startup dialog [p. 103] . You should then switch to sampling or define narrow inclusive filters. Clicking on the hyperlinks in the warning message will quickly make these changes. When selecting inclusive filters, the total amount of instrumented classes is monitored and you are notified if you exceed the approximate maximum number of classes that can be instrumented.

Views that show information on recorded objects, such as the Recorded objects view [p. 143] , the Allocation call tree [p. 146] or the heap walker allocations screen [p. 165] rely on instrumentation of certain classes. Unfortunately, array allocations have to be instrumented at all call sites. When the profiling agent is present at startup, this is not a problem, but in attach mode, a large fraction of all classes has to be instrumented which might fail due to the limitations of the PermGen space.

By default, array allocations are not recorded in attach mode, although the session startup dialog [p. 103] gives you the possibility to do so for "non-client" JVMs (the "client" JVM has a bug that prevents this from working successfully).

B.3.10 Starting Remote Sessions

In most cases, the integration of JProfiler with an application server is handled by the application server integration wizards [p. 61] . If no GUI is available on the remote machine you can use the `jpintegrate` executable in the *`bin`* directory for a console integration wizard.

If you want to quickly profile a JVM of version 1.6 or higher on a remote machine, extract a JProfiler archive from the download page on the remote machine. You do not have to enter a license key there. Run the `bin/jpenable` command line application on the remote machine. You will be able to select a JVM and load the profiling agent into it so that is listens on a specific profiling port.

In your local JProfiler GUI, create an "Attach to profiled JVM (local or remote)" session [p. 77] and enter the host name and the same profiling port that you specified in `jpenable` on the remote machine.

To permanently start your application or application server in such a way that you can connect to it with a remote session from JProfiler's GUI front end, the following steps are required. They are different for the old profiling interface JVMPI and the new profiling interface JVMTI. For that latter, the required modifications are considerably simpler.

- **Java >= 1.5.0 (JVMTI)**

  Add a VM parameter to your startup command that tells the VM to load the profiling agent:

  ```
  -agentpath:{Path to jprofilerti library}
  ```

  where `{Path to jprofilerti library}` depends on the operating system and the architecture of the JVM (**not** the architecture of the operating system):

Windows, 32-bit	*`{JProfiler install directory}`*`\bin\`*`windows`*`\`*`jprofilerti.dll`*
Windows, 64-bit	*`{JProfiler install directory}`*`\bin\`*`windows-x64`*`\`*`jprofilerti.dll`*
Linux x86, 32-bit	*`{JProfiler install directory}/bin/linux-x86/libjprofilerti.so`*
Linux x86, 64-bit	*`{JProfiler install directory}/bin/linux-x64/libjprofilerti.so`*
Linux PPC, 32-bit	*`{JProfiler install directory}/bin/linux-ppc/libjprofilerti.so`*
Linux PPC64, 64-bit	*`{JProfiler install directory}/bin/linux-ppc64/libjprofilerti.so`*
Solaris SPARC, 32-bit	*`{JProfiler install directory}/bin/solaris-sparc/libjprofilerti.so`*
Solaris SPARC, 64-bit	*`{JProfiler install directory}/bin/solaris-sparcv9/libjprofilerti.so`*

Solaris x86, 32-bit	*{JProfiler install directory}/bin/solaris-x86/libjprofilerti.so*
Solaris x86, 64-bit	*{JProfiler install directory}/bin/solaris-x64/libjprofilerti.so*
Mac OS, 32 and 64-bit	*{JProfiler install directory}/bin/macos/libjprofilerti.jnilib*
HP-UX PA_RISC, 32-bit	*{JProfiler install directory}/bin/hpux-parisc/libjprofilerti.sl*
HP-UX PA_RISC, 64-bit	*{JProfiler install directory}/bin/hpux-parisc64/libjprofilerti.sl*
HP-UX IA64, 32-bit	*{JProfiler install directory}/bin/hpux-ia64n/libjprofilerti.so*
HP-UX IA64, 64-bit	*{JProfiler install directory}/bin/hpux-ia64w/libjprofilerti.so*
AIX, 32-bit	*{JProfiler install directory}/bin/aix-ppc/libjprofilerti.so*
AIX, 64-bit	*{JProfiler install directory}/bin/aix-ppc64/libjprofilerti.so*
FreeBSD x86, 32-bit	*{JProfiler install directory}/bin/freebsd-x86/libjprofilerti.so*
FreeBSD x86, 64-bit	*{JProfiler install directory}/bin/freebsd-x64/libjprofilerti.so*

Also, you might need to add other JVM-specific options found in the remote session invocation table [p. 108] .

- **Java <= 1.4.2 (JVMPI)**

1. **Adjust your startup command**

   Add the following command line parameters to your startup command:

   - A VM parameter that tells the VM to load the profiling agent:

     ```
     -Xrunjprofiler
     ```

   - A VM parameter that adds JProfiler-specific classes to the boot classpath:

     - **Windows**

       ```
       -Xbootclasspath/a:{JProfiler install directory}\bin\agent.jar
       ```

     - **all other supported platforms**

       ```
       -Xbootclasspath/a:{JProfiler install directory}/bin/agent.jar
       ```

   - other JVM-specific options found in the remote session invocation table [p. 108]

2. **Adjust the native library path**

The native library path is an environment variable whose name depends on on the operating system and the architecture of the JVM (**not** the architecture of the operating system).

Windows, 32-bit	Add *`{JProfiler install directory}\bin\windows`* to the environment variable `PATH`.
Windows, 64-bit	Add *`{JProfiler install directory}\bin\windows-x64`* to the environment variable `PATH`.
Linux x86, 32-bit	Add *`{JProfiler install directory}/bin/linux-x86`* to the environment variable `LD_LIBRARY_PATH`.
Linux x86, 64-bit	Add *`{JProfiler install directory}/bin/linux-x64`* to the environment variable `LD_LIBRARY_PATH`.
Linux PPC, 32-bit	Add *`{JProfiler install directory}/bin/linux-ppc`* to the environment variable `LD_LIBRARY_PATH`.
Linux PPC64, 64-bit	Add *`{JProfiler install directory}/bin/linux-ppc64`* to the environment variable `LD_LIBRARY_PATH`.
Solaris SPARC, 32-bit	Add *`{JProfiler install directory}/bin/solaris-sparc`* to the environment variable `LD_LIBRARY_PATH`.
Solaris SPARC, 64-bit	Add *`{JProfiler install directory}/bin/solaris-sparcv9`* to the environment variable `LD_LIBRARY_PATH`.
Solaris x86, 32-bit	Add *`{JProfiler install directory}/bin/solaris-x86`* to the environment variable `LD_LIBRARY_PATH`.
Solaris x86, 64-bit	Add *`{JProfiler install directory}/bin/solaris-x64`* to the environment variable `LD_LIBRARY_PATH`.
Mac OS, 32 and 64-bit	*`{JProfiler install directory}/bin/macos`* to the environment variable `DYLD_LIBRARY_PATH`.
HP-UX PA_RISC, 32-bit	Add *`{JProfiler install directory}/bin/hpux-parisc`* to the environment variable `SHLIB_PATH`.
HP-UX PA_RISC, 64-bit	Add *`{JProfiler install directory}/bin/hpux-parisc64`* to the environment variable `SHLIB_PATH`.

HP-UX IA64, 32-bit	Add *`{JProfiler install directory}/bin/hpux-ia64n`* to the environment variable `SHLIB_PATH`.
HP-UX IA64, 64-bit	Add *`{JProfiler install directory}/bin/hpux-ia64w`* to the environment variable `SHLIB_PATH`.
AIX, 32-bit	Add *`{JProfiler install directory}/bin/aix-ppc`* to the environment variable `LIBPATH`.
AIX, 64-bit	*`{JProfiler install directory}/bin/aix-ppc64`* to the environment variable `LIBPATH`.
FreeBSD x86, 32-bit	Add *`{JProfiler install directory}/bin/freebsd-x86`* to the environment variable `LD_LIBRARY_PATH`.
FreeBSD x86, 64-bit	Add *`{JProfiler install directory}/bin/freebsd-x64`* to the environment variable `LD_LIBRARY_PATH`.

The remote session invocation table [p. 108] shows the complete commands for all supported JVMs.

Please note that the profiling interfaces JVMPI and JVMTI only run with the standard garbage collection. If you have VM parameters on your command line that change the garbage collector type such as

- `-Xincgc`
- `-XX:+UseParallelGC`
- `-XX:+UseConcMarkSweepGC`
- `-XX:+UseParNewGC`

please make sure to remove them. It might be a good idea to remove all `-XX` options if you have problems with profiling.

If you start your application from an ant build file, you can use the ant task [p. 262] to easily profile your application.

B.3.11 Remote Session Invocation Table

Please look at the help page on starting remote sessions [p. 105] for a complete sequence of steps that need to be taken for remote profiling. Below you find the condensed instructions on how to modify your startup command for a remote profiling session. The table shows all supported JVM vendors and versions. Square brackets like `[your path to agent.jar]` are to be replaced according to the textual description, or they contain platform dependent options, like `[solaris: -native]`, which means that on Solaris, you should add `-native` but nothing on other platforms.

`${PARAM}` is to be replaced by the parameters you would like to pass to the profiling agent. The following parameters are available:

- **port=nnnnn** chooses the port on which the agent listens for remote connections. Be sure to use the same value in JProfiler's GUI front end.

- **address=[IP address]** chooses the IP address that the socket for the remote connection should bind to. By default, the agent binds the socket to all network interfaces. If this is not desirable for security reasons, you should use this option.
- **nowait** tells the profiling agent to let the JVM start up immediately. Usually, the profiled JVM will wait for a connection from the JProfiler GUI before starting up. For 1.5 JVMs or earlier, the parameters **id** has to be supplied as well. Optionally, you can also supply the **config** parameter in that case.
- **offline** enables the offline profiling [p. 259] mode. You cannot connect with the GUI front end when using the offline profiling mode. The parameters **id** has to be supplied as well. Optionally, you can also supply the **config** parameter.
- **id=nnnnn** chooses the session used with the **offline** or **nowait** parameters. This is only required for 1.5 JVMs or earlier.
- **config=[path to JProfiler config file]** supplies the path to JProfiler's configuration file. This parameter is only relevant for offline profiling [p. 259] and profiling with the **nowait** parameter (in the latter case only if the profiled JVM has a version of 1.5 or earlier). If **config** is not specified for those cases, the profiling agent will attempt to load the config file from its standard location. Reading the config file is necessary to retrieve profiling settings that have to be known at startup for the session that was selected with the **id** parameter.

`${LIBRARY}` (JVMTI only) is to be replaced by the full path to the native JProfiler library [p. 105] .

Multiple parameters are separated by commas such as in

"**offline,id=172,config=~/.jprofiler7/config.xml**".

In addition to the standard parameters above, there are the following trouble-shooting and debugging parameters:

- **verbose-instr** prints the names of all instrumented classes to stderr. This is a debugging parameter.
- **jniInterception** enables the detection of object allocations via JNI calls. This parameter is only relevant for Java 1.5.0_00, 1.5.0_01 and 1.5.0_02. This feature is **enabled by default** for Java 1.5.0_03 and higher. Due to a bug in Java 1.5.0_02 and lower, it is disabled when profiling with those releases. Please make sure **not to use `-Xcheck:jni`** when you specify this parameter for Java 1.5.0_02 and lower.
- **stack=nnnnn** sets the maximum stack size for dynamic instrumentation. Only change this parameter when JProfiler emits corresponding error messages. The default value is 10000.
- **samplingstack=nnnnn** sets the maximum stack size for sampling. Only change this parameter when JProfiler emits corresponding error messages. The default value is 200.

Vendor: **Oracle (formerly Sun)**

Version 1.4.1

- hotspot mode:

```
java  -Xrunjprofiler:${PARAM} -Xbootclasspath/a:[path
to agent.jar] [your JVM parameters] -classpath [class
path] [main class] [parameters]
```

- interpreted mode:

```
java -Xint -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Version 1.4.2

see version 1.4.1

Version 1.5.0

- hotspot mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- interpreted mode:

```
java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- hotspot (JVMPI) mode:

```
java -Xshare:off -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note: deprecated, default interface JVMTI is preferred

- interpreted (JVMPI) mode:

```
java -Xint -Xshare:off -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note: deprecated, default interface JVMTI is preferred

Version 1.6.0

- hotspot mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- interpreted mode:

```
java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Version 1.7.0

see version 1.6.0

Version 1.8.0

see version 1.6.0

Vendor: **IBM Corporation**

Version 1.4.1

- interpreted mode:

```
java -Djava.compiler=none -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- jit compiler mode:

```
java  -Xrunjprofiler:${PARAM} -Xbootclasspath/a:[path
to agent.jar] [your JVM parameters] -classpath [class
path] [main class] [parameters]
```

Note: does not work with sampling

Version 1.4.2

see version 1.4.1

Version 1.5.0

- jit compiler mode:

```
java  -agentpath:${LIBRARY}=${PARAM} -Xshareclasses:none
[your JVM parameters] -classpath [class path] [main
class] [parameters]
```

  Note: does not work with sampling

- interpreted mode:

```
java -Djava.compiler=none -agentpath:${LIBRARY}=${PARAM}
-Xshareclasses:none [your JVM parameters] -classpath
[class path] [main class] [parameters]
```

Version 1.6.0

- jit compiler mode:

```
java  -agentpath:${LIBRARY}=${PARAM} -Xshareclasses:none
[your JVM parameters] -classpath [class path] [main
class] [parameters]
```

  Note: does not work with sampling

- interpreted mode:

```
java -Djava.compiler=none -agentpath:${LIBRARY}=${PARAM}
-Xshareclasses:none [your JVM parameters] -classpath
[class path] [main class] [parameters]
```

Version 1.7.0

see version 1.6.0

Vendor: **Apple Computer, Inc.**

Version 1.4.1

- hotspot mode:

```
java  -Xrunjprofiler:${PARAM} -XX:-UseSharedSpaces
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- interpreted mode:

```
java -Xint -Xrunjprofiler:${PARAM} -XX:-UseSharedSpaces
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Version 1.4.2

see version 1.4.1

Version 1.5.0

- hotspot mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- interpreted mode:

```
java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- hotspot (JVMPI) mode:

```
java -XX:-UseSharedSpaces -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note: deprecated, default interface JVMTI is preferred

- interpreted (JVMPI) mode:

```
java -Xint -XX:-UseSharedSpaces -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note: deprecated, default interface JVMTI is preferred

Version 1.6.0

- hotspot mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- interpreted mode:

```
java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Vendor: **Oracle JRockit**

Version 1.4.1

- default (JVMPI) mode:

```
java -Xjvmpi:entryexit=off -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note:

- noopt mode:

```
java -Xnoopt -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Version 1.4.2

see version 1.4.1

Version 1.5.0

- default mode:

```
java  -Xrunjprofiler:${PARAM} -Xbootclasspath/a:[path
to agent.jar] [your JVM parameters] -classpath [class
path] [main class] [parameters]
```

Note:

- default (JVMPI) mode:

```
java -Xjvmpi:entryexit=off -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

  Note:

- noopt mode:

```
java -Xnoopt -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Version 1.6.0

- default mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

  Note:

Vendor: **Hewlett-Packard Co.**

Version 1.4.1

- hotspot mode:

```
java  -Xrunjprofiler:${PARAM} -Xbootclasspath/a:[path
to agent.jar] [your JVM parameters] -classpath [class
path] [main class] [parameters]
```

- interpreted mode:

```
java -Xint -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Version 1.4.2

see version 1.4.1

Version 1.5.0

- hotspot mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- interpreted mode:

```
java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- hotspot (JVMPI) mode:

```
java -Xshare:off -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

  Note: deprecated, default interface JVMTI is preferred

- interpreted (JVMPI) mode:

```
java -Xint -Xshare:off -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note: deprecated, default interface JVMTI is preferred

Version 1.6.0

- hotspot mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- interpreted mode:

```
java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Vendor: **The FreeBSD Foundation**

Version 1.4.1

- hotspot mode:

```
java  -Xrunjprofiler:${PARAM} -Xbootclasspath/a:[path
to agent.jar] [your JVM parameters] -classpath [class
path] [main class] [parameters]
```

Note: does not work with full instrumentation

- interpreted mode:

```
java -Xint -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Version 1.4.2

see version 1.4.1

Version 1.5.0

- hotspot mode:

```
java  -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note: does not work with full instrumentation

- interpreted mode:

```
java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

- hotspot (JVMPI) mode:

```
java -Xshare:off -Xrunjprofiler:${PARAM}
-Xbootclasspath/a:[path to agent.jar] [your JVM
parameters] -classpath [class path] [main class]
[parameters]
```

Note: deprecated, default interface JVMTI is preferred

- interpreted (JVMPI) mode:

  ```
  java -Xint -Xshare:off -Xrunjprofiler:${PARAM}
  -Xbootclasspath/a:[path to agent.jar] [your JVM
  parameters] -classpath [class path] [main class]
  [parameters]
  ```

  Note: deprecated, default interface JVMTI is preferred

Version 1.6.0

- hotspot mode:

  ```
  java  -agentpath:${LIBRARY}=${PARAM} [your JVM
  parameters] -classpath [class path] [main class]
  [parameters]
  ```

  Note: does not work with full instrumentation

- interpreted mode:

  ```
  java -Xint -agentpath:${LIBRARY}=${PARAM} [your JVM
  parameters] -classpath [class path] [main class]
  [parameters]
  ```

B.3.12 Saving Live Sessions To Disk

Snapshots of live profiling sessions can be saved to disk by selecting *Session->Save snapshot* from JProfiler's main menu or by clicking on the corresponding 💾 tool bar entry in JProfiler's main tool bar.

A file chooser will be brought up where you can select the name and directory of the snapshot file to be written. The standard extension of JProfiler's snapshot files is `*.jps`. Once JProfiler has finished writing the snapshot to disk, a message box informs you that the snapshot was saved.

A bookmarks [p. 135] will be added when a snapshot is saved manually.

Besides JProfiler snapshots, JProfiler can also save and open **HPROF heap dump files** with the *Profiler->Save HPROF snapshot*. You will be asked to provide a file name for the HPROF snapshot. The snapshot file will be given an .hprof extension and will be saved on the computer where the profiled JVM is running. The path will be interpreted as relative to the current directory of the profiled JVM.

In situations where physical memory is sparse, saving an HPROF snapshot can be preferable compared to saving a full JProfiler snapshot. Also, there are alternative ways to save HPROF snapshots:

- **with -XX:+HeapDumpOnOutOfMemoryError**

  The -XX:+HeapDumpOnOutOfMemoryError VM parameter is supported by Sun 1.4.2_12+, 1.5.0_07+ and 1.6+ JVMs and is the basis of the "Out of memory exception" trigger type [p. 92] .
- **with jmap**

  The jmap executable in the JDK can be used to extract an HPROF heap dump from a running JVM. It is partially supported by Sun 1.5 JVMs and supported by all Sun 1.6 JVMs.
- **with jconsole**

  The jconsole executable in the JDK can be used to extract an HPROF heap dump from a running JVM. It is available for Java 1.5+. Starting with Java 1.6 you can attach to any local Java process without any modifications, for Java 1.5, some modifications of the VM parameters are required.

You can also save snapshots with the offline profiling [p. 259] API or use a trigger [p. 91] and the "Save snapshot" and "Create a HPROF heapdump" actions [p. 95] to save snapshot in an exact way. This is also useful for offline profiling [p. 259] .

Saved snapshots can be loaded

- by selecting *Session->Open snapshot* from JProfiler's main menu.
- by selecting a file from the "Open snapshot" tab in JProfiler's start center [p. 60] .

The following restrictions apply when viewing snapshots:

- **JProfiler snapshots**

  After a JProfiler snapshot has been loaded, the functionality of all views is identical to a live profiling session with the exception of the heap walker view [p. 158] : The heap walker overview will be shown if a heap snapshot was taken at the time of saving, otherwise the heap walker will be unavailable.
- **HPROF snapshots**

  When an HPROF snapshot is loaded, only the heap walker is available. Also, the "Allocations" and "Time" views of the heap walker are not available.

The status bar indicates that a snapshot is being viewed by displaying the message 💾 **Snapshot** in its rightmost compartment.

B.3.13 Config Synchronization Options Dialog

This dialog is displayed when clicking on **[config synchronization options]** in the application settings dialog [p. 75] of a remote session [p. 77] .

Note: These settings are only relevant if you are profiling a 1.5 JVM or earlier, and you have specified the `nowait` option for the -Xrun... or -agentpath... VM parameter. In that case, the config file needs to be synchronized on the remote computer when the profiling settings are changed.

There are 3 possible actions when the config file has to by synchronized:

- **manual synchronization**

  Nothing is done, you have to copy the config file yourself if you want the new settings to become active for the next profiling run.
- **copy to directory**

  The config file is copied to the specified directory. You can use the **[...]** chooser button to select the directory with a file chooser.
- **execute command**

  The specified command is executed. For example you could invoke `ssh` to copy the config file to a remote computer.

  No terminal window is shown during the execution. If you have to show a terminal window on Windows, you can use

  ```
  cmd.exe /C "start /WAIT cmd.exe /C [your command here]"
  ```

Please note that in all cases the profiled JVM has to be restarted in order for the changes to take effect.

B.3.14 Importing And Exporting Sessions Settings

You can export session settings to an XML file and import them in a different JProfiler installation. Also, the command line integration wizard [p. 61] produces config files with a remote session that you can import in the JProfiler GUI.

For exporting sessions to an XML file, choose *Session->Export Session Settings* from JProfiler's main menu. You will be asked for the following information:

- **Sessions to export**

  Select one or more sessions to be exported. To select all sessions, press `CTRL-A` in the list and hit `SPACE` for toggling the selection. The file format of the exported file is the same as JProfiler's config file [p. 74] . Licensing information and general settings are omitted.

- **Location of the exported file**

  The location can be a file path or a directory path. For a directory path the exported file will be named *`config.xml`*. The text field that displays the location supports auto-completion.

For importing sessions from an XML file, choose *Session->Import Session Settings* from JProfiler's main menu. In the file chooser, select the config file that should be imported. A dialog will be shown that lists all sessions contained in the config file and allows you to select which sessions to import. To select all sessions, press `CTRL-A` in the list and hit `SPACE` for toggling the selection.

B.4 General Settings

B.4.1 General Settings

JProfiler's general settings are divided into several tabs:

- JDK and JREs [p. 118]

  Configure JDKs for the code editor and JREs for launching profiling sessions.
- Session defaults [p. 120]

  Configure some initial properties of a new session.
- Snapshots [p. 120]

  Configure additional options for snapshots.
- IDE integrations [p. 121]

  Install IDE integrations for JProfiler.
- Miscellaneous [p. 121]

  Configure miscellaneous options for JProfiler.

B.4.2 Configuring JVMs In General Settings

JProfiler needs JDK and JRE configurations for two different purposes:

- **JDKs for code completion and compiling scripts**

  A default JDK can be configured for sessions that do not explicitly set a JDK in their code editor settings [p. 80] . The JDK configuration is used for code completion and compiling scripts [p. 123] .

  When you click on the **[Configure JDKs]** button, the JDK configuration dialog is shown [p. 119] .

  If you do not define a default JDK, JProfiler will use the JRE that is used to run the JProfiler GUI. In that case, code completion does not offer parameter names in the JRE and there is no Javadoc for JRE classes.
- **JREs for launching profiled JVMs**

  Profiling sessions where the profiled JVM is launched by JProfiler need a JRE configuration. Here you can configure the default JRE for new sessions. It will be selected in the JRE drop-down list in the application settings [p. 75] after you create a new session.

  When you click on the **[Configure JREs]** button, the JRE configuration dialog is shown [p. 118] .

B.4.3 JRE Configuration For Launched Sessions

The JRE configuration dialog is displayed when you click the **[Configure JREs]** button in the general settings dialog [p. 118] , or the application settings [p. 75] .

JRE configurations are used by profiling sessions that are **launched by JProfiler**. Any changes you make to an existing JRE configuration directly affect the sessions which already use it.

When you ✚ add a new JRE in the JRE configuration dialog, a file chooser is brought up and prompts you for the selection of the home directory of the JVM (e.g. *c:\Program Files\Java\jre* or */usr/lib/java*). The selected virtual machine will be checked for usability by JProfiler and depending on success, a new entry in the JRE table is added.

The table that shows the configured JREs has several columns:

- Double-click on the "Name" column to change the name of the JRE configuration. This name is used for JRE selection in the application settings dialog [p. 75] .

- Double-click on "Java home directory" and enter a directory manually or click on the button labeled **[...]** to change the home directory of an existing JRE configuration. The new directory will be accepted only if the directory contains a JVM which is usable by JProfiler.
- Choose the JVM Mode from the "JVM Mode" combo box. This setting is initially set to the preferred value for the chosen JVM. See the remote session invocation table [p. 108] for details on this option.

If you ✖ delete an existing JRE configuration, all sessions which currently use the deleted JVM will remain without an associated JVM and will be unusable until you assign them a new one in the application settings dialog [p. 75] .

You can **search for JREs** by clicking the 🔎 search button on the right hand side of the dialog. This invokes the search wizard which corresponds to the functionality found in JProfiler's setup wizard. The search wizard shows all JREs found on your local fixed drives, but only new JREs will be merged into the JRE table.

The **default JRE for new sessions** can be configured in the general settings [p. 118] .

B.4.4 JDK Configuration For Code Editor And Script Compilation

The JDK configuration dialog is displayed when you click the **[Configure JDKs]** button in the general settings dialog [p. 118] , the editor settings dialog [p. 125] or the code editor session settings [p. 80] .

In this dialog, you can add one or more JDKs that will be available for the purposes explained on the script editor [p. 123] help page.

When you add a new JDK, you are asked for the home directory of the JDK that you want to enter. Instead of a JDK, you can also select a JRE, in which case no parameter names will be available in the code completion proposals of JDK methods. After you select the home directory, JProfiler will check whether the directory contains a JDK or JRE and runs `java -version` to determine the version of the selected JDK or JRE.

The table that shows the configured JDKs has several columns:

- **Name**

  Double-click on the "Name" column to change the name of the JDK. This name is used for JDK selection in drop-down lists.

  When you add a JDK, the name "JDK [major version].[minor version]" will be suggested by default. If the selection is a JRE, "JRE [major version].[minor version]" will be suggested instead. The name of the JDK configuration must be unique.
- **Java Home Directory**

  This is the Java home directory that you selected when you added the configuration. You can change the Java home directory by editing this column. The Java version check will be performed again and the version displayed in the "Java Version" column will be updated. The name of the configuration will not be changed.
- **Javadoc Directory**

  In this column, you can enter the location of the Javadoc that should be associated with this JDK configuration. The Javadoc directory can remain empty in which case no context-sensitive Javadoc help will be available for classes from the runtime library.
- **Java Version**

  This uneditable column shows the version of the selected JDK configuration.

When you delete the JDK configuration that is currently used by a session, the session will still reference the same configured name for the JDK. It will then be shown in red color with a [not configured] message attached.

The **default JDK for sessions** that do not explicitly set a JDK in the can be configured in their code editor settings [p. 80] can be configured in the general settings [p. 118] .

B.4.5 Session Defaults

When you create new session, some default settings can be pre-configured:

- **Filter Settings**

  In the drop down list, you choose the template of filter rules [p. 81] that will be used for a new session. By default, the built-in "[Default Excludes]" template is used.

  The **[Manage]** button will bring up the filter template dialog [p. 82] .
- **Profiling Settings**

  In the drop down list, you choose the profiling settings [p. 85] that will be used for a new session. By default, the first built-in template is used.

  The **[Manage]** button will bring up the profiling template dialog [p. 91] .
- **Trigger Settings**

  In the drop down list, you choose the trigger set [p. 91] that will be used for a new session. By default, no triggers are added to a session.

  The **[Manage]** button will bring up the trigger set dialog [p. 98] .
- **Custom Probes**

  In the drop down list, you choose the custom probe set [p. 101] that will be used for a new session. By default, no custom probes are added to a session.

  The **[Manage]** button will bring up the custom probe set dialog [p. 98] .

B.4.6 Snapshots

Here you can configure **how the heap dump analysis is saved for snapshots**.

Most of the time spent when loading snapshots is for the analysis of the raw data, the removal of unreferenced objects and the retained size calculation. JProfiler stores the result of this analysis next to the snapshot if possible. This means that opening a snapshot that has already been analyzed is **orders of magnitudes faster** if a saved heap dump analysis can be found.

If the heap dump analysis takes up a too much disk space, you can switch off the heap dump analysis saving altogether on this tab. The analysis will then be created each time you open the snapshot. In general, if a heap dump analysis is missing or incorrect (e.g. from a different snapshot) it will simply be recreated.

The default storage format for the heap dump analysis is directory-based, e.g. if your snapshot is saved to *`snapshot.jps`*, the analysis is stored in the directory *`snapshot.jps.analysis`*. In that directory there are multiple files and further subdirectories that contain the entire analysis.

If this is not practical for some reason, you can choose the `TAR archive` or `Compressed TAR archive` options on this tab. Both of them make moving snapshots together with their analysis to a different computer easier since you only have one additional file. The compressed tar archive option is noticeably slower than the alternatives, but takes up less disk space.

Snapshots taken with offline profiling do not have an existing heap analysis. If you're taking these snapshots in an automated fashion, you can use the command line tool "jpanalyze" [p. 259] or the corresponding "analyze" ant task [p. 262] in order to massively speed up the opening of these snapshot in the JProfiler GUI.

B.4.7 IDE Integrations

JProfiler integrates seamlessly into most popular IDEs [p. 63] . See here [p. 63] for specific explanations regarding each IDE integration.

Select the desired IDE from the drop down list and click on **[Integrate]**. After completing the instructions, you can invoke JProfiler from the integrated IDE without having to specify class path, main class, working directory, used JVM and other options again. Also, IDE integrations **show source code directly in the IDE**.

JProfiler caches the location of integrated IDEs. If you repeat the installation of a particular integration, JProfiler will ask you whether to reuse the known location of the IDE. This is useful when updating to a newer version of JProfiler or for repairing a broken IDE integration.

B.4.8 Configuring Miscellaneous Options In General Settings

The following miscellaneous options are configurable:

- **Look and feel**

  The look and feel of JProfiler can be chosen as one of

  - **Alloy look and feel**

    Alloy look and feel is a cross-platform look and feel which is developed by Incors GmbH. This is the default setting on Linux/Unix.

  - **Java look and feel**

    Standard cross platform look and feel. Use this look and feel if you use JProfiler through a VNC client or similar and want to reduce the transmitted data.

  - **Native look and feel**

    Native look and feel on your platform. This is the default setting on Windows and Mac OS X.

  When you switch to a different look and feel, you have to restart JProfiler for the new setting to take effect.

  Note: This setting is not available on Mac OS X.

- **Tool bar icons**

  Tool bar icons in the main window and the script editor can be large with text, large without text or small. This setting can also be changed by right-clicking the tool bar in a location without buttons.

- **Hidden messages**

  Warning messages can be disabled by clicking the **Don't show this dialog again** checkbox in the warning dialog. To **enable selected warning messages again**, click the "Configure Hidden Messages" button.

- **Window sizes**

  By default, JProfiler remembers the sizes of important windows. You can disable this feature or clear the cache of stored window sizes.

- **External source viewer**

  The external source viewer command allows you to redirect all view source requests from the JProfiler GUI to an external application. You can use the variables $FILE and $LINE to reference the file and line number to be shown.

If you leave the text box empty, JProfiler will use its internal source viewer to show Java source code. When JProfiler is started from an IDE integration, the source code is always shown in the IDE itself.

B.5 Scripts

B.5.1 Scripts In JProfiler

JProfiler's built-in script editor allows you to enter custom logic in various places in the JProfiler GUI, including custom probe configuration [p. 101] , heap walker filters [p. 169] and inspections [p. 179] and the "Run interceptor script" trigger action [p. 95] .

The box above the edit area show the available parameters of the script as well as its return type. If parameters or return type are classes (and not primitive types), they will be shown as hyperlinks. Clicking on such a hyperlink opens the Javadoc in the external browser.

To get more information on classes from the `com.jprofiler.api.*` packages, please choose *Help->Show Javadoc Overview* from the menu and read the the help topic on custom probes [p. 53] .

A number of packages can be used without using fully-qualified class names. Those packages are:

- java.util.*
- java.io.*
- com.jprofiler.api.*
- com.jprofiler.api.probes.*

You can put a number of import statements as the first lines in the text area in order to avoid using fully qualified class names.

Scripts can be

- **expressions**

  An expression doesn't have a trailing semicolon and evaluates to the required return type.

  Example: `object.toString().contains("test")`

  The above example would work as a filter script in the outgoing reference view of the heap walker.
- **scripts**

  A script consists of a series of Java statements with a return statement of the required return type as the last statement.

  Example: `data[0] = ((Integer)probeContext.getMap().remove("myCount")).intValue();`

  The above example would work as the telemetry script in a custom probe configuration.

JProfiler detects automatically whether you have entered an expression or a script.

The Java editor offers the following code assistance powered by the eclipse platform:

- **Code completion**

  Pressing `CTRL-Space` brings up a popup with code completion proposals. Also, typing a dot (".") shows this popup after a delay if no other character is typed. While the popup is displayed, you can continue to type or delete characters with `Backspace` and the popup will be updated accordingly. "Camel-hump completion" is supported, i.e. typing `NPE` and hitting `CTRL-Space` will propose `NullPointerException` among other classes. If you accept a class that is not automatically imported, the fully qualified name will be inserted.

  The completion popup can suggest:

  - ⓥ variables and default parameters. Default parameters are displayed in bold font.
  - ⓟ packages (when typing an import statement)
  - ⓒ classes
  - ⓕ fields (when the context is a class)
  - ⓜ methods (when the context is a class or the parameter list of a method)

  You can configure code completion behavior in the Editor Settings [p. 125] .

  Parameter classes that are neither contained in the configured session class path [p. 75] nor in the configured JDK [p. 80] are marked as **[unresolved]** and are changed to the generic `java.lang.Object` type. To get code completion for these parameters, add the missing JAR files to the session class path.

- **Problem analysis**

  The code that you enter is analyzed on the fly and checked for errors and warning conditions. Errors are shown as red underlines in the editor and red stripes in the right gutter. Warnings (such as an unused variable declaration) are shown as a yellow backgrounds in the editor and yellow stripes in the right gutter. Hovering the mouse over an error or warning in the editor as well as hovering the mouse over a stripe in the gutter area displays the error or warning message.

  The status indicator at the top of the right gutter is

  - **green**

    if there are no warnings or errors in the code.
  - **yellow**

    if there are warnings but no errors in the code.
  - **red**

    if there are errors in the code. In this case the code will not compile and the session cannot be started.

  You can configure the threshold for problem analysis in the Editor Settings [p. 125] .

- **Context-sensitive Javadoc**

  Pressing `SHIFT-F1` opens the browser at the Javadoc page that describes the element at the cursor position. If no corresponding Javadoc can be found, a warning message is displayed. Javadoc for the Java runtime library can only be displayed if a JDK is configured for the session [p. 80] and a valid Javadoc location is specified in the JDK settings [p. 118] .

All key bindings in the Java code editor are configurable. Choose *Settings->Key Map* to display the Key map editor [p. 125] .

If the gutter icon in the top right corner of the dialog is green, your script is going to compile unless you have disabled error analysis in the Editor Settings [p. 125] . In some situations, you might want to try the actual compilation. Choosing *Code->Test Compile* from the menu will compile the script and display any errors in a separate dialog. Saving your script with the **[OK]** button will not test the syntactic correctness of the script unless the script is used right away.

Often you will want to **reuse a script that you have entered previously**. The **script history** saves recently used scripts. If you click on the script history tool bar button, a dialog will be shown where you can see all scripts that have been used recently. Scripts are organized by script signature and the current script signature is selected by default. When you confirm the script history dialog, the current script in the editor is replaced.

B.5.2 Editor Settings

The editor settings dialog is shown when you select *Settings->Java Editor Settings* from the menu in the script editor dialog [p. 123] .

In the **code completion popup settings** section, you can configure the following options:

- **Auto-popup code completion after dot**

  If selected, each time you type a dot (".") in the script editor, the code completion popup will be displayed after a certain delay unless you type another character in the meantime.
- **Delay**

  The "Auto-popup code completion after dot" feature above uses a configurable delay. By default, the delay is set to 1000 ms.
- **Popup height**

  The height of the completion popup in number of entries is configurable.

In the **display code problems** section, you can configure the threshold for which code problems are shown in the editor.

- **None**

  No code problems are displayed at all.
- **Errors only**

  Only problems that prevent code compilation are displayed. Errors show as red underlines in the editor and red stripes in the right gutter.
- **Errors and warnings**

  In addition to errors, warnings are displayed. Warnings cover all kinds of suspicious conditions that could be sources of bugs such as an unused local variable. Warnings are displayed as yellow backgrounds in the editor and yellow stripes in the right gutter.

In the **Javadoc Settings** section, there is an option to use the online documentation for the JProfiler API instead of the bundled HTML files. Since Windows 7, it is not possible to use anchors when showing URLs anymore, so JavaScript redirection files are used to navigate to anchors in the Javadoc documentation. When Internet Explorer is used, two warnings are displayed each time you invoke a show Javadoc action. By using the online documentation, these warnings are eliminated.

The **JDK for code editor** section mirrors the session JDK configuration in the code editor settings [p. 80] of the session settings dialog [p. 74] .

B.5.3 Key Map Editor

The key map editor is displayed by choosing *Settings->Key map* from the menu in the script editor dialog [p. 123] .

The active key map controls all key bindings in the editor. By default, the **[Default]** key map is active. The default key map cannot be edited directly. To customize key bindings, you first have to copy the default key map. Except for the default key map, the name of a key map can be edited by double-clicking on it.

When assigning new keystrokes or removing existing key strokes from a copied map, the changes to the base key map will be shown as "overridden" in the list of bindings.

The key map editor also features search functionality for locating bindings as well a conflict resolution mechanism.

Key bindings are saved in the file *`$HOME/.jprofiler7/editor_keymap.xml`*. This file only exists if the default key map has been copied. When migrating a JProfiler installation to a different computer, you can copy this file to preserve your key bindings.

B.6 Profiling Views

B.6.1 Views Overview

JProfiler organizes profiling data into **view sections** which collect similar or connected views. The view section chooser is located on the left side of JProfiler's main window, while the single views of a view section can be selected by choosing the tabs on the bottom of the window. View sections can also be switched via JProfiler's *Views* menu or the keyboard shortcuts which are indicated below.

- Memory views [p. 140]

  (`CTRL-1`) The memory view section contains views which are concerned with the details of object allocations.
- Heap walker [p. 158]

  (`CTRL-2`) The heap walker view section allows you to take a snapshot of the heap and analyze it in detail.
- CPU views [p. 190]

  (`CTRL-3`) The CPU view section contains views which are concerned with method calls and time measurements.
- Thread views [p. 213]

  (`CTRL-4`) The thread view section contains views which are concerned with the details of thread statuses and the life cycle of threads.
- Monitor views [p. 219]

  (`CTRL-5`) The monitor view section contains views which are concerned with the details of monitor contentions and wait states.
- Telemetry views [p. 227]

  (`CTRL-6`) The telemetry view section contains views which are concerned with historical characteristics of cumulated virtual machine variables.
- JEE & Probes [p. 229]

  (`CTRL-7`) The probes section contains views which record data from higher-level subsystems of the JRE.

Note: It is possible to create and export views from a saved snapshot [p. 115] from the command line [p. 266] or an ant build file [p. 273] . This is especially useful for an automated quality assurance process.

The functionality of the various views is strongly dependent on the **state of the current session** which is displayed on the right end of the status bar.

- If the session is **attached**, the complete functionality of all views is available.
- If the session is **detached**, the functionality of most views is incomplete. Any information which is not already stored in JProfiler's GUI front end and would have to be queried from the profiled application is unavailable.
- If a profiling snapshot [p. 115] is opened, the status bar displays **Snapshot**. The functionality of all views is identical to the **working state** with the exception of the heap walker view [p. 158] : The heap walker overview will be shown if a heap snapshot was taken at the time of saving, otherwise the heap walker will be unavailable.

Most views have specific **view settings** that can be edited by choosing *View->View settings* from the main menu or the corresponding toolbar button when the view is active.

Common properties of profiling views include

- Exporting views to HTML, CSV and XML [p. 133]
- Undocking views from the main window [p. 133]
- Sorting tables [p. 134]
- Source and bytecode viewer [p. 137]
- Dynamic view filters [p. 137]
- Quick search capability [p. 133]

B.6.2 JProfiler's Menu

JProfiler's toolbar and menu contain actions applicable to all views as well as actions which are view-sensitive or appear for certain views only. The common menu and toolbar entries fall into six categories:

The **session menu** contains actions to create, open and close sessions and snapshots.

- **Start center**

  (`CTRL-O`) Brings up JProfiler's start center [p. 60] . If there already is an open session in the current window, it will be discarded once a new session is opened. This action is also available from JProfiler's toolbar.

- **New window**

  (`CTRL-ALT-O`) Open in a new instance of JProfiler's main window and brings up JProfiler's start center [p. 60] .

- **New session**

  (`CTRL-N`) Creates a new session and brings up the application settings dialog [p. 75] . The new session will be started after leaving the dialog with **[OK]**. If there is already an open session in the current window, it will be discarded.

- **Integration wizards**

  This submenu contains the starting points for the application server integration wizards [p. 61] , just like the "New session" tab on the start center [p. 60] .

- **Conversion wizards**

  This submenu contains the starting points for the conversion wizards, just like the "Convert" tab on the start center [p. 60] .

- **Open session**

  Brings up the open session dialog [p. 103] . If there already is an open session in the current window, it will be discarded once a new session is opened.

- **Export session settings**

  Brings up a dialog where you can export settings for selected sessions [p. 117] to an external config file.

- **Import session settings**

  Brings up a dialog where you can import settings for selected sessions [p. 117] from an external config file.

- **Save snapshot**

(`CTRL-S`) Brings up a file chooser to select a snapshot file [p. 115] to be written. A dialog box informs about the successful completion of the operation. This action is also available from JProfiler's toolbar.

- **Open snapshot**

  Brings up a file chooser to select a snapshot file [p. 115] to be opened. If there already is an open session in the current window, it will be discarded.

- **Session settings**

  Brings up the session settings dialog [p. 74] .

- **General settings**

  Brings up the general settings dialog [p. 118] .

- **IDE integrations**

  Short cut to the IDE integrations tab of the general settings dialog [p. 121] where you can integrate all supported IDEs.

- **Close session**

  Closes the current session. If there is an open session in the current window, you will be asked for confirmation. The window will be kept open and reverted to its original state.

- **Close window**

  (`CTRL-W`) Closes the current window. If there is an open session in the current window, you will be asked for confirmation.

- **Exit JProfiler**

  (`CTRL-ALT-X`) After confirmation, closes all open main windows and exits JProfiler.

The **view menu** contains view-specific actions and gives access to the view settings dialog. View specific actions are described in the help page of the corresponding view [p. 127] .

- **View settings**

  (`CTRL-T`) Brings up the view settings dialog for the corresponding view. If disabled, the currently active view has no particular settings. This action is also available from JProfiler's toolbar.

The **profiling menu** contains actions which change the window or session as a whole.

- **Stop/Detach/Start/Attach session**

  (`F11`) This action is also available from JProfiler's toolbar.

  - Stops the session (all session types [p. 74] except remote session), i.e. the process is destroyed. In a stopped session, the profiling views are not fully functional [p. 127] (visible if currently started and not remote session).
  - Detaches the current remote session [p. 74] . The profiled JVM will be detached from JProfiler's front end and continues to run undisturbed. In a detached session, the profiling views are not fully functional [p. 127] (visible if currently attached and remote session).
  - Starts the application configured in the current session if it is an application session, applet session or Web Start session [p. 74] (visible if currently detached and not remote session).
  - Attaches the current remote session [p. 74] to a remote application or reconnects to it. (visible if currently detached and remote session).

- **Record allocation data**

  This action is also available from JProfiler's toolbar and status bar. The memory views [p. 140] and some telemetry views [p. 227] rely on allocation data.

  - Start recording allocation data. (visible if allocations are currently not recorded). Adds a bookmark with a solid line to all graph views with a time axis.
  - Stop recording allocation data. (visible if allocations are currently recorded). Adds a bookmark with a dashed line to all graph views with a time axis.

- **Record CPU data**

  This action is also available from JProfiler's toolbar and status bar. The CPU views [p. 190] rely on CPU data.

  - Start recording CPU data. (visible if CPU data is currently not recorded). Adds a bookmark with a solid line to all graph views with a time axis.
  - Stop recording CPU data. (visible if CPU data is currently recorded). Adds a bookmark with a dashed line to all graph views with a time axis.

- **Start / Change Request tracking**

  (`CTRL-F8`) Brings up the request tracking dialog [p. 211] . This action is also available from JProfiler's toolbar.

- **Enable triggers**

  This action is also available from JProfiler's status bar and toggles the trigger execution state [p. 99]

  - Enable triggers. (visible if triggers are currently not enabled). Adds a bookmark with a solid line to all graph views with a time axis.
  - Disable triggers. (visible if triggers are currently disabled). Adds a bookmark with a dashed line to all graph views with a time axis.

- **Enable trigger groups**

  Brings up a dialog to enable or disable groups of triggers [p. 99] .

- **Save HPROF snapshot**

  Brings up a dialog to select a path for an HPROF snapshot file [p. 115] to be saved. A dialog box informs about the successful completion of the operation.

- **Run garbage collector**

  Run the garbage collector in the profiled JVM. This action is also available from JProfiler's toolbar.

- **Add bookmark**

  Add a bookmark in all graph views with a time axis. Bookmarks can be renamed or deleted by right-clicking them and choosing the appropriate action from the context menu. Bookmarks can also be set programmatically from the profiling API.

- **Edit bookmarks**

  Brings up a dialog where you can edit all existring bookmarks [p. 136] .

- **Show global filters for method call recording**

Show a dialog with a tree view of all exclusive or inclusive filters [p. 82] that JProfiler uses when recording the method call tree. This action is also available at the bottom of several views that show call trees.

The **go to menu** provides one-click access to all of JProfiler's profiling views, grouped into the seven view sections [p. 127] .

The **window menu** allows you to keep track of all tops level windows created by JProfiler [p. 133] .

- **Undock/Dock view**

  (`CTRL-E`) This action is also available from the context menu when right clicking the view in the tab selector at the bottom of the window.

  - Undocks the view and shows it in a separate top level window. (visible if the currently active view is docked into the main window)
  - Docks the view and returns it to the main window. (visible if the currently active view is undocked)

- **Dock all floating views**

  Docks all currently undocked views into their main windows.
- **Cycle to previous window**

  (`CTRL-F2`) Activate the previous window in the window list and bring it to the front.
- **Cycle to next window**

  (`CTRL-F3`) Activate the next window in the window list and bring it to the front.
- **Tile all undocked views**

  Tile the desktop with all undocked views.
- **Stack all undocked views**

  Resize all undocked views to a standard size and stack them regularly on the desktop.
- **Close unused console windows**

  Close all console windows that do not have an active process associated with them.

At the bottom of the window menu you can directly navigate to a window by selecting it from the list.

The **help menu** gives access to help, web sites, and useful e-mail addresses for JProfiler.

- **Help contents**

  (`F1`) Brings up context sensitive help. This action is also available from JProfiler's toolbar.
- **Show quickstart dialog**

  (`SHIFT-F1`) Brings up the quickstart dialog [p. 58] .
- **Screencasts for JProfiler**

  Opens the web page with screen casts for JProfiler in your browser.
- **Check for update**

  Opens the updater which checks for a new JProfiler version in the same major series.
- **Purchase JProfiler online**

  Opens the online shop for JProfiler in your browser.

- **Contact sales**

  Brings up a sales contact form in your browser.
- **Contact support**

  Brings up a support contact form in your browser.
- **JProfiler on the web**

  Opens the main web site for JProfiler in your browser.
- **Enter license key**

  Allows you to enter your license key [p. 61] .
- **About JProfiler**

  Shows general information about your copy of JProfiler and its license status.

B.6.3 Common Topics

B.6.3.1 Exporting Views

All views can be exported to external formats by selecting **Export** from the *View* menu or context menu or clicking on the corresponding toolbar button. A file chooser will be brought up allowing you to specify the output file and the export format.

The export format is chosen with the "file type" combo box in the file chooser. The following export formats are available:

- **HTML**

  Available for all views. The view will be exported to an HTML file. Besides the HTML file, several image files might be written to a subdirectory `jprofiler_images`. If the option to open files after export [p. 121] is enabled, the web browser configured in the general settings [p. 121] is opened and the exported HTML file is displayed.

- **CSV data**

  Available for tabular views, hot spots views and graphs with a time axis. CSV data suitable for Microsoft Excel is written to a file. If the option to open files after export [p. 121] is enabled, the registered application for CSV is opened and the exported CSV file is displayed.

  Note: When using Microsoft Excel, CSV is not a stable format. Microsoft Excel on Windows takes the separator character from the regional settings. JProfiler uses a semicolon as the separator in locales that use a comma as a decimal separator and a comma in locales that use a dot as a decimal separator. If you need to override the CSV separator character you can do so by setting -Djprofiler.csvSeparator in `bin/jprofiler.vmoptions`.

- **XML data**

  Available for tree views and hot spots views. XML data with a self-explanatory format is written to a file. If the option to open files after export [p. 121] is enabled, the registered application for XML is opened and the exported XML file is displayed.

If you export the same view multiple times to the same directory under the same name, a running number will be appended to the filename. The export directory location is persistent and remembered across restarts.

With the HTML export functionality you can **print** all views from JProfiler via your web browser.

B.6.3.2 Quick Search

All tables or trees in JProfiler can be quick-searched by typing into the table or tree. The search term will be displayed in a yellow dialog at the top of the searched element. If no match is found, the search term is displayed in red. If a match is found, the search term is displayed in black and the match is made visible. The matched portion is drawn inverted with a green background.

To start the quick search, you can also choose *View->Find* where available or press `ALT-F3`.

To navigate between matches, you can use the arrow keys or `F3` and `SHIFT-F3`.

You can use wildcards in your search term, for example: `Font*Handle`.

B.6.3.3 Top-level Windows In JProfiler

All views in JProfiler can be undocked and promoted to a separate top level window by

- choosing *Window->Undock view* from JProfiler's main menu
- right clicking the view in the tab selector at the bottom of the window and choosing *Undock view* from the context menu.

An undocked view has a reduced main menu that contains only the *View* and *Window* menus from the main menu [p. 128] as well as a reduced toolbar. With *Window->Show main window for this session* (`CTRL-H`) the corresponding main window can be activated.

If a view has been undocked, a placeholder is shown in the corresponding tab in the main window. An undocked view can be re-docked into its main window by

- choosing *Window->Dock view* from the main menu of the undocked view.
- closing the window.
- clicking the dock button in the placeholder for the view.
- choosing *Window->Dock view* from JProfiler's main menu
- right clicking the view in the tab selector at the bottom of the window and choosing *Undock view* from the context menu.

Undocked views can be tiled or stacked with the *Window->Tile all undocked view* and *Window->Stack all undocked view* menu entries. Note that undocked views of all main windows are treated uniformly.

To dock all undocked views with a single action, please choose *Window->Dock all floating view*. Note that undocked views of all main windows are docked.

JProfiler keeps track of all created top level windows in the window list available at the bottom of the *Window* menu. These windows include

- main windows
- undocked views
- console windows
- source and bytecode viewers

This list does not include

- native console windows

- windows opened by the profiled application

To navigate to a window in the window list, click on it or use the *Window->Cycle to previous window* (`CTRL-F2`) and *Window->Cycle to next window* (`CTRL-F3`) menu entries.

B.6.3.4 Sorting Tables In Profiling Views

Many of JProfiler's profiling views are displayed as tables. These tables can be sorted by any column in three ways:

- Choose the sort column from the **context menu**.
- Choose the sort column from the *View->Sort* menu which appears for table views.
- Click on the column header of the sort column.

Performing one of these operations multiple times alternates between ascending and descending sort order. The current sort column and sort order is indicated graphically in the column headers as well as in the relevant menus.

Most numeric columns in JProfiler display only positive numbers. If negative negative numbers can be present, you might want to sort using either absolute or the normal ordering. This choice can be made in the view settings dialog of the relevant views.

B.6.3.5 Zooming And Navigating In Graphs

Some of JProfiler's profiling views are displayed as graphs.

The zoom level for these graphs can be adjusted in the following ways:

- **Zoom in** by rolling the mouse wheel toward you, clicking on the zoom in toolbar button or choosing the corresponding entry from the context menu.
- **Zoom out** by rolling the mouse wheel away from you, clicking on the zoom out toolbar button or choosing the corresponding entry from the context menu.
- **Zoom to 100%** by clicking on the zoom 100% toolbar button or choosing the corresponding entry from the context menu.
- **Fit graph to window** by clicking on the fit content toolbar button or choosing the corresponding entry from the context menu.

To zoom in **on a particular object**, you can select it first and then use the zoom in action described above.

Besides using the scrollbars to navigate to other parts of the graph you can drag the graph with the mouse to move it.

B.6.3.6 Bookmarks

All graph views with a time axis display **bookmarks**. Bookmarks are vertical lines at certain points of the time axis. Every bookmark has a **description**. When you hover with the mouse above a bookmark, the description will be displayed in a tooltip window. Bookmarks are **global for all views**, i.e. a bookmark is displayed in all graphs and has the same description everywhere.

Bookmarks are created

- when starting and stopping allocation recording [p. 140]
- when starting and stopping CPU recording [p. 190]
- when enabling or disabling triggers [p. 99]
- when starting and stopping method statistics recording [p. 206]
- when starting and stopping call tracing [p. 208]
- when saving a snapshot [p. 115]
- when taking a heap dump [p. 158]
- when profiling settings are updated [p. 74]
- when starting or stopping monitor recording [p. 219]
- when taking a thread dump [p. 218]
- **manually**

  You can manually add a bookmark at the current time by

  - clicking on the add bookmark button in the toolbar.
  - choosing *Profiler->Add bookmark* from the main menu.

You can add a bookmark at any past moment in time by moving the mouse to the desired point on a graph view with a time axis and choose *Add bookmark here* here from the main menu.

- **from the profiling API**

  You can use the profiling API in order to add a bookmark programatically.
- **with a trigger**

  You can also use a trigger [p. 91] and the "Add bookmark" action [p. 95] to add a bookmark. This is also useful for offline profiling [p. 259] .

For the **start event**, the bookmark is a solid line, for the **stop event**, the bookmark is a dashed line.

In graph views with a time axis you can

- **edit the properties of a bookmark**

  by right-clicking it and choosing *Edit bookmark* from the context menu. The dialog for editing a single bookmark [p. 136] will be displayed.
- **delete a bookmark**

  by right-clicking it and choosing *Delete bookmark* from the context menu.

The list of bookmarks can be shown by choosing *Profiling->Edit Bookmarks* from JProfiler's main menu. The bookmark dialog [p. 136] will be shown where you can edit, delete and export the list of bookmarks.

B.6.3.7 Editing Bookmarks

The bookmark dialog is invoked by choosing *Profiling->Edit Bookmarks* from JProfiler's main menu. It shows a list of all bookmarks [p. 135] . For each bookmark, the following properties are displayed:

- **Time**

  The time when the bookmark was set, relative to the start of the JVM.
- **Line style and color**

  The line style (solid or dashed) and the color of the bookmark line as shown in the graph views with a time axis is shown as a sample. For automatic bookmarks, solid lines indicate a start event, while dashed lines indicate a stop event.
- **Description**

  For automatic bookmarks, the description indicates the origin of the bookmark.

Bookmarks can be

- **edited** by selecting a single bookmark and clicking on the **[Edit]** button or by double-clicking on a bookmark. A dialog will be shown where you can edit the description, the color and the line style of the bookmark.
- **deleted** by selecting one or multiple bookmarks and clicking on the **[Remove]** button or hitting the `DEL` key.
- **sorted** by time or by description by clicking on the table columns.
- **searched** by typing into the table or choosing *Find* from the context menu.
- **exported** to HTML or CSV by clicking on the **[Export]** button in the lower-right corner of the dialog.

B.6.3.8 Integrated Source Code And Bytecode Viewer

Wherever applicable, JProfiler provides access to the source code as well as the bytecode of profiled classes and displays them in a source and bytecode viewer frame. The source and bytecode viewer has two tabs, one for source code and the other for bytecode. Both tabs display the same class. Invoking the source and bytecode viewer through the **Show source** action in the *View* menu or context menu displays the frame with the source tab activated, the **Show bytecode** action activates the bytecode tab first.

To be able to show the source code of a class, the source must be available from the source path [p. 75] of the session. To be able to jump directly to the chosen method in the source code viewer and to display the bytecode of a class, the class file must be available from the class path [p. 75] of the session. Changes in class path and source path for an active session are recognized immediately by the source and bytecode viewer.

The source code tab has a method selector combo box displaying the file structure of the source file, including inner classes and other top level classes. When selecting a method, the bytecode viewer opens the class file tree at the corresponding position. The tool bar actions allow you to copy text to the clipboard and search for text in the source file.

The bytecode of a class is displayed in a tree showing

- General information
- Constant pool
- Interfaces
- Fields
- Methods
- Class file attributes

If you look for the bytecode, select the "Code" child of the desired method. The bytecode viewer is extensively hyperlinked, allowing you to navigate easily to constant pool entries or branch targets and go back and forth in your navigation history with the ⬅ ➡ navigation controls at the top of the tab.

Note: When JProfiler is started through an IDE integration [p. 63] , the integrated source code viewer is not used and the source element is displayed in the IDE.

B.6.3.9 Dynamic View Filters

For many dynamic views and snapshot comparison views [p. 240] , **view filters** can be set at the bottom of the view. Enter a comma separated list of packages into the combo box and hit enter to dynamically filter the view.

You can specify **exceptions**, by adding a minus sign at the start of a package. Those packages will then not be included. For example:

```
com.mycorp,-com.mycorp.parser
```

will resolve all calls to the com.mycorp package hierarchy except any calls to the com.mycorp.parser sub-hierarchy. You can also start the filter list with exceptions, in that case all calls will be resolved except for the specified packages.

In one JProfiler main window, all dynamic views with a view filter box at the bottom share the same current view filter. To reset the view filter and show the entire content of the view again, click on **[Reset view filters]** in the lower right corner of the view. The combo box holds view filters that have been entered during the current session. Selecting an entry from the combo box enables the view filter immediately.

View filters have an effect similar to the inclusive filters that are set for the session. These are configured in the session settings dialog [p. 80] and are not adjustable without loss of recorded data while the session is active. However, the active filter sets of the session strongly influence the speed and memory consumption of the profiled application while the view filters don't. It is therefore advisable to activate as many filter sets as possible in the filter settings [p. 81] and use the view filters for dynamic drill down only.

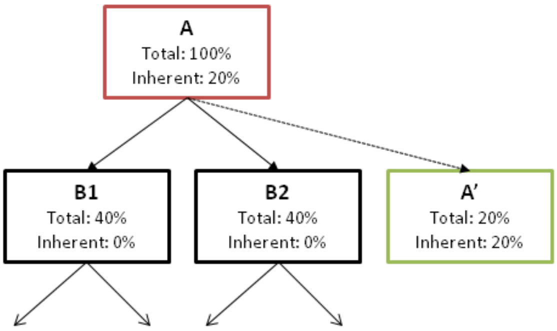
B.6.3.10 Tree Maps

Tree maps are shown by the allocation call tree view [p. 146] , the allocation tree map in the heap walker [p. 165] , the biggest objects view in the heap walker [p. 167] as well as the call tree view [p. 192]

Please see the Wikipedia page on tree maps for more information on tree maps in general.

Tree maps in JProfiler are **alternate visualizations of associated trees**. Each rectangle in the tree map represents a particular node in the tree. The area of the rectangle is proportional to the length of the percentage bar in the tree view. In contrast to the tree, the tree map gives you a **flattened perspective of all leafs in the tree**. If you are mostly interested in the dominant leafs of the tree, you can use the tree map in order to find them quickly without having to dig into the branches of the tree. Also, the tree map gives you an overall impression of the relative importance of leaf nodes.

By design, tree maps **only display values of leaf nodes**. Branch nodes are only expressed in the way the leaf nodes are nested. For non-leaf nodes which have significant inherent values, JProfiler constructs synthetic child nodes. In the diagram below, you can see that node A has an inherent value of 20% so that its child nodes have a sum of 80%. To show the 20% inherent value of A in the tree map, a synthetic child node A' with a total value of 20% is created. It is a leaf node and a sibling node of B1 and B2. A' will be shown as a colored rectangle in the tree map while A is only used for determining the geometric arrangement of its child nodes B1, B2 and A'.



The actual information for tree map nodes is displayed in **tool tips** that are immediately shown when you hover over the tree map. It corresponds to the information that is shown in the tree view mode. If a tree map rectangle exceeds a certain size, its name is printed directly in the tree map.

The tree map is shown up to a maximum nesting depth of 25 levels. The depth of the particular leaf in the tree map is encoded in its color. The color scale blends blue into yellow, where blue indicates a smaller and yellow a larger depth. The scale is always relative to all currently displayed nodes. For example, if you zoom into a particular area of the tree map, the scale will be re-adjusted so that that the depth of the parent node corresponds to blue. Below the tree map, a legend presents all possible colors as well as the displayed maximum and minimum depths.

Double-clicking on any colored rectangle in the tree map will zoom to the parent node unless the node is already a top-level node. There are tool bar actions for for zooming in and zooming out, as well as as context actions for showing the actual root of the associated tree.

In order to explore the hierarchical environment of a particular leaf in the tree map, there is a context action "Show In Tree", that switches to the tree view mode and selects the same node there.

B.6.3.11 Graphs With A Time Axis

There are many graphs with a time axis in JProfiler, such as the VM telemetry views [p. 227] , the thread history view [p. 214] or the time view in the heapwalker [p. 178] .

Graphs with a time axis have two different display modes. The display mode is a persistent view setting and is thus also accessible through the view settings dialog of each such view.

- **fixed scale**

  If you are currently in the "scale to fit window" mode, you can switch to this mode by

  - choosing the scale mode selector button at the top of the graph.
  - choosing *Scale to fit window* from the context menu.
  - checking `Scale to fit window` in the view settings dialog.

  In this mode, the time axis can be scrolled with the scroll bar on the bottom which appears if the total extent of the axis does not fit into the current view size.

  For dynamic views, if the current time is visible, the view is in **auto-follow mode** where the time axis is scrolled automatically when new data arrives to always show the current time. If you are not in auto-follow mode, because you scrolled back in time, just move the scroll bar to the right end of the time scale to re-enable auto-following.

  You can adjust the scale of the time axis by **zooming in or out**. Zooming in increases the level of detail while zooming out decreases it. You change the zoom level by

  - using the zoom controls at the top of the view.
  - choosing *Zoom in* and *Zoom out* from the context menu.

- **scale to fit window**

  If you are currently in the "fixed scale" mode, you can switch to this mode by

  - choosing the scale mode selector button in the lower right corner of the view.
  - choosing *Continue at fixed scale* from the context menu.
  - deselecting `Scale to fit window` in the view settings dialog.

  The time scale on the time axis is adjusted in order to show the total extent of the axis in the current size of the view. Zooming is not possible in this mode.

Grid lines and background of the graph can be configured in the view settings dialog.

B.6.4 Memory Views

B.6.4.1 Memory View Section

The memory view section contains the

- All objects view (JVMTI only) [p. 141]

  The all objects view shows the dynamic class-resolved statistics for the current heap usage. This view is only visible if you profile with Java 1.5 (JVMTI).
- Recorded objects view [p. 143]

  The recorded objects view shows the dynamic class-resolved statistics for the live and garbage collected objects that have been recorded.
- Allocation call tree [p. 146]

  The allocation call tree shows the allocation tree for the current heap usage and garbage collected objects.
- Allocation hot spots view [p. 150]

  The allocation hot spots view shows which methods are responsible for creating objects of a selected class.

Unless "Record allocations on startup" has been selected in the `Startup` section of the profiling settings dialog [p. 85] , data acquisition has to be started manually by clicking on **Record allocation data** in the tool bar or by selecting *Profiler->Record allocation data* from JProfiler's main menu. Bookmarks [p. 135] will be added when recording is started or stopped manually.

Allocation data acquisition can be stopped by clicking on **Stop recording allocation data** in the tool bar or by selecting *Profiler->Stop recording allocation data* from JProfiler's main menu.

The allocation recording state is shown in the status bar with a memory icon which is shown in gray when allocations are not recorded. Clicking on the memory icon will toggle allocation recording.

Restarting data acquisition **resets** all data in the the recorded objects view [p. 143] , the allocation call tree [p. 146] and the allocation hot spots view [p. 150] . Only the all objects view (JVMTI only) [p. 141] is not influenced by allocation recording.

When you stop recording allocations, the recorded objects will still be tracked for garbage collection. For example, if all recorded objects are garbage collected, both the recorded objects view and the allocation call tree will be empty in their default view mode (live objects only). You can then still display all recorded objects if you switch to one of the other two view modes (garbage collected only or both live and garbage collected).

Note that you can also use a trigger [p. 91] and the "Start recording" and "Stop recording" actions [p. 95] to control allocation recording in a fine-grained and exact way. This is also useful for offline profiling [p. 259] .

The heap walker [p. 158] will be able to display allocation call stack information only for recorded objects, otherwise the entire heap is displayed in the heap walker.

The memory views are integrated with the heap walker. The take heap snapshot with selection [p. 158] action on the toolbar, in the *View* and context menus takes a heap snapshot and creates an object set with the currently selected objects.

B.6.4.2 All Objects

B.6.4.2.1 All Objects

The all objects view shows the list of **all loaded classes** together with the number of instances which are allocated on the heap. This view is only visible if you profile with Java 1.5 (JVMTI). To see the objects allocated during a certain time period, and to record allocation call stacks, please use the recorded objects view [p. 143] .

The all objects view has an **aggregation level selector**. It allows you to switch between

- **Classes**

  Every row in the table is a single class. This is the default aggregation level.
- **Packages**

  Every row in the table is a single package. Sub-packages are not included. In this aggregation level, the table becomes a **tree table**. You can open each package by clicking on the tree node on its left and see the contained classes directly beneath it.
- **Java EE components**

  Every row in the table is a Java EE component [p. 88] . This aggregation level is like a filter for the classes mode and enables you to quickly check the loaded Java EE components in your profiled application.

There are three sortable columns shown in the table:

- **Name**

  Depending on the aggregation level, this column shows different values:

  - **classes**

    shows the name of the class or the array type. When using Java 1.4 or Java 1.5 with the old profiling interface JVMPI, the notation `<class>[]` stands for non-primitive arrays of any class type. (e.g. the array might be of type `String[]` or `Object[]`). A further distinction is not possible due to restrictions in the profiling interface.
  - **package**

    shows the name of the package.
  - **Java EE**

    shows the display name of the Java EE component. If the display name is different from the actual class name, the class name is displayed in square brackets.

- **Instance count**

  Shows how many instances are currently allocated on the heap. This instance count is displayed graphically as well.
- **Size**

  Shows the total size of all allocated instances. Note that this is the **shallow size** which does not include the size of referenced arrays and instances but only the size of the corresponding pointers. The size is in bytes and includes only the object data, it does not include internal JVM structures for the class, nor does it include class data or local variables.

The update frequency for the all objects view can be set on the miscellaneous tab [p. 89] in the profiling settings dialog [p. 85] . The update frequency of the all objects view is **adjusted automatically** according to the total number of objects on the heap. If there are many objects on the heap, the calculation of the all objects view becomes more expensive, so the update frequency is reduced. You can always retrieve the current data by clicking on the refresh button in the status bar.

You can add a selected class or package to the class tracker [p. 155] by bringing up the context menu with a right click and choosing `Add Selection To Class Tracker`. If the class tracker is not recording, recording will be started for all classes configured in the class tracker. If the class tracker is recording with a different object type or liveness type, all recorded data will be cleared after a confirmation dialog.

B.6.4.2.2 All Objects View Settings Dialog

The all objects view settings dialog is accessed by bringing the all objects [p. 141] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a size scale mode for all displayed sizes:

- **Automatic**

  Depending on the size value, it's displayed in MB, kB or bytes, in such a way that 3 significant digits are retained.
- **Megabytes (MB)**
- **Kilobytes (kB**
- **Bytes**

The **primary measure** defines which measurement will be shown in the second column of the all objects view. That column shows its values graphically with a histogram, is the default sort column **and is used for the difference column**. By default, the primary measure is the instance count. Alternatively, you can work with the shallow size, which is especially useful if you're looking at arrays.

The **sorting of the difference column** can be toggled between absolute value ordering or normal ordering.

B.6.4.3 Recorded Objects

B.6.4.3.1 Recorded Objects View

The recorded objects view shows the list of classes of all recorded objects and arrays together with the number of instances which are allocated on the heap. Only **recorded objects** will be displayed in this view. See the memory section overview [p. 140] for further details on allocation recording. The all objects view [p. 141] displays all objects, regardless of whether they have been recorded.

The recorded objects view has an **aggregation level selector**. It allows you to switch between

- **Classes**

  Every row in the table is a single class. This is the default aggregation level.
- **Packages**

  Every row in the table is a single package. Sub-packages are not included. In this aggregation level, the table becomes a **tree table**. You can open each package by clicking on the tree node on its left and see the contained classes directly beneath it.
- **Java EE components**

  Every row in the table is a Java EE component [p. 88] . This aggregation level is like a filter for the classes mode and enables you to quickly check the loaded Java EE components in your profiled application.

There are three sortable columns shown in the table:

- **Name**

  Depending on the aggregation level, this column shows different values:

  - **classes**

    shows the name of the class or the array type. When using Java 1.4 or Java 1.5 with the old profiling interface JVMPI, the notation `<class>[]` stands for non-primitive arrays of any class type. (e.g. the array might be of type `String[]` or `Object[]`). A further distinction is not possible due to restrictions in the profiling interface.
  - **package**

    shows the name of the package.
  - **Java EE**

    shows the display name of the Java EE component. If the display name is different from the actual class name, the class name is displayed in square brackets.

- **Instance count**

  Shows how many instances are currently allocated on the heap. This instance count is displayed graphically as well.
- **Size**

  Shows the total size of all allocated instances. Note that this is the **shallow size** which does not include the size of referenced arrays and instances but only the size of the corresponding pointers. The size is in bytes and includes only the object data, it does not include internal JVM structures for the class, nor does it include class data or local variables.

For a selected class or package, you can jump from the recorded objects view to the allocation call tree [p. 146] as well as the allocation hot spots [p. 150] by bringing up the context menu with a right click and choosing `Show allocation tree for selection` or `Show allocation hot spots for selection`.

You can add a selected class or package to the class tracker [p. 155] by bringing up the context menu with a right click and choosing `Add Selection To Class Tracker`. If the class tracker is not recording, recording will be started for all classes configured in the class tracker. If the class tracker is recording with a different object type or liveness type, all recorded data will be cleared after a confirmation dialog.

The recorded objects view can filter objects according to their liveness status:

- **Live objects**

  Only objects which are currently in memory are shown.
- **Garbage collected objects**

  Only objects which have been garbage collected are shown.
- **Live and garbage collected objects**

  All created objects are shown.

To switch between the three modes, you can click on the toolbar entry displaying the current mode and chose the new desired mode. Also, JProfiler's main menu and the context menu allow the adjustment of the view mode via *View->Change view mode*.

If the garbage collected objects are shown, you can reset the accumulated data by clicking on the reset action in the toolbar or choosing the the *Reset garbage collector for this view* menu item in the *View* or context menu. All garbage collector data will be cleared and the view will be empty for the "Garbage collected objects" mode until further objects are garbage collected. Note that you can force garbage collection by clicking on the garbage collector tool bar button or by selecting *Profiler->Run garbage collector* from JProfiler's main menu.

The update frequency for the recorded objects view can be set on the miscellaneous tab [p. 89] in the profiling settings dialog [p. 85] .

You can stop and restart allocation recording [p. 140] to clear the recorded objects view.

B.6.4.3.2 Recorded Objects View Settings Dialog

The recorded objects view settings dialog is accessed by bringing the recorded objects [p. 143] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a size scale mode for all displayed sizes:

- **Automatic**

  Depending on the size value, it's displayed in MB, kB or bytes, in such a way that 3 significant digits are retained.
- **Megabytes (MB)**
- **Kilobytes (kB**
- **Bytes**

The **primary measure** defines which measurement will be shown in the second column of the recorded objects view. That column shows its values graphically with a histogram, is the default sort column **and is used for the difference column**. By default, the primary measure is the instance count. Alternatively, you can work with the shallow size, which is especially useful if you're looking at arrays.

The **sorting of the difference column** can be toggled between absolute value ordering or normal ordering.

B.6.4.4 Allocation Call Tree

B.6.4.4.1 Allocation Call Tree

The allocation call tree shows a top-down call tree cumulated for all threads and filtered according to the filter settings [p. 81] which is similar to the one shown in the call tree view [p. 192] in JProfiler's CPU section [p. 190] except that it shows allocations of class instances and arrays instead of time measurements.

In order to prepare an allocation call tree, you have to click on the calculate toolbar button or choose *View->Calculate allocation call tree* from JProfiler's main menu. If an allocation tree has already been calculated, the context sensitive menu also gives access to this action.

Before the allocation call tree is calculated, the allocation options dialog [p. 156] is shown. The class or package selection as well as the selected liveness mode are displayed at the top of the allocation call tree view.

JProfiler automatically detects Java EE components [p. 88] and displays the relevant nodes in the allocation call tree with special icons that depend on the Java EE component type:

servlets

JSPs

EJBs

For JSPs and EJBs, JProfiler shows a display name:

- **JSPs**

  the path of the JSP source file
- **EJBs**

  the name of the EJB interface

If URL splitting is enabled in the servlet probe [p. 100] each request URL creates a new node with a special icon and the prefix **URL:**, followed by the part of the request URL on which the allocation call tree was split. Note that URL nodes **group request by the displayed URL**.

The allocation call tree view has an **aggregation level selector**. It allows you to switch between

- **methods**

  Every node in the tree is a method call. This is the default aggregation level. Special Java EE component methods have their own icon (see above) and display name, the real class name is appended in square brackets.
- **classes**

  Every node in the tree is a single class. Java EE component classes have their own icon (see above) and display name, the real class name is appended in square brackets.
- **packages**

  Every node in the tree is a single package. Sub-packages are not included.
- **Java EE components**

  Every node in the tree is a Java EE component [p. 88] . If the component has a separate display name, the real class names are omitted.

When you switch between two aggregation levels, JProfiler will make the best effort to **preserve your current selection**. When switching to a a more detailed aggregation level, there may not be a unique mapping and the first hit in the allocation call tree is chosen.

The allocation call tree doesn't display all method calls in the JVM, it only displays

- **unfiltered classes**

  Classes which are unfiltered according to your configured filter sets [p. 81] are used for the construction of the allocation call tree.
- **first level calls into unfiltered classes**

  Every call into a filtered class that originates from an unfiltered class is used for the construction of the allocation call tree. Further calls into filtered classes are not resolved. This means that a filtered node can include information from other filtered calls. Filtered nodes are painted with a **red marker in the top left corner**.
- **thread entry methods**

  The methods `Runnable.run()` and the main method are always displayed, regardless of the filter settings.

A particular node is a **bridge node** if it would normally not be displayed in the view, but has descendant nodes that have to be displayed. The icons of bridge nodes are **grayed out**. For the allocation call tree view this is the case if the current node has no allocations, but there are descendant nodes that have allocations.

When **navigating** through the allocation call tree by opening method calls, JProfiler automatically expands methods which are only called by one other method themselves.

To quickly **expand larger portions** of the allocation call tree, select a method and choose *View->Expand Multiple Levels* from the main window's menu or choose the corresponding menu item from the context menu. A dialog is shown where you can adjust the number of levels (20 by default) and the threshold in per mille of the parent node's value that determines which child nodes are expanded.

If you want to **collapse an opened part** of the allocation call tree, select the topmost method that should remain visible and choose *View->Collapse all* from the main window's menu or the context menu.

If a method node is selected, the context menu allows you to quickly add a method trigger [p. 91] for the selected method with the add method trigger action. A dialog [p. 98] will be displayed where you can choose whether to add the method interception to an existing method trigger or whether to create a new method trigger.

Nodes in the allocation call tree **can be hidden** by selecting them and hitting the `DEL` key or by choosing *Hide Selected* from the context menu. Percentages will be corrected accordingly as if the hidden node did not exist. All similar nodes in other call stacks will be hidden as well.

When you hide a node, the toolbar and the context menu will get a Show Hidden action. Invoking this action will bring up a dialog where you can select hidden elements to be shown again.

For method, class or package nodes, the context menu and the *View* menu have an **Add Filter From Selection** entry. The sub-menu contains actions to add appropriate filters [p. 81] as well as an action to add an ignored method entry [p. 84] .

If a node is excluded, you will get options to add an inclusive filter, otherwise you will get options to add an exclusive filter. These actions are not available for classes in the "java." packages.

The **tree map selector** above the allocation call tree view allows you to switch to an alternate visualization: A tree map that shows all call stacks as a set of nested rectangles. Please see the help on tree maps [p. 138] for more information.

If enabled in the view settings [p. 149] , every node in the allocation call tree has a **percentage bar** whose length is proportional to the total number of allocations including all descendant nodes and whose light-red part indicates the percentage of allocations in the current node.

Every node in the allocation call tree has textual information attached that depends on the allocation call tree settings [p. 149] and shows

- a **percentage number** which is calculated with respect to the root of the tree or calling node.
- a **size measurement** in bytes or kB which displays the shallow size of those objects which were allocated here (depends on cumulation view setting, see below).
- an **allocation count** which shows how many instances of classes and arrays have been allocated here (depends on cumulation view setting, see below).
- a **name** which depends on the aggregation level:
  - **methods**

    a method name that is either fully qualified or relative with respect to to the calling method.
  - **classes**

    a class name.
  - **packages**

    a package name.
  - **Java EE components**

    the display name of the Java EE component.
- a **line number** which is only displayed if
  - the aggregation level is set to "methods"
  - line number resolution has been enabled in the profiling settings [p. 86]
  - the calling class is unfiltered

  Note that the line number shows the line number of the invocation and not of the method itself.

The size and the allocation count are either cumulated for all calls below the associated node or not, depending on the corresponding cumulation view setting [p. 149] . Note that allocations performed in calls to filtered classes are consolidated in the first call into a filtered class.

If garbage collected objects are shown, you can reset the accumulated data by clicking on the reset action in the toolbar or choosing the the *Reset garbage collector for this view* menu item in the *View* or context menu. All garbage collector data will be cleared and the view will be empty for the "Garbage collected objects" mode until further objects are garbage collected and a new allocation call tree or allocation hot spots are calculated. Note that you can force garbage collection by clicking on the garbage collector tool bar button or by selecting *Profiler->Run garbage collector* from JProfiler's main menu.

Only recorded objects will be displayed in the allocation call tree view. See the memory section overview [p. 140] for further details on allocation recording.

The *View->Take heap snapshot for selection* menu item and the corresponding toolbar entry take a new snapshot, switch to the heap walker view [p. 158] and create an object set with the currently selected class and allocation spot.

B.6.4.4.2 Allocation Call Tree Settings

The allocation call tree view settings dialog is accessed by bringing the allocation call tree [p. 146] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The view mode can be toggled with the **cumulate allocations** checkbox. This sets whether allocations should be cumulated to show all allocations below any method or not.

You can select a size scale mode for all displayed sizes:

- **Automatic**

  Depending on the size value, it's displayed in MB, kB or bytes, in such a way that 3 significant digits are retained.
- **Megabytes (MB)**
- **Kilobytes (kB**
- **Bytes**

The **node description** options control the amount of information that is presented in the description of each node.

- **Show percentage bar**

  If this option is checked, a percentage bar will be displayed whose length is proportional to the number of allocations including all descendant nodes and whose light-red part indicates the percentage of allocations in the current node.
- **Always show fully qualified names**

  If this option is not checked, class names are omitted in intra-class method calls which enhances the conciseness of the display. This option is only relevant for the "methods" aggregation level.
- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear on the same level. This option is only relevant for the "methods" aggregation level.

The **percentage calculation** determines against what allocation numbers percentages are calculated.

- **Absolute**

  Percentage values show the contribution to the total number of allocations.
- **Relative**

  Percentage values show the contribution to the parent method.

Whether the contribution is cumulated or not depends on the `Cumulate allocations` setting (see above).

B.6.4.5 Allocation Hot Spots View

B.6.4.5.1 Allocation Hot Spots View

The allocation hot spots view shows a list of methods where objects of a selected class have been allocated. Only methods which contribute at least 0.1% of the total number of allocations are included. The methods are filtered according to the filter settings [p. 81] . This view is similar to the hot spots view [p. 197] in JProfiler's CPU section [p. 190] except that it shows allocations of class instances and arrays instead of time measurements.

Note: The notion of a hot spot is relative. Hot spots depend on the filter sets that you have enabled in the filter settings [p. 81] . Filtered methods are opaque, in the sense that they include allocations performed in calls into other filtered methods. If you change your filter sets you're likely to get different hot spots since you are changing your point of view. Please see the help topic on hot spots and filters [p. 41] for a detailed discussion.

In order to prepare allocation hot spots, you have to click on the calculate toolbar button or choose *View->Calculate allocation hot spots* from JProfiler's main menu. If allocation hot spots have already been calculated, the context sensitive menu also gives access to this action.

Before the allocation hot spots are calculated, the allocation options dialog [p. 156] is shown. The class or package selection as well as the selected liveness mode are displayed at the top of the allocation call tree view.

The combo box at the top-right corner of the view allows you to treat allocations of filtered classes in two different ways:

- **show separately**

  Filtered classes can contribute hot spots of their own. This is the default mode.
- **add to calling class**

  Allocations of filtered classes are always added to the calling class. In this mode, a filtered class cannot contribute a hot spot, except if it has a thread entry method (run and main methods).

With these two modes you can change your viewpoint and the definition of a hot spot. Please see the help topic on hot spots and filters [p. 41] for a detailed discussion of this topic.

Depending on your **selection of the aggregation level**, the method hot spots will change. They and their hot spot backtraces will be aggregated into classes or packages or filtered for Java EE component types.

Every hot spot is described in several columns:

- a **name** which depends on the aggregation level:
  - **methods**

    a method name that is either fully qualified or relative with respect to to the calling method.
  - **classes**

    a class name.
  - **packages**

    a package name.
  - **Java EE components**

    the display name of the Java EE component.
- the **percentage** of all allocations together with a bar whose length is proportional to this value.

- the **number of allocations**.

The hot spot list can be sorted on all columns [p. 134] .

If you click on the ⚠ handle on the left side of a hot spot, a tree of backtraces will be shown. Every node in the backtrace tree has textual information attached to it which depends on the allocation hot spots view settings [p. 154] .

- the **percentage** of all allocations. This value is calculated with respect either to the parent hot spot or the called method. The percentage base can be changed in the allocation hot spots view settings [p. 154] .
- the **number of allocations** that are contributed to the hot spot along this call path. If enabled in the view settings, every node in the hot spot backtraces tree has a **percentage bar** whose length is proportional to this number.

  Note: This is **not** the number of allocations in this method.
- a **name** which depends on the aggregation level:
  - **methods**

    a method name that is either fully qualified or relative with respect to to the calling method.
  - **classes**

    a class name.
  - **packages**

    a package name.
  - **Java EE components**

    the display name of the Java EE component.
- a **line number** which is only displayed if
  - the aggregation level is set to "methods"
  - line number resolution has been enabled in the profiling settings [p. 86]
  - the calling class is unfiltered

  Note that the line number shows the line number of the invocation and not of the method itself.

JProfiler automatically detects Java EE components [p. 88] and displays the relevant nodes in the hot spot backtraces tree with special icons that depend on the Java EE component type:

servlets

JSPs

EJBs

For JSPs and EJBs, JProfiler shows a display name:

- **JSPs**

  the path of the JSP source file
- **EJBs**

the name of the EJB interface

If URL splitting is enabled in the servlet probe [p. 100] each request URL creates a new node with a special icon and the prefix **URL:**, followed by the part of the request URL on which the hot spot backtraces tree was split. Note that URL nodes **group request by the displayed URL**.

The allocation hot spots view has an **aggregation level selector**. It allows you to switch between

- **methods**

  Every node in the tree is a method call. This is the default aggregation level. Special Java EE component methods have their own icon (see above) and display name, the real class name is appended in square brackets.
- **classes**

  Every node in the tree is a single class. Java EE component classes have their own icon (see above) and display name, the real class name is appended in square brackets.
- **packages**

  Every node in the tree is a single package. Sub-packages are not included.
- **Java EE components**

  Every node in the tree is a Java EE component [p. 88] . If the component has a separate display name, the real class names are omitted.

When you switch between two aggregation levels, JProfiler will make the best effort to **preserve your current selection**. When switching to a a more detailed aggregation level, there may not be a unique mapping and the first hit in the hot spot backtraces tree is chosen.

The hot spot backtraces tree doesn't display all method calls in the JVM, it only displays

- **unfiltered classes**

  Classes which are unfiltered according to your configured filter sets [p. 81] are used for the construction of the hot spot backtraces tree.
- **first level calls into unfiltered classes**

  Every call into a filtered class that originates from an unfiltered class is used for the construction of the hot spot backtraces tree. Further calls into filtered classes are not resolved. This means that a filtered node can include information from other filtered calls. Filtered nodes are painted with a **red marker in the top left corner**.
- **thread entry methods**

  The methods `Runnable.run()` and the main method are always displayed, regardless of the filter settings.

When **navigating** through the hot spot backtraces tree by opening method calls, JProfiler automatically expands methods which are only called by one other method themselves.

To quickly **expand larger portions** of the hot spot backtraces tree, select a method and choose *View->Expand Multiple Levels* from the main window's menu or choose the corresponding menu item from the context menu. A dialog is shown where you can adjust the number of levels (20 by default) and the threshold in per mille of the parent node's value that determines which child nodes are expanded.

If you want to **collapse an opened part** of the hot spot backtraces tree, select the topmost method that should remain visible and choose *View->Collapse all* from the main window's menu or the context menu.

If a method node is selected, the context menu allows you to quickly add a method trigger [p. 91] for the selected method with the add method trigger action. A dialog [p. 98] will be displayed where you can choose whether to add the method interception to an existing method trigger or whether to create a new method trigger.

Nodes in the hot spot backtraces tree **can be hidden** by selecting them and hitting the `DEL` key or by choosing *Hide Selected* from the context menu. Percentages will be corrected accordingly as if the hidden node did not exist.

When you hide a node, the toolbar and the context menu will get a Show Hidden action. Invoking this action will bring up a dialog where you can select hidden elements to be shown again.

For method, class or package nodes, the context menu and the *View* menu have an **Add Filter From Selection** entry. The sub-menu contains actions to add appropriate filters [p. 81] as well as an action to add an ignored method entry [p. 84] .

If a node is excluded, you will get options to add an inclusive filter, otherwise you will get options to add an exclusive filter. These actions are not available for classes in the "java." packages.

By **marking** the current state, you can follow the evolution of the allocation hot spots. This is particularly useful for quickly finding the origin of memory leaks. Marking the current values can be achieved by

- choosing *View->Mark current values* from JProfiler's main menu
- choosing the corresponding toolbar entry
- choosing *Mark current values* from the context menu

Upon marking, a fourth column labeled **Difference** appears with all values initially set to zero. With each subsequent calculation of the allocation hot spots, the column's values track the difference of the allocation count with respect to the point in time where the mark was set. The graphical representation of the percentage column shows the marked state in green and positive differences in red.

By default, the difference column is sorted on the **absolute values** in it, this can be changed in the allocation hot spots view settings dialog [p. 154] .

You can remove the mark by

- choosing *View->Remove mark* from JProfiler's main menu
- choosing *Remove mark* from the context menu

If garbage collected objects are shown, you can reset the accumulated data by clicking on the reset action in the toolbar or choosing the the *Reset garbage collector for this view* menu item in the *View* or context menu. All garbage collector data will be cleared and the view will be empty for the "Garbage collected objects" mode until further objects are garbage collected and a new allocation call tree or allocation hot spots are calculated. Note that you can force garbage collection by clicking on the garbage collector tool bar button or by selecting *Profiler->Run garbage collector* from JProfiler's main menu.

Only recorded objects will be displayed in the allocation hot spots view. See the memory section overview [p. 140] for further details on allocation recording.

The *View->Take heap snapshot for selection* menu item and the corresponding toolbar entry take a new snapshot, switch to the heap walker view [p. 158] and create an object set with the currently selected class and allocation hot spot.

B.6.4.5.2 Allocation Hot Spots View Settings

The allocation hot spots view settings dialog is accessed by bringing the allocation hot spots [p. 150] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a size scale mode for all displayed sizes:

- **Automatic**

  Depending on the size value, it's displayed in MB, kB or bytes, in such a way that 3 significant digits are retained.
- **Megabytes (MB)**
- **Kilobytes (kB**
- **Bytes**

The **node description** options control the amount of information that is presented in the description of each node.

- **Show percentage bar**

  If this option is checked, a percentage bar will be displayed whose length is proportional to the number of allocations that was contributed to the hot spot along the particular call path.
- **Always show fully qualified names**

  If this option is not checked, class name are omitted in intra-class method calls which enhances the conciseness of the display. This option is only relevant for the "methods" aggregation level.
- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear on the same level. This option is only relevant for the "methods" aggregation level.

The **percentage calculation** determines against what allocation numbers percentages are calculated for the hot spot backtraces.

- **Absolute**

  Percentage values show the contribution to the total number of allocations.
- **Relative**

  Percentage values show the contribution relative to the called method.

The **sorting of the difference column** can be toggled between absolute value ordering or normal ordering.

B.6.4.6 Class Tracker

B.6.4.6.1 Class Tracker View

The class tracker view can contain an arbitrary number of graphs that show **instances of selected classes and packages versus time**.

In order to start tracking classes, you have to click on the record toolbar button or choose *View->Record class tracker data* from JProfiler's main menu.

Before class tracking is started, the class tracker options dialog [p. 155] is shown. The selected classes and packages are shown in a combo box, the object type (all objects or recorded objects) and liveness mode (for recorded objects only) selections are shown at the top of the class tracker view.

After class tracking is started, the record button becomes a stop button that allows to to end recording for all feeds.

Data display and zoom controls are equivalent to those in the VM telemetry views [p. 227] . Always one class or package is displayed as a graph (a single "feed"), the combo box above the graph allows you to switch between the recorded classes and packages. With the add and remove buttons you can add and remove classes and package recordings without disrupting the recording of other feeds. The graph for each feed always starts at the point in time when a feed has been added. When you remove a feed, all associated data is deleted.

Stopping class tracking and re-starting it again at a later point does not delete previously recorded data unless the object type or liveness mode (for recorded objects) are changed.

The selection of classes and packages for the class tracker as well as the selected object type (all objects or recorded objects) and liveness type is **persistent for a session, across restarts of JProfiler**.

B.6.4.6.2 Class Tracker Options Dialog

The class tracker options dialog is displayed if you execute the record action for the class tracker view [p. 155] . It allows you to specify parameters that determine the way the displayed instance counts are calculated. Your selection will be displayed at the top of the class tracker.

The add button brings up the class and package selection dialog [p. 156] that allows you to select either a class or a package for addition to the list of classes and packages that should be tracked. With the remove button and the reorder buttons you can change the contents of that list before the tracking is started.

The class tracker view itself offers add and remove buttons in the top right corner as well.

If you profile with JVMTI (Java 1.5 and higher), you can select whether to use the total number of objects [p. 141] in the heap as the value for the graph or only the recorded objects [p. 143] . For JVMPI (Java 1.4 and lower), the recorded objects are always used.

If you track recorded objects, you can select their liveness which is explained in the help for the recorded objects view [p. 143] .

When you click on **[OK]**, tracking is started on the selected classes and packages and the graph for the first element in the list is displayed.

B.6.4.6.3 Class Tracker View Settings

The class tracker view settings dialog is accessed by bringing the class tracker [p. 155] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

This view settings dialog is equivalent to the VM telemetry view settings dialog [p. 228] .

B.6.4.7 Allocation Options Dialog

The allocation options dialog is displayed if you execute the calculate action for the allocation call tree view [p. 146] or the allocation hot spots view [p. 150] . It allows you to specify parameters that determine the information contained in the call tree. Your selection will then be displayed at the top of both views. The allocation call tree and the allocation hot spots are always calculated together, so the settings in this dialog apply to both views.

The allocation call tree and allocation hot spots can display:

- **Cumulated allocations for all classes**

  The allocation call tree and the allocation hot spots will show all allocations, regardless of the class or array type.
- **Allocations for a selected class or package**

  Use the **[...]** chooser button to select a class or package that should be displayed by the allocation call tree and the allocation hot spots views. This brings up the class selection dialog [p. 156] .

If the allocation recording mode [p. 88] is set to "Live and GCed objects without class resolution", it is not possible to switch to select class for the "Allocations for a selected class or package" mode and a corresponding warning message will be displayed.

The allocation call tree can show objects according to their liveness status:

- **Live objects**

  Only objects which are currently in memory are shown.
- **Garbage collected objects**

  Only objects which have been garbage collected are shown.
- **Live and garbage collected objects**

  All created objects are shown.

If the allocation recording mode [p. 88] is set to "Live objects only", it is not possible to switch to view modes with garbage collected objects and a corresponding warning message will be displayed.

By default, the data in the allocation call tree and allocation hot spots views will not be updated automatically. If you would like to periodically update the views with the current data, select the `Auto-update the allocation views` check box. Please note that for large heaps this can incur a significant performance overhead.

When you click on **[OK]**, the allocation tree and the allocation hot spots are calculated. If you have a large heap, this can take a few seconds. If you click cancel, no new allocation tree and allocation hot spots will be calculated.

B.6.4.8 Class And Package Selection Dialog

The class and package selection dialog is shown when JProfiler prompts you to select a class or package.

The tree view displays all arrays and classes in a hierarchical package tree. You can select

- **Classes**

  A single class can be chosen by double-clicking on it or selecting it in the tree and clicking **[OK]** or pressing the `Enter` key.
- **Packages**

An entire package **and all its recursively contained sub-packages** can be chosen by selecting the desired package in the tree and clicking **[OK]** or pressing the `Enter` key.

- **Arrays**

  An array type can be chosen by opening the `<Arrays>` top level node and double-clicking on the desired array type or selecting it and clicking **[OK]** or pressing the `Enter` key.

You can leave the dialog by pressing `Escape` or clicking **[Cancel]**.

B.6.5 Heap Walker

B.6.5.1 Heap Walker View Section

With the heap walker, you can find memory leaks, look at single instances and flexibly select and analyze objects in several steps.

Important notions are

- **the current snapshot**

  The heap walker operates on a static snapshot of the heap which is taken by

  - clicking on the corresponding toolbar button
  - using the "Take heap snapshot for selection" action in the memory views [p. 140] .

  If a snapshot has already been taken, it will be discarded after confirmation. If the current session [p. 74] is detached [p. 127] , it is not possible to take a new snapshot, Taking a snapshot may take from a few seconds to a few minutes depending on the heap size of the profiled application.

  A bookmark [p. 135] will be added when a heap snapshot is taken manually.

  Note that you can also use a trigger [p. 91] and the "Trigger heap dump" action [p. 95] to take a snapshot. This is especially useful for offline profiling [p. 259] .
- **the initial object set**

  After a snapshot has been fully prepared, you are taken to the the classes view [p. 163] and all objects in the snapshot are displayed. You can return to this view at any later point by

  - choosing *View->Heap walker start view* from JProfiler's main menu
  - clicking on the the corresponding toolbar button

- **the current object set**

  After each selection step a new object set is created which then becomes the current object set. Starting with the initial object set, you add selection steps and change the current object set to drill down toward your objective. The contents of the current object set (any number of instances of classes and arrays) are described in the title area of the heap walker.

  You can calculate the retained size and the deep size of the entire object set by clicking on the "Calculate retained and deep sizes" hyperlink in the title area. Once the calculation is finished, the hyperlink is replaced with the results.

  The history of your selection steps can be shown at the bottom by clicking on the the corresponding toolbar button
- **the view on the current object set**

  All views share the same basic layout [p. 160] . There are 5 top-level views which **show information on the current object set**:

  - the classes view [p. 163]
  - the allocation view [p. 165]
  - the biggest objects view [p. 167]
  - the reference view [p. 169]
  - the time view [p. 178]

  In addition there are two more views:

  - the inspections view [p. 179] which shows inspection that **operate on the current object set**
  - the graph [p. 184] which does not show data from the current object set. You can add objects from the reference and biggest objects views that are **not cleared when you add selection steps**.

  The view is chosen either

  - using the view selector at the bottom of the heap walker.
  - or from the view helper dialog [p. 188] that is displayed each time a new object set is created. You can suppress this dialog in the heap walker view settings [p. 188] .

- **the three types of size measurements**

  The title area of the heap walker displays several sizes for single objects or object sets. All sizes include only the object data, they do not include internal JVM structures for classes, nor do they include class data or local variables.

  - **shallow size**

    The shallow size does not include the size of referenced arrays and instances but only the size of the corresponding pointers. Shallow sizes are trivially available for all objects and object sets and are displayed in all views.
  - **retained size**

    The retained size is calculated as the shallow size plus total size of all objects that would be garbage collected if the current object or object set were removed. This size tells you how much memory is really behind an object or object set. Retained size calculation is done for all objects when the heap dump is processed. Retained sizes are shown for single instances in several views.
  - **deep size**

    The deep size is calculated as the shallow size plus total size of all referenced objects. In extreme cases, this value may be a significant percentage of the entire heap. Deep size calculation is only available for the current object set.

The ⇦ ⇨ history controls of the heap walker in JProfiler's toolbar allow you to go backward and forward in the **history of your view changes**. View changes where selection steps were performed, as well as those performed through the view selector are recorded in the history.

Changing the current object set is done by clicking on the **[Use selected]** buttons in the heap walker views. You first select objects of interest and then use this button to create a new object set that contains only these objects. In many cases you can double click on an item to create a new object set with it.

The heap walker can only display allocation call stack information for recorded objects. See the memory section overview [p. 140] for further details.

B.6.5.2 Heap Snapshot Option Dialog

The heap snapshot options dialog is displayed each time before the actual heap snapshot [p. 158] is taken. The dialog has two tabs, grouping all overhead-related options on the second tab.

If the **Select recorded objects** option is checked, the heap walker will restrict the heap snapshot to recorded objects only. In this way you can focus on the objects that have been created during a selected time span. If the option is unchecked, all objects on the heap will be shown (excluding any objects removed by the overhead options below).

The overhead options are:

- **Remove unreferenced and weakly referenced objects**

  If this option is checked, JProfiler will remove all objects from the heap that are **not strongly referenced**. These include:

  - unreferenced objects that are eligible for garbage collection
  - objects that are referenced only through soft, weak and phantom references
  - objects that are in the finalizer queue and will be garbage collected as soon as the finalizers have been run

  For strongly referenced objects, the heap walker will not display soft, weak and phantom references.

  This mode is preferable for memory leak detection, and is especially helpful to obtain useful information when showing the path to root [p. 176] for selected objects. Deselecting this option reduces the time for processing the heap snapshot and allows you to analyze the heap "as-is".

  Note: With Java >= 1.5.0 (JVMTI), unreferenced objects are not shown by the heap walker. The dynamic memory views like the all objects view [p. 141] and the recorded objects view [p. 143] can therefore show higher instance counts.

- **Calculate retained sizes**

  Calculating retained sizes adds memory overhead while the heap snapshot is processed and can take some time for large heap snapshots. If you experience memory problems when taking heap snapshot or if you want the heap snapshot processing to take less time, you can deselect this option. In that case, no retained sizes will be available. Also, the biggest objects view [p. 167] will not be available.

  Retained sizes can only be calculated if the "Remove unreferenced and weakly referenced objects" is selected.

- **Record primitive data**

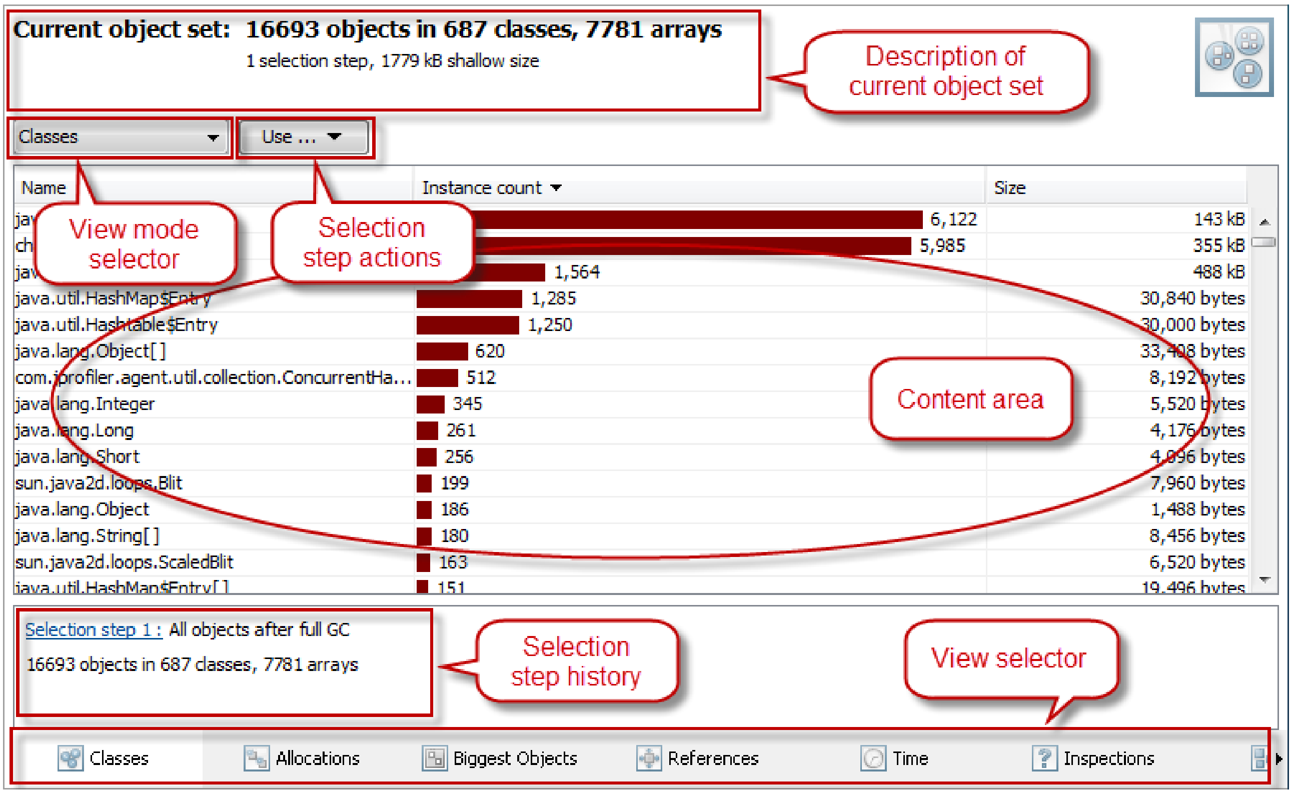
  Note: This option is only visible when you profile with Java 1.4 (JVMPI) or with Java 1.6+ (JVMTI 1.1). With Java 1.5 (JVMTI 1.0), primitive data is not recorded.

  If this option is checked, the heap walker will record primitive data and display string values and values of primitive fields in the reference views [p. 169] .

  Deselecting this option will save memory and is advisable if you experience memory problems when taking heap snapshot. If primitive data is not recorded, it will be requested on demand in a live session, depending on whether the object still exists. The data may not be the same as at the time of the heap snapshot in that case. These on-demand requests only work for Java 1.5+. For Java 1.4, the outgoing references view [p. 169] will display `N/A` for primitive values.

B.6.5.3 Heap Walker View Layout

All heap walker views [p. 158] share the same basic layout:



Current object set: 16693 objects in 687 classes, 7781 arrays

1 selection step, 1779 kB shallow size

Name	Instance count	Size
ja	6,122	143 kB
ch	5,985	355 kB
ja	1,564	488 kB
java.util.HashMap$Entry	1,285	30,840 bytes
java.util.Hashtable$Entry	1,250	30,000 bytes
java.lang.Object[]	620	33,408 bytes
com.jprofiler.agent.util.collection.ConcurrentHa...	512	8,192 bytes
java.lang.Integer	345	5,520 bytes
java.lang.Long	261	4,176 bytes
java.lang.Short	256	4,096 bytes
sun.java2d.loops.Blit	199	7,960 bytes
java.lang.Object	186	1,488 bytes
java.lang.String[]	180	8,456 bytes
sun.java2d.loops.ScaledBlit	163	6,520 bytes
java.util.HashMap$Entry[]	151	19,496 bytes

Selection step 1 : All objects after full GC

16693 objects in 687 classes, 7781 arrays

The description of the current object set shows

- **what kind of objects** are in the current object set. If there is more than one class or array type in the current object set, a cumulative count will be given separately for class instances and arrays. As it is often the case, if all objects are of a single class or array type, the class name or array type will be displayed.
- **how many selection steps** have occurred so far. This gives an idea of the complexity of the current selection.
- **how much space** the current object set uses on the heap. Note that this is the shallow size which does not include the sizes of referenced arrays and class instances.

Most screens in the heap walker have **more than one view mode**. The drop-down list in the top-left corner give access to different related views. For example, the reference view has 4 different view mode, for outgoing and incoming references as well as for cumulated outgoing and cumulated incoming references.

With the selection button you can add another selection step. A new object set that contains only the currently selected objects will be created. Some views offer more than one way to add a selection step in a drop-down menu.

The main portion of the screen displays the specific content of the current view.

The selection history shows all selection steps that have occurred so far. The selection history pane is a vertical split pane and can be resized to the most convenient size. You can toggle the visibility of the selection history window by

- choosing *View->Show selection steps* from JProfiler's main menu
- clicking on the corresponding toolbar button

The view selector allows you to switch between the six different views **without changing the current object set**. The views show

- the classes [p. 163] in the current object set
- the allocation spots [p. 165] of the current object set
- the biggest objects [p. 167] in the current object set
- the references [p. 169] of the current object set
- a graph of allocation times [p. 178] of the current object set
- a list of inspections [p. 179] that can be performed on the current object set
- the graph [p. 184] where objects from different object sets can be added. This view is different from the others in that is does not only show data from the current object set.

B.6.5.4 Classes View

B.6.5.4.1 Heap Walker - Classes

The heap walker classes view conforms to the basic layout [p. 160] of all heap walker views. Also see the help on key concepts [p. 158] for the entire heap walker.

The functionality of the classes view is identical to that of the all objects view [p. 141] and the recorded objects view [p. 143] except that it is static with respect to the current snapshot and only instances of classes and arrays in the current object set are shown.

If you have multiple classes with the same name from different classloaders and want to differentiate between those classes, you have to navigate to a specific instance, go to the references view [p. 169] of the heap walker and continue with the class selection as described there.

No specific view settings apply to the classes view.

The classes view has an **aggregation level selector**. It allows you to switch between

- **Classes**

  Every row in the table is a single class. This is the default aggregation level.
- **Packages**

  Every row in the table is a single package. Sub-packages are not included. In this aggregation level, the table becomes a **tree table**. You can open each package by clicking on the tree node on its left and see the contained classes directly beneath it.
- **Java EE components**

  Every row in the table is a Java EE component [p. 88] . This aggregation level is like a filter for the classes mode and enables you to quickly check the loaded Java EE components in your profiled application.

There are three sortable columns shown in the table:

- **Name**

  Depending on the aggregation level, this column shows different values:

  - **classes**

    shows the name of the class or the array type. When using Java 1.4 or Java 1.5 with the old profiling interface JVMPI, the notation `<class>[]` stands for non-primitive arrays of any class type. (e.g. the array might be of type `String[]` or `Object[]`). A further distinction is not possible due to restrictions in the profiling interface.
  - **package**

    shows the name of the package.
  - **Java EE**

    shows the display name of the Java EE component. If the display name is different from the actual class name, the class name is displayed in square brackets.

- **Instance count**

  Shows how many instances are currently allocated on the heap. This instance count is displayed graphically as well.
- **Size**

  Shows the total size of all allocated instances. Note that this is the **shallow size** which does not include the size of referenced arrays and instances but only the size of the corresponding pointers.

The size is in bytes and includes only the object data, it does not include internal JVM structures for the class, nor does it include class data or local variables.

To add a selection step from this view you can select one or multiple rows from the table and click on the **[Use ...]** button above the table. In the drop-down menu you can decide whether to use the

- **Selected instances**

  The new object set will consist of all objects of the selected classes. For a single class, you can also double-click on a row in the table.
- **Selected java.lang.Class objects**

  The new object set will consist of all `java.lang.Class` objects of the selected classes.

After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.5 Allocation View

B.6.5.5.1 Heap Walker - Allocations

The heap walker allocation view conforms to the basic layout [p. 160] of all heap walker views. Also see the help on key concepts [p. 158] for the entire heap walker.

The allocation view of the heap walker offers four **view modes** that can be changed in the drop-down list at in the top-left corner:

- Cumulated allocation tree [p. 165]

  Shows the allocation tree for the current object set. Each method node includes the allocations from all descendant method nodes.
- Allocation tree [p. 165]

  Shows the allocation tree for the current object set. Each method node only includes the allocations in that particular method.
- Allocation tree map [p. 165]

  Shows the allocation tree map for the current object set.
- Allocation hot spots [p. 166]

  Shows the allocation hot spots for the current object set.

B.6.5.5.2 Heap Walker Allocation View - Allocation Tree

The contents and functionality of the allocation tree view mode correspond to those of the allocation call tree [p. 146] in the memory view section [p. 140] . Contrary to the allocation call tree, only allocations in the current object set are shown. You can customize this view through the heap walker view settings [p. 188] .

The heap walker will be able to display allocation information only for recorded objects, unrecorded objects are summed up in a top-level entry called `unrecorded objects`. See the memory section overview [p. 140] for further details.

To add a selection step from this view you can select one or multiple allocation spots from the table and click the **[Use selected]** button above the table.

A new object set will be created that contains

- all instances of classes and arrays allocated in the selected allocation spots **and in allocation spots below** for the "cumulated allocation tree" view mode.
- only the instances of classes and arrays allocated in the selected allocation spots for the "allocation tree" view mode.

After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

Note: If you wish to see the allocations performed in a node regardless on what call sequence has lead to this node, you can switch to the allocation hot spots view mode [p. 166] .

B.6.5.5.3 Heap Walker Allocation View - Allocation Tree Map

The contents of the allocation tree map is an alternate visualization of the allocation tree [p. 165] . The tree map shows all call stacks as a set of nested rectangles. Please see the help on tree maps [p. 138] for more information.

The heap walker will be able to display allocation information only for recorded objects, unrecorded objects are summed up in a top-level rectangle called `unrecorded objects`. See the memory section overview [p. 140] for further details.

To add a selection step from this view you can select one or multiple allocation spots in the tree map and click the **[Use selected]** button above the tree map.

A new object set will be created that contains all instances of classes and arrays allocated in the selected allocation spots. After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.5.4 Heap Walker Allocation View - Allocation Hot Spots

The contents and functionality of the allocation hot spots list are similar to those of the allocation hot spots view [p. 150] in the memory view section [p. 140] . Contrary to that view, only allocations in the current object set are shown. You can customize this view through the heap walker view settings [p. 188] .

The heap walker will be able to display allocation information only for recorded objects, unrecorded objects are summed up in a top-level entry called `unrecorded objects`. See the memory section overview [p. 140] for further details.

To add a selection step from this view you can select one or multiple allocation hot spots or parts of their back traces from the table and click the **[Use selected]** button above the table.

A new object set will be created that contains all instances of classes and arrays allocated in the selected hot spots. If nodes in back traces are selected, all objects that contribute to the hot spot along the selected paths are included. After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.6 Biggest Objects View

B.6.5.6.1 Heap Walker - Biggest Objects View

The heap walker biggest objects view conforms to the basic layout [p. 160] of all heap walker views. Also see the help on key concepts [p. 158] for the entire heap walker.

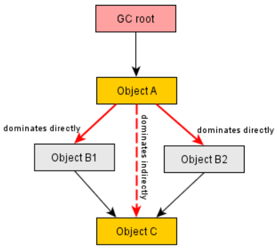
The biggest objects view shows a list of the biggest objects in in the current object set. The table shows the following information:

- The first column shows the name of the object's class and the ID of the object
- The second column shows the object's retained size together with a bar visualizing the relative importance of that number with the respect to all the objects that are shown. Also, a percentage number is shown that indicates how much of the total used heap size is retained by this object.

  Please see the key concepts of the heap walker [p. 158] for an explanation of retained size.

Each object can be expanded to show outgoing references to other objects that are retained by this object. In this way, you can recursively expand the tree of retained objects (also called a "dominator tree") that would be garbage collected if the one of the parents were to be removed. The information displayed for each object in this tree is similar to the outgoing reference view [p. 169] , except that only dominating references are displayed.

Not all dominated objects are directly referenced by their dominators. For example, consider the references in the following figure:



Object A dominates objects B1 and B2, it does not have a direct reference to object C. Both B1 and B2 reference C. Neither B1 nor B2 dominates C, but A does. In this case, B1, B2 and C are listed as direct children of A in the dominator tree, and C will not be listed a child of B1 and B2. For B1 and B2, the field names in A by which they are held are displayed. For C, **[transitive reference]** is displayed on the reference node.

At the left side of each reference node in this tree, a percentage bar shows how many percent of the retained size of the top-level object heap are still retained by the target object. The numbers will decrease as you drill down further into the tree. In the view settings [p. 188] , you can change the percentage base to the total heap size.

The dominator tree has a built-in **cutoff** that eliminates all objects that have a retained size that is lower than 0.5% of the retained size of the parent object. This is to avoid excessively long lists of small dominated objects that distract from the important objects. If such a cutoff has been performed, a cutoff child node will be shown that notifies you about the number of objects that are not shown on this level, their total retained size and the maximum retained size of the single objects.

The **view mode selector** above the biggest objects view allows you to switch to an alternate visualization: A tree map that shows all dominated objects as a set of nested rectangles. Please see the help on tree maps [p. 138] for more information.

Each rectangle represents a dominated object. The area of the rectangle is proportional to its retained size. In contrast to the tree, the tree map gives you a **flattened perspective of all leafs in the**

dominator tree. If you're mostly interested in big arrays, you can use the tree map in order to find them quickly without having to dig into the branches of the tree. Also, the tree map gives you an overall impression of the relative importance of dominated objects and the object size distribution in the heap.

At the bottom right of the tree map you can see the total percentage of the entire heap that is represented by the tree map. If you have not zoomed in, the remaining part of the heap is dominated by objects that have not made it into the list of biggest objects due to the internal threshold for retained sizes.

To analyze both incoming and outgoing references and to explore the relationship between objects of interest, use the **[Show in graph]** button at the top of the view. The selected instances will be then be added to the graph [p. 184] . The graph is not cleared when you choose a new object set or go back in the history, so you can add objects from different object sets to the graph.

If you're profiling in live mode with a 1.5 JVM or higher, the **[Show toString() values]** button at the top of the view is active. When you click it, JProfiler invokes `toString()` on all expanded references in the view and shows the results. If you open more references or add more references with the hyperlink at the bottom of the table, those objects will not have their `toString()` values displayed. You will have to click the button again in order to show the missing values.

The reason why this operation is not performed automatically is that calculating toString() values is an expensive operation that invokes Java code in the profiled JVM and may even have unwanted side effects in buggy implementations.

To add a selection step from this view you can select one or more objects and click the **[Use selected]** button above the table.

A new object set will be created that contains only the instances of the selected objects. After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.6.2 Dependency Of The Biggest Objects View On Retained Size Calculation

If "Calculate retained sizes" has not been enabled for the heap dump, the biggest objects view [p. 167] will not be available. For the "Calculate retained sizes" option to be effective, the "Remove unreferenced and weakly referenced" option has to be enabled for the heap dump as well.

Both these options are "overhead options" intended to speed up the heap dump and use less memory. The cost of this lower overhead includes the loss of the biggest objects view. By default, both options are are enabled.

The "Calculate retained sizes" option can be enabled in the

- heap walker options dialog [p. 159] , if the heap dump is taken manually.
- the configuration of the "Trigger heap dump" [p. 95] action, if the heap dump is taken by a trigger.
- the parameters passed to the `triggerHeapDump` method of the `Controller` class in the profiling API, if the heap dump is taken programatically.

B.6.5.7 Reference View

B.6.5.7.1 Heap Walker - Reference View

The heap walker reference view conforms to the basic layout [p. 160] of all heap walker views. Also see the help on key concepts [p. 158] for the entire heap walker.

The reference view of the heap walker offers three **view modes** that can be changed in the combo box at the top of the view:

- Outgoing references [p. 169]

  Shows a tree of the outgoing references separately from all objects in the current object set.
- Incoming references [p. 171]

  Shows a tree of the incoming references separately to all objects in the current object set.
- Cumulated incoming references [p. 173]

  Shows a tree-table of the cumulated references that hold the objects in the current object set.
- Cumulated outgoing references [p. 175]

  Shows a tree-table of the cumulated references that originate from objects in the current object set.

The reference view helps you to **find memory leaks**. Please note the **"Show path to GC root"** functionality in the incoming references [p. 171] for this purpose.

Incoming references in the reference view show **compact paths** for for some well-known collections with an internal reference structure. For linked lists, the "collection content" reference shown in the screen shot points directly from the linked list to the list item. If you search for paths to garbage collector roots, the found paths can be interpreted much more clearly that way.

Compact paths are also shown for hash maps and tree maps>. This is especially important in the cumulated incoming reference view, because the internal reference structure of those collections could fragment collection content into many blocks, thereby preventing a comprehensive analysis of the incoming references. Also, hash maps are very common in reference chains and the "map key" and "map value" nodes are much more descriptive than the internal structure.

B.6.5.7.2 Heap Walker Reference View - Outgoing References

The outgoing references view shows instances in the current object set. Each instance can be opened to show outgoing references as well as primitive data.

The table only concerns the top-level instances and shows the following sortable columns:

- **Retained size**

  The amount of memory that would be freed if the object were removed from the heap.
- **Shallow size**

  The amount of memory directly used by the object.
- **Allocation time**

  The time when the object was allocated. This information is only available if allocation time recording is enabled in the profiling settings [p. 88] .

The number of top-level objects that are shown is limited to 100 by default. You can add more objects with the hyperlink after the last row in the table. The default number of objects can be adjusted in the view settings [p. 188] .

Each reference node consists of three parts:

- **Field name**

  The field name of the object in the parent node that holds the referenced object
- **Reference icon**

  The reference icon separates the holder from the referenced object. The icon is one of

  - ➡ A regular reference.
  - ➡ A reference from an object that is already present as an ancestor node. This indicates a reference cycle. Cycles are more conveniently analyzed in the graph view [p. 184]
- **Referenced object**

  This is the object referenced by the outgoing reference. Direct child references below this node refer to this object.

Each object is optionally annotated with an **object ID**. With this ID, you can check whether two objects are the same or not. The display of IDs can be switched off the the context menu and the view settings [p. 188] .

The **[Apply filter ...]** menu at the top of the view allows you to **filter the current object set**. Filters are always applied to the top-level objects, i.e. the objects that are actually part of the current object set.

When you open outgoing references and select a reference or a primitive value, the filter uses the selected node as the criterion. Top-level objects that do not have a path of outgoing references such as the selected path, are discarded by the filter.

If a non-primitive value is selected, and you are profiling a Java 5 or higher JVM in live mode, you can apply a filter **with a code snippet**. In the script, you can use the `object` parameter to write your filter expression. The objects that are passed to your script are on the same level as the one that you have selected. Return `true` if the associated top-level object should be retained, otherwise it will be discarded. If you want to filter repeatedly with the same expression, don't forget the script history feature of the script editor [p. 123] .

If you have selected a top-level object, the parameter is only typed if all objects in the current object set have the same class. Also, in that case the result is equivalent to running the custom filter inspection [p. 179] on the current object set.

Alternatively, you can apply a filter **by restricting the selected value**. If you are profiling a Java 5 or higher JVM in live mode, you can perform a match against the result of the `toString()` method of the selected objects. If you have selected a reference which is not at the top level, you can also filter by null references or non-null references. For primitive values, you can restrict the value by settings bounds or testing for equality. All text fields where you can enter values have a drop down list with a history that is persistent across sessions.

To analyze both incoming and outgoing references and to explore the relationship between objects of interest, use the **[Show in graph]** button at the top of the view. The selected instances will be then be added to the graph [p. 184] . The graph is not cleared when you choose a new object set or go back in the history, so you can add objects from different object sets to the graph.

If you're profiling in live mode with a 1.5 JVM or higher, the **[Show toString() values]** button at the top of the view is active. When you click it, JProfiler invokes `toString()` on all expanded references in the view and shows the results. If you open more references or add more references with the hyperlink at the bottom of the table, those objects will not have their `toString()` values displayed. You will have to click the button again in order to show the missing values.

The reason why this operation is not performed automatically is that calculating toString() values is an expensive operation that invokes Java code in the profiled JVM and may even have unwanted side effects in buggy implementations.

To add a selection step from this view you can select one or multiple objects and click the **[Use ...]** button above the graph and choose in the popup menu. Multiple objects are selected by keeping the SHIFT or CTRL keys pressed during selection. The following selection modes are available:

- **Selected Objects**

  A new object set will be created that contains only the selected instances.
- **Exclusively Referenced Objects**

  A new object set will be created that contains all objects that would be garbage collected if the selected objects did not exist.
- **Items in Selected Collection**

  This option is only enabled if you select an array of objects or a standard collection from the `java.util` package. A new object set will be created that contains the objects in the array or collection. If you select a map collection, you are prompted whether you want to include the key objects as well.

After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.7.3 Heap Walker Reference View - Incoming References

The incoming references view shows instances in the current object set. Each instance can be opened to show incoming references.

The table only concerns the top-level instances and shows the following sortable columns:

- **Retained size**

  The amount of memory that would be freed if the object were removed from the heap.
- **Shallow size**

  The amount of memory directly used by the object.
- **Allocation time**

  The time when the object was allocated. This information is only available if allocation time recording is enabled in the profiling settings [p. 88] .

The number of top-level objects that are shown is limited to 100 by default. You can add more objects with the hyperlink after the last row in the table. The default number of objects can be adjusted in the view settings [p. 188] .

Each reference node has one or two icons. The first icon is one of

- a regular reference.
- a reference expanded by the search to garbage collector root (see below).
- a reference from an object that is already present as an ancestor node. This indicates a reference cycle. Cycles are more conveniently analyzed in the graph view [p. 184]

The second icon is either not present or one of

- a reference from a class.

  In most circumstances, classes are the last step on the path to the GC root that you are interested in. Classes are not garbage collector roots, but in all situations where no custom classloaders are used it is appropriate and easier to treat them as such. This is JProfiler's default mode when searching for garbage collector roots, you can change this in the path to root options dialog [p. 176] .

  Class objects have references to

  - all implemented interfaces
  - their classloader unless they were loaded by the bootstrap classloader
  - all references in their constant pool

  Note that class objects have no reference to their super class.

  Classes are garbage collected **together with their classloader** when

  - there is no class loaded by that classloader that has any live instances
  - the classloader is unreferenced except by its classes (this is a JVM level reference and not visible in the source of `java.lang.Class`).
  - None of the `java.lang.Class` objects is referenced except by the classloader and other classes of that classloader.

- a garbage collector root.

  A garbage collector root is an entity in the JVM that itself is not garbage collected and pins other objects or classes. There are the following types of garbage collector roots:

  - **JNI references**

    Native code can request references from the JNI (local or global)
  - **stack**

    Local variables all current stack frames
  - **sticky class**

    The JVM itself can flag certain classes as non-garbage collectable
  - **thread block**

    Live threads are not garbage collected
  - **monitor used**

    A monitor that is held by someone cannot be garbage collected
  - **other GC root**

    The JVM can pin objects by attaching this unspecified GC root to them

  For classes there is a special condition that prevents garbage collection: Since each instance has an implicit reference to its class, any live instance prevents a class from being garbage collected. This construct groups all such instances for reasons of conciseness. In this way you can also select all instances of a specific class (rather than a specific class name).

Each object is optionally annotated with an **object ID**. With this ID, you can check whether two objects are the same or not. The display of IDs can be switched off the the context menu and the view settings [p. 188] .

To check why an instance is not garbage collected, you can select it and click the **[Show paths to GC root]** button at the top of the view. The options dialog [p. 176] allows you to configure the way JProfiler performs the search.

After the search has completed, the tree is expanded up to the garbage collector roots that were found. If the object is **not** referenced by a garbage collector root, a message box will be displayed. Note that this case is only possible if the "Remove unreferenced and weakly referenced objects" option in the heap walker option dialog [p. 159] is unchecked.

Newly expanded nodes on the path to the GC root have a red reference icon. To highlight the found path without any distractions, no sibling references are shown on that level. To show all sibling references, you can either choose the *Show all incoming references* action from the context menu or *View* menu or collapse and expand the parent node.

To analyze both incoming and outgoing references and to explore the relationship between objects of interest, use the **[Show in graph]** button at the top of the view. The selected instances will be then be added to the graph [p. 184] . The graph is not cleared when you choose a new object set or go back in the history, so you can add objects from different object sets to the graph.

If you're profiling in live mode with a 1.5 JVM or higher, the **[Show toString() values]** button at the top of the view is active. When you click it, JProfiler invokes `toString()` on all expanded references in the view and shows the results. If you open more references or add more references with the hyperlink at the bottom of the table, those objects will not have their `toString()` values displayed. You will have to click the button again in order to show the missing values.

The reason why this operation is not performed automatically is that calculating toString() values is an expensive operation that invokes Java code in the profiled JVM and may even have unwanted side effects in buggy implementations.

To add a selection step from this view you can select one or multiple objects and click the **[Use ...]** button above the graph and choose in the popup menu. Multiple objects are selected by keeping the SHIFT or CTRL keys pressed during selection. The following selection modes are available:

- **Selected Objects**

  A new object set will be created that contains only the selected instances.
- **Exclusively Referenced Objects**

  A new object set will be created that contains all objects that would be garbage collected if the selected objects did not exist.
- **Items in Selected Collection**

  This option is only enabled if you select an array of objects or a standard collection from the `java.util` package. A new object set will be created that contains the objects in the array or collection. If you select a map collection, you are prompted whether you want to include the key objects as well.

After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.7.4 Heap Walker Reference View - Cumulated Incoming References

The cumulated incoming references show the list of all reference types through which the instances of classes and arrays in the current object set are held. This view has two display modes that determine how the "Object count" and the "Size" column have to be interpreted:

- **Show counts and sizes of reference holders**

  The "Object count" and the "Size" columns refer to the objects that reference any objects in the current object set through a certain reference type.

  In this mode, the cumulated incoming reference view shows object counts, sizes and percentages that refer to the top level entry. This makes it easy to analyze what percentage of the current object set is held through a particular chain of references.

- **Show counts and sizes of referenced objects**

  The "Object count" and the "Size" columns refer to the objects in the current object set that are referenced through a certain reference type.

  In this mode, each level is treated like a new independent object set.

There are three columns shown in the table, which can be sorted [p. 134] :

- **Reference type**

  Shows the type of the incoming reference which is one of

  - **field**

    some of the objects or arrays in the current object set are held in the indicated field of an instance of the indicated class.
  - **static field**

    some of the objects or arrays in the current object set are held in the indicated static field of the indicated class.
  - **constant**

    some of the objects or arrays in the current object set are held in the constant pool of the indicated class. These references mostly stem from constants declared as `private static final`.
  - **object array content**

    some of the objects in the current object set are held in an array of instances of classes. The arrays are of types or supertypes of the held objects. A further distinction is not possible due to the nature of Java bytecode.
  - **JNI global/local reference**

    some of the objects or arrays in the current object set are held through the Java Native Interface. Generally global references are persistent across a number of native calls which local references are only valid for the duration of one native call. These references are of interest to JNI programmers only. If you do not use any extra native libraries and encounter these reference types nonetheless, they can be attributed to the internal state of the JVM. In that case, there won't be any accessible objects behind these references and the `Size` column will show a zero value.
  - **java stack**

    some of the objects in the current object set are held in a stack frame of a thread. Thread and method information are shown if available.
  - **sticky class, thread block, unknown type**

    internal references in the JVM.

  Note that for static fields, constants, java stack references and the internal references in the JVM the origin of the reference do not belong to accessible objects. The `Size` column shows a zero value and a filter selection is not possible for these incoming reference types.

- **Object count**

  Depending on the display mode, shows

  - **Show counts and sizes of reference holders**

    How many objects are holding on to any object in the current object set through this reference type and along the selected chain of references.
  - **Show counts and sizes of referenced objects**

    How many objects in the current object set are referenced through this reference type.

  The reference count is displayed graphically as well.
- **Size**

  Depending on the display mode, shows

  - **Show counts and sizes of reference holders**

    The total size of all objects that are holding on to any object in the current object set through this reference type.
  - **Show counts and sizes of referenced objects**

    The total size of all objects in the current object set that are referenced through this reference type.

  Note that this is the **shallow size** which does not include the size of referenced arrays and instances but only the size of the corresponding pointers.

No specific view settings apply to the cumulated incoming references.

The cumulated reference view is a **tree table**, you can open single references and view cumulated reference chains. Multiple selection is only possible on the same level in the tree.

The lengths of the bars in the object count column are adjusted for the sibling nodes in the tree (not the top level) and the colors of the bars alternate between dark and light red for descending tree levels.

To add a selection step from this view you can

- select one or multiple references from the table and click the **[Use ...]** button above the table and choose *reference holders* in the popup menu. A new object set will be created that contains all objects that hold any object in the current object set by way of the selected reference types.
- select one or multiple references from the table and click the **[Use ...]** button above the table and choose *referenced objects* in the popup menu. A new object set will be created that contains all objects in the current set that are held by a reference of one of the the selected types.
- double click on a reference. Depending on the display mode, either the reference holders or the referenced objects are selected as the new object set.

All reference types in your selection that do not lead to selectable objects are removed for the selection step. If no selectable objects are contained in your selection, the corresponding action will be disabled.

A new object set will be created that contains all instances of classes and arrays that reference objects in the current object set via the selected references. After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.7.5 Heap Walker Reference View - Cumulated Outgoing References

The cumulated outgoing references show the list of all reference types which originate from the instances of classes and arrays in the current object set.

There are three columns shown in the table, which can be sorted [p. 134] :

- **Reference type**

  Shows the type of the outgoing reference which is one of

  - **field**

    the referenced object or array is held in the indicated field of an instance of the indicated class.
  - **static field**

    the referenced object or array is held in the indicated static field of the indicated class.
  - **constant**

    the referenced object or array is held in the constant pool of the indicated class. These references mostly stem from constants declared as `private static final`.
  - **object array content**

    the referenced object or array is held in an array of instances of classes (e.g. the array might be of type `String[]` or `Object[]`).

- **Object count**

  Shows how many references of this outgoing reference type are present in the current object set. The reference count is displayed graphically as well.
- **Size**

  Shows the total size of the object set which would result if this reference type was added as a filter step. Note that this is the **shallow size** which does not include the size of referenced arrays and instances but only the size of the corresponding pointers.

No specific view settings apply to the cumulated outgoing references.

The cumulated reference view is a **tree table**, you can open single references and view cumulated reference chains. Multiple selection is only possible on the same level in the tree.

The lengths of the bars in the object count column are adjusted for the sibling nodes in the tree (not the top level) and the colors of the bars alternate between dark and light red for descending tree levels.

To add a selection step from this view you can

- select one or multiple references from the table and click the **[Use selected]** button above the table.
- double click on a reference.

A new object set will be created that contains all instances of classes and arrays that are referenced by objects in the current object set via the selected references. After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.7.6 Path To Root Option Dialog

The path to root option dialog is displayed after clicking the **[Show path to GC root]** button in the graph view [p. 184] and the incoming references view [p. 171] of the heap walker.

The path to root analysis can calculate:

- **a single root**

  Only a single garbage collector root will be found. When searching for a memory leak, this option is often appropriate since any path to a garbage collector root will prevent the instance from being garbage collected.

- **up to a certain number of roots**

  A specified maximum number of roots will be found and displayed. If a single root is not sufficient, try displaying one root more at a time until you get a useful result.
- **all roots**

  All paths to garbage collector roots will be found and displayed. This analysis takes much longer than the single root option and can us a lot of memory.

By default, the path to root search does not follow weak references. If you would like to show garbage collector roots that are only reachable through a weak reference, you can check the `Include weak references` option.

By default the path to root search uses classes as garbage collector roots. This is not strictly correct but valid in most situations and makes the path to root search much more usable. For example, a static field of a class is technically not a garbage collector root, but in practice any information about why a class is not garbage collected is not interesting. The only case were you need a different behavior is when searching for classloader-related memory leaks. In that case, you can deselect `"Use classes as roots"` to use the true garbage collector roots exclusively.

After completing the dialog with the **[OK]** button, the analysis will be calculated and the result will be shown in the reference view.

With the **[Cancel]** button, the path to root option dialog is closed and no analysis is performed.

B.6.5.7.7 Restricted Availability Of The Reference View

If the initial data set of the heap walker [p. 158] is displayed, the reference view is not available. You have to perform one selection step first. This can be one of

- selection of one or several classes [p. 163]
- selection of one or several allocation spots [p. 165]
- selection of one or several biggest objects [p. 167]

After such a selection step, the reference view will be available.

B.6.5.8 Time View

B.6.5.8.1 Heap Walker - Time View

The heap walker time view conforms to the basic layout [p. 160] of all heap walker views. Also see the help on key concepts [p. 158] for the entire heap walker.

The time view shows a time-resolved histogram of object allocations. The bin size depends on the zoom level.

This view can only be used if the "Record object allocation times" feature is activated on the "Memory Profiling" tab [p. 88] of the profiling settings dialog [p. 85] . Allocation times are **only available for recorded objects**. The number of unrecorded objects is displayed above the graph.

When you move the mouse across the time view, the time at the position of the mouse cursor will be shown in JProfiler's status bar.

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views.

You can select multiple time intervals by

- clicking and dragging with the mouse on the graph in the horizontal direction.
- choosing the select up to here action from the context menu.
- choosing the select from here action from the context menu.
- choosing the select between bookmarks action from the tool bar right above the view or the context menu. A dialog will be shown that allows you to select a range of bookmarks. All objects allocated between the first selected and the last selected bookmark are selected in the view.

You can clear your selections by clicking on the clear selections button at the top of the view or by selecting the corresponding action from the context menu.

To add a selection step from this view you can select one or more time intervals and click the **[Use selected]** button above the graph.

A new object set will be created that contains only the instances of the selected objects. After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.8.2 Restricted Availability Of The Time View

If the initial data set of the heap walker [p. 158] is displayed, the time view is not available. You have to perform one selection step first. This can be one of

- selection of one or several classes [p. 163]
- selection of one or several allocation spots [p. 165]
- selection of one or several biggest objects [p. 167]

After such a selection step, the time view will be available.

B.6.5.9 Inspections View

B.6.5.9.1 Heap Walker - Inspections View

The heap walker reference view conforms to the basic layout [p. 160] of all heap walker views. Also see the help on key concepts [p. 158] for the entire heap walker.

The inspections view of the heap walker does not show any information on the current object set. Rather, it displays a number of operations that will **analyze the current object set in some way**. As a result of any inspection, a new object set will be created.

All available inspections [p. 179] are shown in a tree on the left side, for better usability they are ordered into several categories. On the right side, the property panel explains the inspection, offers configuration options for the selected inspection and shows a button to calculate it.

Since inspections can be expensive to calculate for large heaps, the **results are cached**. In this way, you can go back in the history and look at the results of previously calculated inspections without waiting. Inspections with cached results have a 🔍 special symbol in the tree and a ✓ "Calculated" status in the property panel.

After an inspection has been calculated, the view change dialog [p. 188] will be shown. By default, the reference view [p. 169] is recommended.

An inspection can **partition the calculated object set into groups**. Groups are shown in a table at the top of the heap walker. Initially, the first row in the group table is selected. By changing the selection, you change the current object set. For example, the "Duplicate strings" inspection shows the duplicate string values as groups. If you are in the reference view, you can then see the `java.lang.String` instances with the selected string value below.

Beside the group name column in the group table there are the following sortable columns:

- **Priority**

  Each inspection that creates groups decides which groups are most important in the context of the inspection. Since this does not always correspond to a sort order of one of the other columns, the priority column contains a numeric value that enforces that sort order. By default, the group table is sorted by this column.
- **Instance Count**

  The number of objects that are contained in the group. If you select the group, the current object set below will have this number of objects.
- **Shallow Size**

  The combined shallow size of the objects that are contained in the group. If you select the group, the current object set below will have this shallow size. For an explanation of sizes of object sets, please see the heap walker overview [p. 158] .

You can **search** in the group table by typing into it or right-clicking it and selecting the *Find* action from the context menu. The group table can be **exported** to HTML or CSV, by choosing *Export View* from its context menu. Note that the group table will not be exported when you export the current heap walker view with the export action in the tool bar.

The group selection is not a separate selection step in the heap walker, but it becomes part of the selection step made by the inspection. You can see the group selection in the selection step pane at the bottom. When you change the group selection, the selection step pane is updated immediately.

B.6.5.9.2 Heap Walker - List Of Inspections

The following inspections are provided by JProfiler:

- **Custom filter [Custom inspections]**

  Filter all objects in the current object set with a code snippet. Return <tt>true</tt> if an object should be added to the new object set and <tt>false</tt> if it should be discarded.<p><b>Note: In the reference view, you can apply a filter to a selected outgoing chain of references.</b>

  Configuration options:

  - **Filter script**

    The script that decides whether an object should be part of the new object set or not. The script is passed a <tt>currentObject</tt> parameter. If you return <tt>true</tt>, the object will be retained, otherwise it will be discarded.

- **Custom grouping [Custom inspections]**

  Group the current object set with a code snippet. Return the key for each object as a <tt>java.lang.String</tt> object. Objects with the same key will be in the same group.<p>After the inspection is calculated, you will see a statistics table at the top of all heap walker view where you can select each group and analyze its members separately.

  Configuration options:

  - **Grouping script**

    The script that returns the group name of the group that the object should be part of. The script is passed a <tt>currentObject</tt> parameter. If all objects in the current object set are of the same class, the parameter is typed, so you will get code completion for the parameter. If you return <tt>null</tt>, the object will be retained, otherwise it will be added to the group with the name of the returned string value.

- **Duplicate strings [Duplicate objects]**

  Find duplicate <tt>java.lang.String</tt> objects in the current object set.<p>After the inspection is calculated, you will see a statistics table at the top of all heap walker view where you can select each duplicate string value and analyze the corresponding string objects separately.<p>Note: If no <tt>java.lang.String</tt> objects are contained in the current object set, the inspection will return the empty object set.

  Configuration options:

  - **Minimum length**

    The minimum size as an integer value. The default size is 20.

- **Duplicate primitive wrappers [Duplicate objects]**

  Find duplicate primitive wrapper objects like <tt>java.lang.Integer</tt> in the current object set.<p>After the inspection is calculated, you will see a statistics table at the top of all heap walker view where you can select each duplicate primitive value and analyze the corresponding wrapper objects separately.<p>Note: If no wrapper objects of the selected type are contained in the current object set, the inspection will return the empty object set.

  Configuration options:

  - **Primitive wrapper type**

    The primitive type for which the inspection will be calculated. One of "Boolean,Byte,Character,Double,Float,Integer,Long,Short".

- **Duplicate arrays [Duplicate objects]**

  Find duplicate arrays in the current object set.<p>After the inspection is calculated, you will see a statistics table at the top of all heap walker view where you can select each duplicate array value and analyze the corresponding arrays separately.<p>Note: If no arrays of the selected type are contained in the current object set, the inspection will return the empty object set.

  Configuration options:

  - **Minimum shallow size in bytes**

    The minimum size as an integer value. The default size is 100.

  - **Array type**

    The array type for which the inspection will be calculated. One of "Object,Boolean,Byte,Character,Double,Float,Integer,Long,Short".

- **Sparse arrays [Collections & Arrays]**

  Find object arrays that contain a high percentage of <tt>null</tt> values.<p>After the inspection is calculated, the object group table will group arrays according to their percentage of null values. There is a cutoff below which no arrays are included in the object set.<p>Note: If no arrays of the selected type are contained in the current object set, the inspection will return the empty object set.

  Configuration options:

  - **Minimum shallow size in bytes**

    The minimum size as an integer value. The default size is 100.

- **Arrays with zero length [Collections & Arrays]**

  Find object arrays whose length is zero. This may be an opportunity to use a <tt>null</tt> value in order to reduce memory consumption.<p>Note: If no arrays of the selected type are contained in the current object set, the inspection will return the empty object set.

  Configuration options:

  - **Array type**

    The array type for which the inspection will be calculated. One of "Object,Boolean,Byte,Character,Double,Float,Integer,Long,Short".

- **Hash maps with bad key distribution [Collections & Arrays]**

  Find hash maps with a bad distribution of keys. This may be an opportunity to improve the <tt>hasCode()</tt> method of objects in order to speed up lookups in the map.<p>After the inspection is calculated, the object group table will group hash maps according to their distribution quality. There is a cutoff below which no hash maps are included in the object set. The objects with the highest hash map distribution quality will be at the top.

  Configuration options:

  - **Minimum map size**

    The minimum size as an integer value. The default size is 20.

- **Null fields [Reference & field analysis]**

Find objects with fields that have a high percentage of null values. These fields could be moved to derived classes or aggregated objects.

- **Weakly referenced objects [Reference & field analysis]**

  Find objects that are (transitively) referenced through a weak, soft of phantom reference.<p>To analyze the reference paths, go to the "Reference" view after the inspection is calculated and show the path to the garbage collector root for selected objects.

  Configuration options:

  - **Reference type**

    The type of the reference for which the inspection will be calculated, one of "Weak reference,Soft reference,Phantom reference".

- **Objects retained by inner class [Reference & field analysis]**

  Find objects that only referenced implicitly by one of their non-static inner classes. Sometimes this can be the cause of a memory leak.

- **Objects with many incoming references [Reference & field analysis]**

  Find objects that have many incoming references.<p>After the inspection is calculated, the object group table will group instances according to their incoming reference count. There is a cutoff below which no instances are included in the object set. The objects with the most incoming references will be at the top.

- **Objects that reference themselves [Reference & field analysis]**

  Find objects that reference themselves directly. This may be an opportunity to remove a field.<p>After the inspection is calculated, the object group table will group instances and classes according to how many of their (static) fields reference itself. The objects with the most self-references will be at the top.

- **Classes with identical names [Classes & Class loaders]**

  Find classes with the same name that are loaded by different class loaders.<p>After the inspections is calculated, the object group table will show the class names and the counts of how many classes were loaded under that name. The inspection selects <tt>java.lang.Class</tt> objects, not instances. If you are interested in instances of a particular class,switch to the "Incoming references" view and use the "live instances" reference to select all instances.

- **Instances grouped by class loaders [Classes & Class loaders]**

  Partition all instances by the class loaders that loaded them.<p>After the inspection is calculated, the object group table shows the list of class loaders with their loaded instance counts. If you are interested in seeing the classes rather than the instances, switch to the "Classes" view after the inspection has completed.

- **Instances of classes derived from specific base class [Classes & Class loaders]**

  Find instances that are derived from a selected class or that implement a selected interface.<p>If you are interested in seeing the classes rather than the instances, switch to the "Classes" view after the inspection has completed.

  Configuration options:

  - **Class name**

    The class name for which the inspection will be calculated.

- **HTTP session objects [Classes & Class loaders]**

Find all HTTP session objects. These are instances that implement <tt>javax.servlet.http.HttpSession</tt>.<p>This is a convenience inspection and has the same effect as running the "Instances of classes derived from specific base class" inspection with the above interface.

B.6.5.10 Graph

B.6.5.10.1 Heap Walker - Graph

The heap walker graph does not automatically show any objects from the current object set, nor is it cleared when you change the current object set. You **manually add selected objects** to the graph in the outgoing references view [p. 169] , the incoming references view [p. 171] or the biggest objects view [p. 167] .

In the graph, you can explore the incoming and outgoing references of the selected objects and find paths between objects or paths to garbage collector roots.

The graph has the following properties:

- Instances are painted as rectangles with the class name of the instance written inside the rectangle.
- References are painted as arrows, the arrowhead points from the holder toward the holdee. If you move the mouse over the reference, a **tooltip window** will be displayed that shows details for the particular reference.
- Instances that were manually added from the reference views have a **blue background**. The more recently an instance has been added, the darker the background color.
- Garbage collector roots have a red background.

  A garbage collector root is an entity in the JVM that itself is not garbage collected and pins other objects or classes. There are the following types of garbage collector roots:

  - **JNI references**

    Native code can request references from the JNI (local or global)
  - **stack**

    Local variables all current stack frames
  - **sticky class**

    The JVM itself can flag certain classes as non-garbage collectable
  - **thread block**

    Live threads are not garbage collected
  - **monitor used**

    A monitor that is held by someone cannot be garbage collected
  - **other GC root**

    The JVM can pin objects by attaching this unspecified GC root to them

  For classes there is a special condition that prevents garbage collection: Since each instance has an implicit reference to its class, any live instance prevents a class from being garbage collected. This construct groups all such instances for reasons of conciseness. In this way you can also select all instances of a specific class (rather than a specific class name).

  A set of live instances that reference a yellow class object (see above) has a green background.
- Classes (objects of `java.lang.Class`) have a yellow background.

  In most circumstances, classes are the last step on the path to the GC root that you are interested in. Classes are not garbage collector roots, but in all situations where no custom classloaders are used it is appropriate and easier to treat them as such. This is JProfiler's default mode when searching for garbage collector roots, you can change this in the path to root options dialog [p. 176] .

  Class objects have references to

    - all implemented interfaces
    - their classloader unless they were loaded by the bootstrap classloader
    - all references in their constant pool

  Note that class objects have no reference to their super class.

  Classes are garbage collected **together with their classloader** when

    - there is no class loaded by that classloader that has any live instances
    - the classloader is unreferenced except by its classes (this is a JVM level reference and not visible in the source of `java.lang.Class`).
    - None of the `java.lang.Class` objects is referenced except by the classloader and other classes of that classloader.

- String values are shown directly in the `java.lang.String` instance rectangle.

By default, the reference graph only shows the direct incoming and outgoing references of the current instance. You can expand the graph by **double clicking on any object**. This will expand either the direct incoming or the outgoing references for that object, depending on the direction you're moving in. Selective actions for expanding the graph are available in the view-specific toolbar and the context menu:

- Show outgoing references
- Show incoming references

If applicable, an instance has plus signs at the left and the right side to show or hide incoming and outgoing references. The controls at the left side are for incoming, the controls at the right side for outgoing references. The plus signs have the same effect as the Show outgoing references and the Show incoming references actions. If there is no plus sign, all references have been expanded.

Each object is optionally annotated with an **object ID**. With this ID, you can check whether two objects are the same or not. The display of IDs can be switched off the the context menu and the view settings [p. 188] .

You can **hide nodes** by selecting them and pressing the delete key. You can select multiple nodes by holding the with the CTRL or SHIFT key and delete them together.

The graph may contain a number of **unconnected branches**. To clean up the graph, select a node on the branch that should be retained and select the remove unconnected items action from the graph toolbar or the context menu.

To remove all objects from the graph to its original state, you can choose *Clear graph* from the context menu.

The reference graph offers a number of navigation and zoom options [p. 135] .

To check why an instance is not garbage collected, you can select it and click the **[Show paths to GC root]** button at the top of the view. The options dialog [p. 176] allows you to configure the way JProfiler performs the search.

After the search has completed, the graph is expanded up to the garbage collector roots that were found. If the object is **not** referenced by a garbage collector root, a message box will be displayed. Note that this case is only possible if the "Remove unreferenced and weakly referenced objects" option in the heap walker option dialog [p. 159] is unchecked.

The garbage collector roots themselves are displayed with a red background.

Another kind of path that can be interesting is the path between two selected objects. The **[Find path between two selected nodes]** button at the top of the graph becomes active once you select exactly two nodes in the graph. The path search options dialog [p. 186] allows you to select the type of the path and the stopping points of the search.

Any found path will be **highlighted in red** along the edges of the path. When you search for another path, the old highlighted path displayed in black again.

There are four layout strategies for showing the reference graph which can be chosen by clicking on in the toolbar or choosing the layout strategy from the context menu.

- **Hierarchic layout**

  Standard layout that tries to layout the graph from left to right. This is suitable for most purposes.
- **Hierarchic layout (Top to Bottom)**

  Like above, only that the layout axis is vertical. This can be suitable for viewing long chains of references.
- **Organic layout**

  Layout that tries to layout instances for optimal proximity. This layout is suitable for complex situations and can visualize clusters.
- **Orthogonal layout**

  Layout that tries to layout instances on a rectangular grid. This layout is suitable if your objects form a matrix.

To add a selection step from this view you can select one or multiple objects and click the **[Use ...]** button above the graph and choose in the popup menu. Multiple objects are selected by keeping the SHIFT or CTRL keys pressed during selection. The following selection modes are available:

- **Selected Objects**

  A new object set will be created that contains only the selected instances.
- **Exclusively Referenced Objects**

  A new object set will be created that contains all objects that would be garbage collected if the selected objects did not exist.
- **Items in Selected Collection**

  This option is only enabled if you select an array of objects or a standard collection from the `java.util` package. A new object set will be created that contains the objects in the array or collection. If you select a map collection, you are prompted whether you want to include the key objects as well.

After your selection, the view helper dialog [p. 188] will assist you in choosing the appropriate view for the new object set.

B.6.5.10.2 Path Search Options Dialog

The path search options dialog is displayed after clicking the **[Find path between two selected nodes]** button in the heap walker graph view [p. 184] .

There are three optional consecutive passes when searching for a path:

- **Directed path from first to second object**

Find a path of outgoing references from the first object that you have selected to the second object that you have selected.

- **Directed path from second to first object**

  Find a path of outgoing references from the second object that you have selected to the first object that you have selected.

- **Undirected path**

  Find any kind of connection between the two selected objects **even if the direction of the path changes in between**. This works well for objects that are closely related, for example objects that have a common holder that references them both through a low number of outgoing references.

  If the two objects are not closely related, a found path will likely involve class objects and stack frames and may be of little practical use. That is why this option is not selected by default.

JProfiler starts the search for the first selected path type and stops as soon as it finds a path. For large heaps the search can take a long time, so if you know that there is no direct path between the objects or that you are only interest in one direction, you can disable the other options in order to save time. If no path could be found, an error message is displayed.

Similar to the path to GC root search [p. 176] , the search stops at class objects by default. Deselect the `Stop search at classes` check box only if you have class loader problems, otherwise the found paths can cross classes arbitrarily for undirected paths. Also, weak references are not searched be default. If you are interested in paths along weak references, you can enable them in this option dialog.

B.6.5.11 Heap Walker View Helper Dialog

The view helper dialog is displayed each time when a new object is created. New object sets are created by choosing objects in the heapwalker views [p. 158] and clicking on the **[Use selected]** buttons.

The view helper dialog is intended to assist you in choosing the view that is most interesting for the new object set. You can switch to desired view by selecting the corresponding radio button and closing the dialog with the **[OK]** button. On the right hand side of the dialog a short description of the selected view is displayed.

The view helper dialog automatically suggest a view based on the contents of the new object set.

To discard the new object set you can leave the dialog with the **[Cancel]** button. You will then be returned to the previous heap walker view.

You can suppress this dialog by clicking the `Do not show this dialog again` checkbox at the bottom of the dialog. In this case the view change to the automatically suggested view will be performed without confirmation.

To show the dialog again at a later time, you can adjust this setting in the heap walker view settings [p. 188] .

B.6.5.12 Heap Walker View Settings Dialog

The heap walker view settings dialog is accessed by bringing the heap walker [p. 158] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The **General** tab of the view settings dialog controls aspects which apply to all heap walker views.

- **Show selection steps**

  If checked, the selection history window at the bottom of the heap walker is shown.
- **Show view helper dialog for new object sets**

  If checked, the view helper dialog [p. 188] will be displayed when a new object set is created.

The **Classes** tab applies to the classes view [p. 163] only. It is analogous to the recorded objects view settings [p. 144] .

The **Allocations** tab applies to the allocation view [p. 165] only. It is analogous to the allocation call tree settings [p. 149] .

Note: Unlike for the allocation call tree, there is no "cumulate allocations" option since the view mode combo box in the allocations view of the heap walker offers both an "allocation tree" and a "cumulated allocation tree".

The **Biggest objects** tab applies to the biggest objects view [p. 167] only.

- **Size scale**

  You can select a size scale, just like in the recorded object view settings [p. 144] .
- **Show object IDs**

  If checked, all objects are annotated with object IDs. This can help you to check if an object is the same as one displayed in another view.
- **Show retained size bar for dominator tree**

  If checked, a percentage bar will be shown in from of each outgoing reference node. The percentage base can be configured as

  - **Top level object**

    The percentages refer to the retained size of the top level object. This is the default setting.
  - **Total heap**

    The percentages show how much of the total heap is retained by this reference. The lengths of all percentage bars are always comparable with this option.

The **References** tab applies to the references view [p. 169] only.

- **Size scale**

  You can select a size scale, just like in the recorded object view settings [p. 144] .
- **Show object IDs**

  If checked, all objects are annotated with object IDs. This can help you in checking if two objects in two different reference graphs are the same or not.
- **Show declaring class if different from actual class**

  In the incoming and outgoing reference tree views, the declaring class of a field will be displayed as well if it is different from the actual class or the object (i.e. the field has been declared in a super-class). Since this can add a lot of potentially distracting information to the reference trees, you can switch it off with this setting. In the reference graph, the declaring class is always displayed in the tool tip on the reference arrows.
- **Instance block size**

  The reference view only show a capped number of instances. This cap which is configurable here, has a default value of 100. Note that you can easily add more objects with the hyperlinks at the bottom of the reference tables.

The **Time** tab applies to the time view [p. 178] only. It is analogous to the VM telemetry view settings dialog [p. 228] .

The **Graph** tab applies to the graph [p. 184] only.

- **Show object IDs**

  If checked, all objects are annotated with object IDs. This can help you in checking if two objects in two different reference graphs are the same or not.
- **Warning threshold for opening references**

  If an object has a lot of incoming or outgoing references, the graph can be visually overwhelmed with new objects. That's why JProfiler asks you if you really want to open a large number of references. The default threshold which is configurable here is set to 100.

B.6.5.13 Restricted Availability For HPROF Snapshots

When viewing an HPROF snapshot, the allocations view [p. 165] and the time view [p. 178] of the heap walker are not available.

B.6.6 CPU Views

B.6.6.1 CPU View Section

The CPU view section contains several views which are **thread resolved**. Directly above those views you can see the current selection of thread and thread state.

The thread selection can be one of

- thread groups
- active threads
- dead threads

Next to the thread selector you find information about the **thread state** which is one of

- **All states**

  No filtering is performed.
- **Runnable**

  Only runnable thread states will be shown. This is the standard setting.
- **Waiting**

  Only waiting thread states will be shown.
- **Blocked**

  Only blocked thread states will be shown.
- **Net I/O**

  Only blocking network operations of the java library will be shown.

When you switch between two thread states, JProfiler will make the best effort to **preserve your current selection**.

Below the thread selector you find information about the aggregation level which is one of

- **methods**
- **classes**
- **packages**
- **Java EE components**

The call tree is always recorded on the method level. If you switch to a higher aggregation level, the information contained in the method call tree is aggregated accordingly into a new tree from which the current view is calculated. Java EE components can only be shown if component recording has been enabled in on the Probes tab [p. 88] of the profiling settings dialog [p. 85] .

In the dynamic views thread selection, thread state and aggregation level are displayed in combo boxes. After changing the selection in the thread selector or the thread state selector, the dynamic views are updated immediately with the new settings. The thread selector applies to all dynamic views simultaneously. Initially it is set to `All thread groups` and may be switched to specific threads or thread groups as soon as they come into existence.

Please turn to the thread view section [p. 213] for more detailed information on threads.

The update frequency can be set on the miscellaneous tab [p. 89] in the profiling settings dialog [p. 85] for all dynamic views of the CPU view section.

Unless "Record CPU data on startup" has been selected in the `Startup` section of the profiling settings dialog [p. 85] , data acquisition has to be started manually by clicking on **Record CPU data** in the tool bar or by selecting *Profiler->Record CPU data* from JProfiler's main menu. Bookmarks [p. 135] will be added when recording is started or stopped manually.

CPU data acquisition can be stopped by clicking on **Stop recording CPU data** in the tool bar or by selecting *Profiler->Stop recording CPU data* from JProfiler's main menu.

The CPU recording state is shown in the status bar with a CPU icon which is shown in gray when CPU is not recorded. Clicking on the CPU icon will toggle CPU recording.

Restarting data acquisition **resets** the CPU data in all dynamic views of the CPU view section.

Note that you can also use a trigger [p. 91] and the "Start recording" and "Stop recording" actions [p. 95] to control CPU recording in a fine-grained and exact way. This is also useful for offline profiling [p. 259] .

The CPU view section contains the

- Call tree view [p. 192]

  The call tree view shows top down call trees for the selected thread or thread group.
- Hot spots view [p. 197]

  The hot spots view shows the methods where most of the time is spent in the profiled application.
- Call graph [p. 202]

  The call graph shows call graphs for selected threads or thread groups.
- Method statistics [p. 206]

  The method statistics view shows information on the distribution of calls to the same method.
- Call tracer [p. 208]

  The call tracer shows a multi-threaded chronological sequence of method calls.

B.6.6.2 Call Tree View

B.6.6.2.1 Call Tree View

The call tree view shows a thread resolved [p. 190] top-down call tree which is shows method detail according to the configured filters [p. 80] .

JProfiler automatically detects Java EE components [p. 88] and displays the relevant nodes in the call tree with special icons that depend on the Java EE component type:

servlets

JSPs

EJBs

For JSPs and EJBs, JProfiler shows a display name:

- **JSPs**

  the path of the JSP source file
- **EJBs**

  the name of the EJB interface

If URL splitting is enabled in the servlet probe [p. 100] each request URL creates a new node with a 🌐 special icon and the prefix **URL:**, followed by the part of the request URL on which the call tree was split. Note that URL nodes **group request by the displayed URL**.

The call tree view has an **aggregation level selector**. It allows you to switch between

- **methods**

  Every node in the tree is a method call. This is the default aggregation level. Special Java EE component methods have their own icon (see above) and display name, the real class name is appended in square brackets.

  For methods that have been configured for exceptional method run recording, different icons will be shown. Please see the help on exceptional method run recording [p. 82] for more information.
- **classes**

  Every node in the tree is a single class. Java EE component classes have their own icon (see above) and display name, the real class name is appended in square brackets.
- **packages**

  Every node in the tree is a single package. Sub-packages are not included.
- **Java EE components**

  Every node in the tree is a Java EE component [p. 88] . If the component has a separate display name, the real class names are omitted.

When you switch between two aggregation levels, JProfiler will make the best effort to **preserve your current selection**. When switching to a a more detailed aggregation level, there may not be a unique mapping and the first hit in the call tree is chosen.

The call tree doesn't display all method calls in the JVM, it only displays

- **unfiltered classes**

  Classes which are unfiltered according to your configured filter sets [p. 81] are used for the construction of the call tree.

- **first level calls into unfiltered classes**

  Every call into a filtered class that originates from an unfiltered class is used for the construction of the call tree. Further calls into filtered classes are not resolved. This means that a filtered node can include information from other filtered calls. Filtered nodes are painted with a **red marker in the top left corner**.

- **thread entry methods**

  The methods `Runnable.run()` and the main method are always displayed, regardless of the filter settings.

A particular node is a **bridge node** if it would normally not be displayed in the view, but has descendant nodes that have to be displayed. The icons of bridge nodes are **grayed out**. For the call tree view this is the case if the inherent time of the current node is below the defined threshold [p. 194] , but there are descendant nodes that are above the threshold.

When **navigating** through the call tree by opening method calls, JProfiler automatically expands methods which are only called by one other method themselves.

To quickly **expand larger portions** of the call tree, select a method and choose *View->Expand Multiple Levels* from the main window's menu or choose the corresponding menu item from the context menu. A dialog is shown where you can adjust the number of levels (20 by default) and the threshold in per mille of the parent node's value that determines which child nodes are expanded.

If you want to **collapse an opened part** of the call tree, select the topmost method that should remain visible and choose *View->Collapse all* from the main window's menu or the context menu.

If a method node is selected, the context menu allows you to quickly add a method trigger [p. 91] for the selected method with the add method trigger action. A dialog [p. 98] will be displayed where you can choose whether to add the method interception to an existing method trigger or whether to create a new method trigger.

You can use this view as a starting point for determining which methods are candidates for exceptional method run recording [p. 82] . Once you have identified methods of interest, you can right-click them in the table and choose *Add as exceptional method* from the context menu.

Nodes in the call tree **can be hidden** by selecting them and hitting the `DEL` key or by choosing *Hide Selected* from the context menu. Percentages will be corrected accordingly as if the hidden node did not exist. All similar nodes in other call stacks will be hidden as well.

When you hide a node, the toolbar and the context menu will get a Show Hidden action. Invoking this action will bring up a dialog where you can select hidden elements to be shown again.

For method, class or package nodes, the context menu and the *View* menu have an **Add Filter From Selection** entry. The sub-menu contains actions to add appropriate filters [p. 81] as well as an action to add an ignored method entry [p. 84] .

If a node is excluded, you will get options to add an inclusive filter, otherwise you will get options to add an exclusive filter. These actions are not available for classes in the "java." packages.

The **tree map selector** above the call tree view allows you to switch to an alternate visualization: A tree map that shows all call stacks as a set of nested rectangles. Please see the help on tree maps [p. 138] for more information.

If enabled in the view settings [p. 194] , every node in the call tree has a **percentage bar** whose length is proportional to the total time spent in the current node including all descendant nodes and whose light-red part indicates the percentage of the inherent time of the current node.

Every entry in the call tree has textual information attached which depends on the call tree view settings [p. 194] and shows

- a **percentage number** which is calculated with respect to either the root of the tree or the calling node.
- a **total time measurement** in ms or µs. This is the total time that includes calls into other nodes.
- an **inherent time measurement** in ms or µs. This is the inherent time that does not include calls into unfiltered classes.
- an **invocation count** which shows how often the node has been invoked on this path.
- a **name** which depends on the aggregation level:

  - **methods**

    a method name that is either fully qualified or relative with respect to to the calling method.
  - **classes**

    a class name.
  - **packages**

    a package name.
  - **Java EE components**

    the display name of the Java EE component.

- a **line number** which is only displayed if

  - the aggregation level is set to "methods"
  - line number resolution has been enabled in the profiling settings [p. 86]
  - the calling class is unfiltered

  Note that the line number shows the line number of the invocation and not of the method itself.

You can set **change the root** of the call tree to any node by selecting that node and choosing *View->Set as root* from the main window's menu or by choosing the corresponding menu item from the context menu. Percentages will now be calculated with respect to the new root if the percentage base has been set to "total thread time" in the view settings dialog [p. 194] . To **return to the full view** of all nodes called in the current thread or thread group, select *View->Show all* from the main window's menu or the context menu.

You can stop and restart CPU data acquisition [p. 190] to clear the call tree.

B.6.6.2.2 Show Hidden Elements Dialog

The show hidden elements dialog is displayed when choosing *Hide Selected* from the context menu or hitting the `DEL` key in a call tree or hot spots view.

The dialog shows a list of all the elements that you have previously hidden. You can select multiple elements from the list and press **[OK]** to show these elements again.

The list of hidden elements is persistent across multiple recordings on the same run. It is cleared when the session is restarted.

B.6.6.2.3 Call Tree View Settings Dialog

The call tree view settings dialog is accessed by bringing the call tree [p. 192] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The **node description** options control the amount of information that is presented in the description of the node (methods, classes, packages or Java EE components, depending on the selected aggregation level).

- **Show percentage bar**

  If this option is checked, a percentage bar will be displayed whose length is proportional to the time spent in this node including all descendant nodes and whose light-red part indicates the percentage of the inherent time of the current node.
- **Show time**

  Show the total time that was spent in the node.
- **Show inherent time**

  Show the inherent time (excluding calls to unfiltered methods) that was spent in the node.
- **Show invocation count**

  Show how many times the node was called in this particular call sequence.
- **Always show fully qualified names**

  If this option is not checked (default), class name are omitted in intra-class method calls which enhances the conciseness of the display.

  Only applicable if the aggregation level has been set to "methods".
- **Always show signature for method calls**

  Only applicable if the aggregation level has been set to "methods". If this option is not checked, method signatures are shown only if two methods with the same name appear on the same level.

  Only applicable if the aggregation level has been set to "methods".
- **Show average time values in brackets**

  Show the total time divided by the number of invocations for each node in brackets. Is not displayed if the invocation count is 0, e.g. if an invocation has not completed yet or if sampling is chosen as the call tree collection method.

You can select a time scale mode for all displayed times:

- **Automatic**

  Depending on the time value, it's displayed in seconds, millseconds or microseconds, in such a way that 3 significant digits are retained.
- **Seconds**
- **Millseconds**
- **Microseconds**

The **display threshold** below which nodes are ignored is entered in percent. Calls whose inherent time makes up less than that percentage are not shown in the call tree except for the case where they are part of a call sequence which leads to a node with an inherent time above the given threshold. Those nodes are indicated by a grayed out icon.

To activate the threshold, you have to select the "Hide calls with less than ..." check box.

This option allows you to **trim down the call tree** to the most important parts.

The **percentage base** determines against what time span percentages are calculated.

- **Absolute**

Percentage values show the contribution to the total time.

- **Relative**

  Percentage values show the contribution to the calling node.

B.6.6.3 Hot Spot View

B.6.6.3.1 Hot Spots View

The hot spots view shows a list of calls of a selected type. The list is truncated at the point where calls use less than 0.1% of the total time of all calls. See the help on the estimated CPU time/elapsed time setting [p. 89] and take into account the selection of the thread state selector [p. 190] to properly assess the meaning of these time measurements. By opening a hot spot node, the tree of backtraces leading to that node are calculated and shown.

The **type of the hot spots** can be selected in the combo box above the table labeled "hot spot type". The available types fall into two categories:

1. **method calls**

   - **method calls (show filtered classes separately)**

     The displayed hot spots are calculated from method calls. Filtered classes can contribute hot spots of their own. This is the default mode.

   - **method calls (add filtered classes to calling class)**

     The displayed hot spots are are calculated from method calls. Calls to filtered classes are always added to the calling class. In this mode, a filtered class cannot contribute a hot spot, except if it has a thread entry method (run and main methods).

   Depending on your **selection of the aggregation level**, the method hot spots will change. They and their hot spot backtraces will be aggregated into classes or packages or filtered for Java EE component types.

   Note: The notion of a method hot spot is relative. Method hot spots depend on the filter sets that you have enabled in the filter settings [p. 81] . Filtered methods are opaque, in the sense that calls into other filtered methods are attributed to their own time. If you change your filter sets you're likely to get different method hot spots since you are changing your point of view. Please see the help topic on hot spots and filters [p. 41] for a detailed discussion.

Every hot spot is described in several columns:

- The hot spot column shows a **name** which depends on the aggregation level:

  - **methods**

    a method name that is either fully qualified or relative with respect to to the calling method.

  - **classes**

    a class name.

  - **packages**

    a package name.

  - **Java EE components**

    the display name of the Java EE component.

- the **inherent time**, i.e. how much time has been spent in the hot spot together with a bar whose length is proportional to this value. All calls into this method are summed up regardless of the particular call sequence.

  If the method belongs to an unfiltered class, this time does not include calls into other methods. If the method belongs to a filtered class, this time includes calls into other filtered methods.

- the **average time**, i.e. the inherent time (see above) divided by the invocation count (see below).
- the **invocation count** of the hot spot. If "Sampling" is selected as the method call recording type [p. 86] , the invocation count is not available.

If you click on the ⚠ handle on the left side of a hot spot, a tree of backtraces will be shown. Every entry in the backtrace tree has textual information attached to it which depends on the view settings.

- a **percentage number** which is calculated with respect either to the total time or the called method.
- a **time measurement** in ms or µs of how much time has been contributed to the parent **hot spot** on this path. If enabled in the view settings, every node in the hot spot backtraces tree has a **percentage bar** whose length is proportional to this number.
- an **invocation count** which shows how often the **hot spot** has been invoked on this path.

  Note: This is **not** the number of invocations of this method.
- a **name** which depends on the aggregation level:

  - **methods**

    a method name that is either fully qualified or relative with respect to to the calling method.
  - **classes**

    a class name.
  - **packages**

    a package name.
  - **Java EE components**

    the display name of the Java EE component.

- a **line number** which is only displayed if

  - the aggregation level is set to "methods"
  - line number resolution has been enabled in the profiling settings [p. 86]
  - the calling class is unfiltered

  Note that the line number shows the line number of the invocation and not of the method itself.

JProfiler automatically detects Java EE components [p. 88] and displays the relevant nodes in the hot spot backtraces tree with special icons that depend on the Java EE component type:

servlets

JSPs

EJBs

For JSPs and EJBs, JProfiler shows a display name:

- **JSPs**

  the path of the JSP source file
- **EJBs**

  the name of the EJB interface

If URL splitting is enabled in the servlet probe [p. 100] each request URL creates a new node with a special icon and the prefix **URL:**, followed by the part of the request URL on which the hot spot backtraces tree was split. Note that URL nodes **group request by the displayed URL**.

The hot spots view has an **aggregation level selector**. It allows you to switch between

- **methods**

  Every node in the tree is a method call. This is the default aggregation level. Special Java EE component methods have their own icon (see above) and display name, the real class name is appended in square brackets.
- **classes**

  Every node in the tree is a single class. Java EE component classes have their own icon (see above) and display name, the real class name is appended in square brackets.
- **packages**

  Every node in the tree is a single package. Sub-packages are not included.
- **Java EE components**

  Every node in the tree is a Java EE component [p. 88] . If the component has a separate display name, the real class names are omitted.

When you switch between two aggregation levels, JProfiler will make the best effort to **preserve your current selection**. When switching to a a more detailed aggregation level, there may not be a unique mapping and the first hit in the hot spot backtraces tree is chosen.

The hot spot backtraces tree doesn't display all method calls in the JVM, it only displays

- **unfiltered classes**

  Classes which are unfiltered according to your configured filter sets [p. 81] are used for the construction of the hot spot backtraces tree.
- **first level calls into unfiltered classes**

  Every call into a filtered class that originates from an unfiltered class is used for the construction of the hot spot backtraces tree. Further calls into filtered classes are not resolved. This means that a filtered node can include information from other filtered calls. Filtered nodes are painted with a **red marker in the top left corner**.
- **thread entry methods**

  The methods `Runnable.run()` and the main method are always displayed, regardless of the filter settings.

When **navigating** through the hot spot backtraces tree by opening method calls, JProfiler automatically expands methods which are only called by one other method themselves.

To quickly **expand larger portions** of the hot spot backtraces tree, select a method and choose *View->Expand Multiple Levels* from the main window's menu or choose the corresponding menu item from the context menu. A dialog is shown where you can adjust the number of levels (20 by default) and the threshold in per mille of the parent node's value that determines which child nodes are expanded.

If you want to **collapse an opened part** of the hot spot backtraces tree, select the topmost method that should remain visible and choose *View->Collapse all* from the main window's menu or the context menu.

If a method node is selected, the context menu allows you to quickly add a method trigger [p. 91] for the selected method with the add method trigger action. A dialog [p. 98] will be displayed where you can choose whether to add the method interception to an existing method trigger or whether to create a new method trigger.

Nodes in the hot spot backtraces tree **can be hidden** by selecting them and hitting the `DEL` key or by choosing *Hide Selected* from the context menu. Percentages will be corrected accordingly as if the hidden node did not exist.

When you hide a node, the toolbar and the context menu will get a Show Hidden action. Invoking this action will bring up a dialog where you can select hidden elements to be shown again.

For method, class or package nodes, the context menu and the *View* menu have an **Add Filter From Selection** entry. The sub-menu contains actions to add appropriate filters [p. 81] as well as an action to add an ignored method entry [p. 84] .

If a node is excluded, you will get options to add an inclusive filter, otherwise you will get options to add an exclusive filter. These actions are not available for classes in the "java." packages.

You can stop and restart CPU data acquisition [p. 190] to clear the hot spots view.

B.6.6.3.2 Hot Spots View Settings Dialog

The hot spots view settings dialog is accessed by bringing the hot spots [p. 197] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The **node description** options control the amount of information that is presented in the description of the node.

- **Show percentage bar**

  If this option is checked, a percentage bar will be displayed whose length is proportional to the time that was contributed to the hot spot along the particular call path.
- **Show time**

  Show the total time that was spent in the method call.
- **Show invocation count**

  Show how many time the method was called in this particular call sequence.
- **Always show fully qualified names**

  If this option is not checked, class name are omitted in intra-class method calls which enhances the conciseness of the display.
- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear on the same level.
- **Show average time values in brackets**

  Show the total time spent in the hot spot divided by the number of hot spot invocations for each node in brackets. Is not displayed if the invocation count is 0, e.g. if an invocation has not completed yet or if sampling is chosen as the call tree collection method. This setting only applies to the back traces, the average time for the hot spot itself is always displayed in a separate column.

You can select a time scale mode for all displayed times:

- **Automatic**

  Depending on the time value, it's displayed in seconds, millseconds or microseconds, in such a way that 3 significant digits are retained.

- **Seconds**
- **Millseconds**
- **Microseconds**

The **percentage calculation** determines against what time span percentages are calculated.

- **Absolute**

  Percentage values show the contribution to the total recorded time.
- **Relative**

  Percentage values shows the contribution to the invoked method.

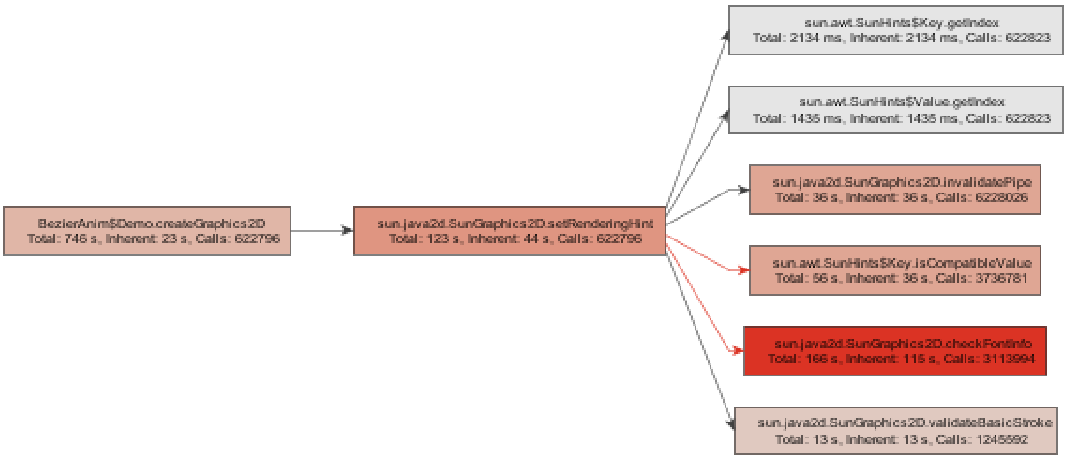
B.6.6.4 Call Graph

B.6.6.4.1 Call Graph

The call graph shows a statically calculated thread resolved [p. 190] call graph for selected **nodes**. The nodes are methods, classes, packages, or Java EE components, depending on the selected aggregation level.

To calculate a call graph, click **Generate graph** in the tool bar or select *View->Generate graph* from JProfiler's main menu. If a graph has been calculated, the context menu also provides access to this action.

Before a graph is calculated, the call graph wizard [p. 203] is brought up. The resulting graph is static and can be re-calculated be executing **Generate graph** again. The call graph wizard remembers your last selection.


BezierAnim$Demo.createGraphics2D
Total: 746 s, Inherent: 23 s, Calls: 622796
sun.java2d.SunGraphics2D.setRenderingHint
Total: 123 s, Inherent: 44 s, Calls: 622796
sun.awt.SunHints$Key.getIndex
Total: 2134 ms, Inherent: 2134 ms, Calls: 622823
sun.awt.SunHints$Value.getIndex
Total: 1435 ms, Inherent: 1435 ms, Calls: 622823
sun.java2d.SunGraphics2D.invalidatePipe
Total: 36 s, Inherent: 36 s, Calls: 6228026
sun.awt.SunHints$Key.isCompatibleValue
Total: 56 s, Inherent: 36 s, Calls: 3736781
sun.java2d.SunGraphics2D.checkFontInfo
Total: 166 s, Inherent: 115 s, Calls: 3113994
sun.java2d.SunGraphics2D.validateBasicStroke
Total: 13 s, Inherent: 13 s, Calls: 1245592

The call graph has the following properties:

- Nodes are painted as rectangles. The rectangle includes information about
  - The node name (method name, class name, package name or or Java EE component name). For methods, no parameters are displayed. In order to see the parameters of a method, switch on **signature tooltips** in the call graph view settings [p. 204] or select the corresponding check item in the context menu.
  - The total time (including calls into unfiltered classes)
  - The inherent time (excluding calls into unfiltered classes)
  - The number of calls into this node
- The node rectangles have a background coloring which - depending on the call graph view settings [p. 204] is taken from a gray to red scale for increasing
  - inherent time
  - **or** total time

  The percentage base is

  - the time spent in the displayed nodes only

  - **or** the time spent in all nodes

- Calls are painted as arrows, the arrowhead points from the caller toward the callee. If you move the mouse over the call arrow, a **tooltip window** will be displayed that shows details for the particular call.
- Call arrows have a color which is taken from a black to red scale for an increasing percentage in execution time. In this way you can spot the most important calls of a node without checking their tooltips one by one.

By default, the call graph only shows the direct incoming and outgoing calls of the initially selected nodes. You can expand the graph by **double clicking on any node**. This will expand the direct incoming and outgoing calls for that node. Selective actions for expanding the graph are available in the toolbar, the *View* menu and the context menu:

- Show calling nodes
- Show called nodes
- Add nodes to graph, to add other unrelated nodes to the graph. The node selection dialog [p. 204] will then be displayed.

If applicable, an node has plus signs at the left and the right side to show or hide calling and called nodes. The controls at the left side are for calling, the controls at the right side for called nodes. The plus signs have the same effect as the Show calling nodes and the Show called nodes actions. Additionally, the plus signs give you the indication that there might be nodes to display and that you have not yet tried to expand them.

You can **hide nodes** by selecting them and pressing the delete key. You can select multiple nodes and delete them together. Alternatively, you can select the remove nodes from graph action from the graph toolbar or the context menu.

If you delete methods, the call graph may contain a number of **unconnected branches**. To clean up the graph, select a method on the branch that should be retained and select the cleanup unconnected methods action from the graph toolbar or the context menu. The "remove all but selected nodes" action in the context method allows you to trim the graph to a few selected nodes.

The call graph offers a number of navigation and zoom options [p. 135] .

B.6.6.4.2 Call Graph Wizard

The call graph wizard is displayed before a call graph [p. 202] is calculated and sets parameters for the call graph.

1. **Graph Options**

   Similar to the the dynamic views of the CPU view section [p. 190] , you can select a thread or thread group and a thread state for which the call graph will be calculated.

   The **aggregation level selector** allows you to calculate a call graph for

   - **methods**

     Every node in the graph is a method call. This is the default aggregation level.
   - **classes**

     Every node in the graph is a single class. Java EE component classes have their own display name, the real class name is appended in square brackets.

   - **packages**

     Every node in the graph is a single package. Sub-packages are not included.
   - **Java EE components**

     Every node in the graph is a Java EE component [p. 88] . If the component has a separate display name, the real class names are omitted.

2. **Initially displayed nodes**

   The call graph initially displays a number of selected nodes and their immediate call environment. Select one or multiple nodes in this step. The node table shows

   - node name
   - inherent time
   - total time
   - invocations

   and can be sorted [p. 134] on all columns. Initially it is sorted by inherent time to show the most interesting hot spots at the top of the table.

   You can add further nodes later on with the node selection dialog [p. 204] .

After you click **[Finish]** in the last step, the call graph will be calculated, if you leave the wizard with **[Cancel]**, you are returned to the old call graph.

B.6.6.4.3 Node Selection Dialog

The node selection dialog is displayed when adding new nodes to the call graph [p. 202] .

The node selection dialog offers a list of nodes similar to step 2 in the call graph wizard [p. 203] . If you leave the dialog with **[OK]**, the selected nodes and their immediate call environments will be shown in the call graph. If you leave the dialog with **[Cancel]**, the call graph will not be changed.

B.6.6.4.4 Call Graph View Settings Dialog

The call graph view settings dialog is accessed by bringing the call graph [p. 202] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

- **Show signature tooltips**

  If checked, the signature of a method will be shown in a **tooltip window** when you move the mouse over it.
- **Color information**

  This setting determines the meaning of the gray to red scale of the background color of node rectangles. It can be one of

  - Inherent time
  - Total time

- **Color scale base**

  This setting determines the percentage base for calculating the background color of node rectangles. It can be one of

  - Displayed nodes only. If this setting is checked, the coloring of nodes changes as new nodes are expanded or added.
  - All nodes. If this setting is checked, the coloring stays the same as new nodes are expanded or added.

- **display threshold**

  The display threshold below which nodes are ignored is entered in percent. Calls whose inherent time makes up less than that percentage are not shown in the method graph. If you raise the threshold, none of the currently displayed nodes are hidden. If you lower the threshold, nodes who do not have plus signs for expanding incoming and outgoing calls may get them again.

  To activate the threshold, you have to select the "Hide calls with less than ..." check box.

  This option allows you to **trim down the call graph** to the most important parts.

B.6.6.5 Method Statistics

B.6.6.5.1 Method Statistics

The method statistics view shows information on the distribution of calls to the same method.

Recording method statistics is a memory intensive operation, so it is split from regular CPU recording. To record method statistics, click **Record method statistics** in the tool bar or select *View->Record method statistics* from JProfiler's main menu. If you have previously recorded method statistics, the old recorded data will be lost. Bookmarks [p. 135] will be added when recording is started or stopped manually.

If CPU recording [p. 190] is not enabled, it will be enabled when you start recording method statistics. Note that CPU recording will not be stopped when you stop recording method statistics.

The method statistics view shows a table with all methods from profiled classes [p. 80] that were invoked during method statistics recording. The following columns are shown in the table:

- **Method**

  The name of the method and its parameters.
- **Total Time**

  The total time spent in the method.
- **Invocations**

  The number of times a method was called.
- **Average Time**

  The average time spent in a method. This is equal to the total time divided by the invocation count.
- **Median Time**

  The median time is the time for which half of the method calls were shorter and half were longer.
- **Minimum Time**

  The minimum time of a single method invocation.
- **Maximum Time**

  The maximum time of a single method invocation.
- **Standard Deviation**

  The standard deviation measures the breadth of the distribution of method call times. If all method call times are nearly equal, the value will be close to zero, the more spread-out the call times are, the higher the standard deviation will be.
- **Outlier Coefficient**

  The outlier Coefficient is calculated as (maximum time - median time) / median time. It measures how significant the maximum time deviates from the median time. Outliers with small times are not considered. Methods with high outlier coefficients are suitable candidates for exceptional method run measurements in the call tree view [p. 192] .

You can sort [p. 134] the table on all columns. Double-clicking on a table row will show the source code of the selected method.

You can use this view as a starting point for determining which methods are candidates for exceptional method run recording [p. 82] . Once you have identified methods with a high outlier coefficient, you can right-click them in the table and choose *Add as exceptional method* from the context menu.

Below the method table, a graph with the distribution of invocation counts versus call times is shown. The graph is always shown for the currently selected method in the method table.

By default, the graph shows invocation counts on a linear scale. However, in order to identify outliers with a low relative frequency, it is useful to switch to a logarithmic axis. This can be done in the view settings [p. 207] or in the context menu.

The graph can be exported to HTML or CSV by right-clicking into the graph area and selecting *Export* from the context menu. The export action in the tool bar and in the context menu of the method table export the method table without the currently shown graph.

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views. The time axis in this case is the call duration axis.

B.6.6.5.2 Method Statistics View Settings Dialog

The method statistics view settings dialog is accessed by bringing the method statistics [p. 206] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The following options are available:

- **Scale to fit window**

  Determines whether the view operates in the "fixed time scale" or "scale to fit window" mode. These modes are described in the VM telemetry view help page [p. 227] .
- **Grid lines for time axis**

  Controls on what ticks grid lines will be shown along the time axis.
- **Grid lines for vertical axis**

  Controls on what ticks grid lines will be shown along the vertical axis.
- **Logarithmic Display of Invocation Counts**

  If this option is selected, the invocation counts are plotted on a logarithmic axis. This makes it easier to find outliers with a low relative frequency.

B.6.6.6 Call Tracer

B.6.6.6.1 Call Tracer

The call tracer shows a multi-threaded chronological sequence of method calls.

To record call traces, click **Record call traces** in the tool bar or select *View->Record call traces* from JProfiler's main menu. If you have previously recorded call traces, the old recorded data will be lost. Bookmarks [p. 135] will be added when recording is started or stopped manually.

Please note that recording call traces can generate **massive amounts of data in a very short time**. To avoid problems with excessive memory consumption, a **cap** is set on the maximum number of collected call traces. That cap is configurable in the view settings [p. 209] . The amount of collected traces heavily depends on your filter settings [p. 80] . Also see the help topic on method call filters [p. 24] for background information.

By default, calls into filtered classes are recorded, similarly to the default behavior of the hot spots view [p. 197] . Calls into filtered classes can be excluded in the view settings [p. 209] .

Call tracing only works when the method call recording type [p. 86] is set to "dynamic instrumentation". Sampling does not keep track of single method calls, so it is technically not possible to collect call traces with sampling.

To facilitate navigation, all method calls are grouped in a tree on three levels:

- **Threads**

  Every time the executing thread changes in the call sequence, a new **thread node** is created.
- **Packages**

  Every time the Java package changes in the call sequence, a new **package node** is created.
- **Classes**

  Every time the class changes in the call sequence, a new **class node** is created.

At the lowest level there are **method entry** and **method exit** nodes. If call traces into other methods have been recorded from the current method or if another thread interrupts the current method, the entry and exit nodes for the that method will not be adjacent. Initially, all nodes are collapsed, so you see a sequence of thread nodes after the traces have been recorded.

You can navigate on the method level only by using the **skip to next method trace** (`Alt-Down`) and **skip to previous method trace** (`Alt-Up`) actions.

Each node displays the following information:

- **Name**

  For thread nodes, this is the thread name, for package nodes this is the package name and for class nodes this is the fully qualified class name. By default, method nodes show the method name and the method signature. In the view settings [p. 209] , you can decide to drop the signature or add the fully qualified class name. The latter can be useful when using the quick search feature.
- **Trace count**

  Thread, package and class nodes display the number of method call traces that are contained in them.
- **Trace time**

  The trace time on the right side is one of

- **Relative to first trace**

  The displayed time is the difference between the current call trace and the first displayed call trace. This is the default setting.
- **Relative to previous node**

  The displayed time is the difference between the current call trace and the previous node. If the previous node is the parent node, that difference will be zero.
- **Relative to previous node of the same type**

  The displayed time is the difference between the current call trace and the previous node of the same type. For example, if the current node is a class node, the previous node of the same type is the previous class node in the tree.

The time display type can be configured in the view settings [p. 209] .

Below the table with the call traces, a **stack trace list** shows you the stack trace of the currently selected method trace. You can double-click on the stack trace element to show the source code. The context menu gives you access to source and bytecode navigation.

A huge number of traces can be collected in a very short time. To eliminate traces that are of no interest, the call tracer allows you to quickly trim the displayed data. For example, traces in certain threads might not be interesting or traces in certain packages or classes might not be relevant. Also, recursive method invocations can occupy a lot of space and you might want to eliminate those single methods only.

You can **hide nodes** by selecting them and pressing the delete key. All other instances of the selected nodes and all associated child nodes will be hidden as well. You can select multiple nodes and delete them together. Alternatively, you can select the **hide selected nodes** action from the toolbar or the context menu.

To show hidden nodes again, you can click on the **show hidden** button or select *View->Show Hidden* from the main menu to show the show hidden elements dialog [p. 209] .

B.6.6.6.2 Show Hidden Elements Dialog

The show hidden elements dialog is displayed when clicking on the show hidden button or selecting *View->Show Hidden* from the main menu when the call tracer view [p. 208] is visible.

The dialog shows a list of all the elements that you have previously hidden with the hide button or the `DELETE` key. Hidden elements can be threads, packages, classes and methods.

You can select multiple elements from the list and press **[OK]** to show these elements again in the call tracer view. Note that some elements can be subsets of others, so unhiding an element might not make it visible. For example, if you have hidden the class `com.mycorp.MyClass` and then the package `com.mycorp`, unhiding the class `com.mycorp.MyClass` will not make it visible again, you also have to unhide the package `com.mycorp` for that.

The list of hidden elements is persistent across multiple trace recordings on the same run. It is cleared when the session is restarted.

B.6.6.6.3 Call Graph View Settings Dialog

The call tracer view settings dialog is accessed by bringing the call tracer [p. 208] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The **trace recording options** control the amount of recorded call traces:

- **Maximum number of recorded call traces**

  To avoid excessive memory consumption, the profiling agent stops collecting call traces after this threshold has been reached.
- **Record calls into filtered classes**

  If selected, calls into filtered classes are traced as well. Please see help topic on method call filters [p. 24] for background information.

The **time display options** control the displayed trace time. The time display can be one of

- Relative to first trace
- Relative to previous node
- Relative to previous node of the same type

The above settings are explained on the help page for the call tracer view [p. 208] .

The **method display options** determine the presentation of method nodes. The following options are available:

- **Show signature**

  If selected, each method node shows the signature of the method.
- **Show class names in method nodes**

  If selected, the fully qualified class name is prepended to each method node.

B.6.6.7 Request Tracking

Request tracking connects call sites with execution sites in asynchronous execution flows by adding hyperlinks into the call tree view [p. 192] . For an explanation of the underlying concepts, please see the corresponding help topic [p. 43] .

Request tracking can be changed with the tool bar button or via the **[Request Tracking]** button in the startup dialog [p. 103] . In the latter case, the selected request tracking settings are active immediately after JProfiler connects to the profiled JVM.

In the request tracking dialog you can switch request tracking on and off separately for the following supported request tracking types:

- **Executors**

  The **call site** is the last profiled method before a task is handed off to an executor service from the `java.util.concurrent` package. The **execution site** is in the thread that executes the task.

  For example, if you call

  ```
  Executors.newSingleThreadExecutor().submit(new Runnable() {
      public void run() {
          // your code
      }
  });
  ```

  the enclosing method that calls `submit` is the call site, and the code below `// your code` is the execution site.

  Executors are used by many higher-level libraries for managing asynchronous executions, those libraries are implicitly supported by this request tracking type.

- **AWT**

  The **call site** is last profiled method before a deferred action is posted to the AWT event queue with `EventQueue.invokeLater(...)` or similar. The **execution site** is always in the event dispatch thread.

  For example, if you call

  ```
  EventQueue.invokeLater(new Runnable() {
      public void run() {
          // your code
      }
  });
  ```

  the enclosing method that calls `invokeLater` is the call site, and the code below `// your code` is the execution site.

  Together with the default entry in the exceptional method configuration [p. 82] , this feature provides a way to comprehensively analyze long-running AWT events.

- **SWT**

  The **call site** is the last profiled method before a deferred action is posted on the UI thread with `Display.getDefault().asyncExec(...)` or similar. The **execution site** is always in the UI thread.

  For example, if you call

  ```
  Display.getDefault().asyncExec(new Runnable() {
      public void run() {
          // your code
      }
  });
  ```

the enclosing method that calls `asyncExec` is the call site, and the code below `// your code` is the execution site.

- **Thread start**

  The **call site** is the last profiled method before `Thread.start()` is called. The **execution site** is a a top-level node in the started thread. If multiple threads are merged, each recorded execution site is still displayed separately.

  For example, if you call

  ```
  new Thread() {
      public void run() {
          // your code
      }
  }.start();
  ```

  the enclosing method that calls `start` is the call site, and the code below `// your code` is the execution site.

  Request tracking for threads can add a lot of nodes into your call trees that may be hard to interpret, because threads are started by the JRE in ways that are not immediately obvious. It is recommended to use thread start request tracking only in the case of a related problem.

Since the call tree can merge several invocation of a method, one call site can be related to several execution sites, for example an executor invocation can use different threads in a thread pool for different invocations. In this case, the **execution site dialog** is shown which allows you select the desired execution site. by looking at the displayed thread names and back traces. Call sites are assigned numeric IDs by JProfiler starting with #1, so you can recognize the same call site when browsing call trees for different threads.

On the other hand, a execution site can only by called by a single call site. A hyperlink that leads to the call site is shown in the tree. If more than one call site start a task in the same call stack, multiple execution sites are created side by side.

When jumping between call sites and execution sites, the **call tree history** is useful to move back and forth in your selection history. This is a general feature of the call tree view [p. 192] which also works for changes in thread, thread status and aggregation level selection.

Note that following a hyperlink will select the explicit thread of the call site or execution site. If you're starting in the "All threads" thread selection, the call tree will always change to that of a single thread. You can subsequently choose the parent thread group or "All threads" again and the current selection will be preserved.

B.6.7 Threads Views

B.6.7.1 Thread View Section

The thread view section contains the

- Threads history view [p. 214]

  The threads history view shows detailed historic information about the status of all threads in the JVM.
- Threads monitor view [p. 216]

  The threads monitor view shows dynamic information about the currently running threads.
- Threads dumps view [p. 218]

  The threads dumps view shows manually taken thread dumps with stack traces for all active threads.

B.6.7.2 Thread History View

B.6.7.2.1 Thread History View

The thread history view shows the list of all threads in the JVM in the order they were started. On the left hand side of the view, the names of the threads appear as a fixed column, the rest of the view is filled with a scrollable measuring tool which shows time on its horizontal axis. The origin of the time axis coincides with the starting time of the first thread in the JVM. Each alive thread is shown as a colored line which starts when the thread is started and ends when the thread dies. The color indicates a certain thread status and is one of

- **green**

  🟩 Green color means that the thread is **runnable** and eligible for receiving CPU time by the scheduler. This does not mean that the thread has in fact consumed CPU time, only that the thread was ready to run and was not blocking or sleeping. How much CPU time a thread is allotted, depends on various other factors such as general system load, the thread's priority and the scheduling algorithm.
- **orange**

  🟧 Orange color means that the thread is **waiting**. The thread is sleeping and will be woken up either by a timer or by another thread.
- **red**

  🟥 Red color means that the thread is **blocking**. The thread has is trying to enter a `synchronized` code section or a `synchronized` method whose monitor is currently held by another thread.
- **blue**

  🟦 Light blue color means that the thread is in **Net I/O**. The thread is waiting for a `network operation` of the java library to complete. This thread state occurs if a thread is listening for socket connections or if it is waiting to read or write data to a socket.

Note: If you are color-blind, you can edit *`bin/jprofiler.vmoptions`* and set `-Djprofiler.highContrastMode=true`. The above colors will then have an optimal contrast.

At the top of the view, there is a thread filter selector. You can use it to filter the displayed threads by

- **liveness status**

  From the combo box you can choose if you wish to display

  - Both alive and dead threads
  - Alive threads only
  - Dead threads only

- **name**

  In the text box you can enter the full name of a thread or only a part of it. Only threads whose names begin with this fragment are displayed. You can also use wildcards ("*" and "?") to select groups of threads. Please note that if you use wildcards, you have to manually append a trailing "*" if desired. You can display the union of multiple filters at the same time by separating multiple filter expressions with commas, e.g. `AWT-, MyThreadGroup-*-Daemon`.

  The selection is performed once you press the enter key. The combo box contains all entries performed during the current session. The **[Reset filters]** button can be used to remove all filters.

When you move the mouse across the thread history view, the time at the position of the mouse cursor will be shown in JProfiler's status bar. If you have recorded monitor events [p. 219] , a tool tip with the stack trace and links into the locking history graph [p. 221] and the monitor history view [p. 225] will be displayed. The link to the locking history graph points to the time that the event has started, the linked entry in the monitor history view shows the entire event. If the event has not yet completed, the link into the monitor history view is not available.

When you right-click a thread name on the left side of the view, a context menu will be displayed that allows you to jump to the Call tree view [p. 192] or the Hot spots view [p. 197] and display the single selected thread there.

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views.

Grid lines and background of the thread history view can be configured in the thread history view settings dialog [p. 215] .

B.6.7.2.2 Thread History View Settings Dialog

The thread history view settings dialog is accessed by bringing the thread history [p. 214] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

- **Scale to fit window**

  Determines whether the view operates in the "fixed time scale" or "scale to fit window" mode. These modes are described in the thread history view help page [p. 214] .
- **Show bookmarks**

  Controls where bookmarks will be shown, one of

  - **None**

    No bookmarks will be shown in the thread history view.
  - **In time scale**

    The vertical bookmark line will only be drawn in the time scale at the top of the view.
  - **In entire view**

    The vertical bookmark line will be drawn in the time scale and in the view itself.

- **Grid lines for time axis**

  Controls on what ticks grid lines will be shown along the time axis.
- **Background**

  Controls the appearance of the background of the thread history view.

B.6.7.3 Thread Monitor View

B.6.7.3.1 Thread Monitor View

The thread monitor view shows the filtered list of all threads in the JVM together with associated information on times and status. There are a maximum of six columns shown in the table, which can be sorted [p. 134] .

- **Name**

  Shows the name of the thread. If the thread has not been named explicitly, the name is provided by the JVM. To make most use of this view, name your threads according to their function by invoking the `setName()` method on all threads created by you.
- **Group**

  Shows the name of the thread group associated with this thread.
- **Start time**

  Shows the time when the thread has been started. This time is calculated relative to the start time of the first thread in the JVM.
- **End time**

  This column is only visible when `show dead threads` is enabled in the view settings dialog [p. 217] . It shows the time when the thread has died and is empty if the thread is still alive. This time is calculated relative to the start time of the first thread in the JVM.
- **CPU time**

  Shows the CPU time which has been consumed by the thread.

  Note: The CPU time column is only visible if the `CPU time type` is set to `Estimated CPU times` on the Miscellaneous [p. 89] tab of the profiling settings [p. 85] . In addition, the CPU time is only measured when you record CPU data [p. 190] . Otherwise the CPU time column is always empty.

  This column may also be empty if your system and JVM do not support thread specific CPU time reporting.
- **Creating thread**

  Shows the name of the thread and its thread group that created this thread.

  Note: The creating thread column is only visible if you profile with Java 1.5 and higher (JVMTI). For Java 1.4 and lower (JVMPI), this column is not shown.

  This column may also be empty if your system and JVM do not support thread specific CPU time reporting.
- **Status**

  Shows the status of the thread which corresponds to the status reported in the thread history view [p. 214] .

If you profile with Java 1.5 and higher (JVMTI), the above table will be the top component of a split pane. In the lower part of the split pane, the filtered **stack trace of the thread creation** of the currently selected thread is displayed. Stack traces can only be displayed if CPU data was being recorded [p. 190] when the thread was created.

You can decide which threads are shown in the thread monitor view by checking the desired filters in the thread monitor view settings dialog [p. 217] . If `Show dead threads` is not enabled, the `End time` column will not be visible.

B.6.7.3.2 Thread Monitor View Settings Dialog

The thread monitor view settings dialog is accessed by bringing the thread monitor [p. 216] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

- Show runnable threads
- Show waiting threads
- Show blocking threads
- Show threads in net I/O
- Show dead threads

These options determine the filter for the thread monitor view [p. 216] . See the thread history help page [p. 214] for a detailed explanation of the different types of thread status.

B.6.7.4 Thread Dumps View

B.6.7.4.1 Thread Dumps View

In the thread dumps view you can take thread dumps that show the current stack traces of all threads that can be displayed in the thread history view [p. 214] .

A new thread dump is taken by clicking on the **[Thread dump]** tool bar button. This button is also present for the thread history view [p. 214] and the thread monitor view [p. 216] . A bookmark [p. 135] will be added to the time-resolved views.

The new thread dump will by added to the list of thread dumps and it will be selected automatically. The two lists to the right show the threads that are contained in the currently selected thread dump as well as the stack trace of the currently selected thread.

The list of threads is organized according to thread groups, similar to the thread selector in the CPU views [p. 190] .

The stack traces in thread dumps are **not filtered**, i.e. the filter settings [p. 80] in the session settings do not apply. The context menu gives access to source and byte code navigation. Double-clicking on a stack trace element shows the selected method.

Thread dumps can be copied to the clipboard with the **[Copy To Clipboard]** button at the top of the list of thread dumps. The entire selected thread dump is copied as plain text to the clipboard.

To copy a single thread only, choose the *Copy Selected Thread To Clipboard* menu item from the context menu of the list of threads.

When exporting [p. 133] the thread dumps view to HTML, the file chooser offers a combo box for exporting the selected thread dump only, or all thread dumps to the same file.

Thread dumps can also be taken with the trigger thread dump [p. 95] trigger action or via the API.

B.6.8 Monitor Views

B.6.8.1 Monitor View Section

The monitor view section contains the

- Current locking graph [p. 221]

  The current locking graph visualizes the current locking situation in the JVM.
- Current monitors view [p. 225]

  The current monitors view shows monitors that are currently involved in a waiting or blocking operation.
- Locking history graph [p. 221]

  The locking history graph visualizes the recorded locking situations in the JVM.
- Monitor history view [p. 225]

  The monitor history view shows waiting and blocking operations on monitors.
- Monitor usage statistics [p. 226]

  The statistics view shows statically calculated statistics for monitor usage.

For all views that are not only showing current events, you have to **record monitor events** in order to see data. Recording is started by clicking **Record monitor events** in the tool bar. Bookmarks [p. 135] will be added when recording is started or stopped manually.

Monitor event recording can be stopped by clicking on **Stop recording monitor events** in the tool bar.

Restarting data acquisition **resets** the monitor data in all historical views of the monitor view section.

In most applications, a large number of short events is generated continuously and would be unmanageable to navigate. Because of this, JProfiler applies minimum thresholds for recording and waiting events below which events are discarded. The thresholds are displayed on the locking history graph [p. 221] and the monitor history view [p. 225] together with a hyperlink to open the view settings dialog where the thresholds can be changed. Changes are effective immediately.

Note that you can also use a trigger [p. 91] and the "Start recording" and "Stop recording" actions [p. 95] to control monitor event recording in a fine-grained and exact way. This is also useful for offline profiling [p. 259] .

The update frequency can be set on the miscellaneous tab [p. 89] in the profiling settings dialog [p. 85] for all dynamic views of the monitor view section.

B.6.8.2 Locking Graphs

B.6.8.2.1 Common Properties Of Locking Graphs

Locking graphs show single locking situations in the JVM. In contrast to the monitor views [p. 224] , the locking graphs focus on the entire set of **relationships** of all involved monitors and threads rather than the duration of isolated monitor events.

There are two locking graphs:

- Current locking graph [p. 221]

  The current locking graph visualizes the current locking situation in the JVM.
- Locking history graph [p. 221]

  The locking history graph visualizes the recorded locking situations in the JVM.

The following elements are shown in locking graphs:

- Threads which participate in a locking situation are painted as blue rectangles. The rectangle includes information about
  - The thread name
  - The thread group (in brackets)
- Monitors which participate in the locking situation are painted as gray rectangles. The rectangle includes information about
  - The class of the monitor
  - The monitor id which can be used to get further information about the monitor in the monitor views [p. 224]
- The **ownership of monitors** which participate in a locking situation is painted as a **solid black arrow**. The arrowhead points from the thread to the monitor. To see details about where the monitor was entered, move the mouse over the arrow and see the information in the **tool tip window**.
- The **blocking** of threads which participate in a locking situation is painted as a **dashed red arrow**. The arrowhead points from the blocked thread to the monitor that the thread wants to enter. To see details about where the thread is blocking, move the mouse over the arrow and see the information in the **tool tip window**.
- The **waiting** of threads which participate in a locking situation is painted as a **solid yellow arrow** with a hollow arrowhead. The arrowhead points from the waiting thread to the monitor that the thread is waiting on. To see details about where the thread is waiting, move the mouse over the arrow and see the information in the **tool tip window**.
- Threads or monitors that are part of a **deadlock** are painted in **red**.

The tool tip window shows a stack trace in a scrollable list whose context menu allows you to navigate to the source code or show the selected method in the byte code viewer. You can pin the tool tip window by toggling the pin button in the top right corner of the tool tip window.

Locks are analyzed for

- the primitive synchronization mechanism that's built into the Java platform, i.e. when using the **synchronized** keyword.

- the locking facility in the **java.util.concurrent** package which does not use monitors of objects but a different natively implemented mechanism.

You can show any monitor in the heap walker [p. 158] by selecting the monitor node and choosing *Show Selection In Heap Walker* from the context menu. If a heap dump was already taken, you can choose to select the object in the current heap dump, otherwise a new heap dump will be taken.

Note that the selected monitor might not exist in the heap dump because the heap dump might have been taken before the monitor was allocated or after the monitor was garbage collected.

If you profile with Java <=1.4 (JVMPI), the monitor class names can only be displayed if they are recorded objects. You can enable "Record allocations on startup" in the session startup dialog [p. 103] to record all objects.

B.6.8.2.2 Current Locking Graph

The current monitor graph shows monitors that are currently involved in a waiting or blocking operation. Data in this view is available even if monitor events are not being recorded [p. 219] .

Otherwise, this view is explained by the common properties of locking graphs [p. 220] .

B.6.8.2.3 Locking History Graph

The locking history graph visualizes the recorded locking situations in the JVM. Only recorded monitor events [p. 219] are shown.

Please see the common properties of monitor views [p. 224] for an explanation of the locking graph.

There are two sets of events that you step through with the navigation buttons at the top of the view:

- **All events**

  All monitor events that have been recorded. Next to the navigation buttons you see the current position and the total event count as well as the time of the currently shown event. If a time spam has been cumulated (see below), that time span as well as the number of events before and after the currently selected time span are shown.
- **Events of interest**

  Monitor events that involve a thread or monitor that you have marked as being of interest to you. You can mark nodes as being of interest by selecting them and choosing *Mark Node Of Interest* from the context menu. Multiple nodes can be selecting by holding down the `Shift` key. Marked nodes are painted in a different color.

  Next to the navigation buttons you see the current position and the total event count involving nodes of interest or the number of events if an event of interest is currently shown. If the current event is not an event of interest, you see the number of events of interest before and after the current event.

  Events of interest do not necessarily have to contain a node of interest. For example, if a thread that has been marked as a node of interest releases a lock, the associated event does not contain that thread node anymore, but the event is still an event of interest.

  To change your selection of nodes of interest, simply select new nodes of interest or choose *Remove mark* from the context menu.

The tool tips that appear when you hover of the arrows in the graph contain several navigation options:

- **Origin time**

  For blocking and waiting relationships, the tool tip contains a hyperlink to the event where the arrow first appeared.

- **Monitor history**

  To analyze the duration of an event, it can be useful to show it in the monitor history view [p. 225] . At the bottom of the tool tip, a corresponding hyperlink is available.

At the bottom of the view, you see a time line, where all recorded events are shown as blue lines. The currently shown event is surrounded with a green marker while events of interest are shown in red.

When you hover with the mouse over event lines, you can see the number of associated events in the status bar. When you click on an event line, the first event associated with that event line is shown in the graph. When a new event is selected with the navigation buttons or a hyperlink in the tool tip window, the timeline is scrolled so that the selected event is visible.

You can **cumulate multiple events** by clicking an dragging the mouse in the time line. The selected area will be shown with a green background and all events in the selected time span will be shown together in the graph. If you have marked nodes of interest, **only the events of interest in the selection will be cumulated**.

In a cumulated graph, each arrow can contain multiple events of the same type. In that case, the tool tip window shows the number of events as well as the total time of all contained events. A drop-down list in the tool tip window lets you switch between the stack traces of the different events and the navigation hyperlinks in the tool tip window refer to the currently selected event.

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views.

B.6.8.2.4 Locking History Graph View Settings Dialog

The locking history graph view settings dialog is accessed by bringing the locking history graph [p. 221] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

On the **Recording** tab, the following options are available:

- **Monitor blocking threshold**

  Select the minimum time threshold in microseconds (µs) for which a monitor contention (i.e. when a thread is blocking) is displayed in the locking history graph [p. 221] .

- **Monitor waiting threshold**

  Select the minimum time threshold in microseconds (µs) for which a monitor wait state (i.e. when a thread is waiting) is displayed in the locking history graph [p. 221] .

On the **Time Line** tab, rhe following options are available:

- **Scale to fit window**

  Determines whether the view operates in the "fixed time scale" or "scale to fit window" mode. These modes are described in the VM telemetry view help page [p. 227] .

- **Show bookmarks**

  Controls where bookmarks will be shown, one of

  - **None**

    No bookmarks will be shown in the VM telemetry view.

  - **In time scale**

    The vertical bookmark line will only be drawn in the time scale at the top of the view.

  - **In entire view**

The vertical bookmark line will be drawn in the time scale and in the view itself.

- **Grid lines for time axis**

  Controls on what ticks grid lines will be shown along the time axis.

B.6.8.3 Monitor Views

B.6.8.3.1 Common Properties Of Monitor Views

Monitor views show a table where every row corresponds to a waiting or blocking event on a monitor. There are two monitor views:

- current monitors view [p. 225]

  The current monitors view shows monitors that are currently involved in a waiting or blocking operation.
- monitor history view [p. 225]

  The monitor history view shows the sequence of waiting and blocking operations on monitors.

The monitor views show the following 6 columns: sortable [p. 134] .

- **Time**

  The start time of the event.
- **Duration**

  The duration of the event. The event may still be in progress.
- **Type**

  The type of the event, one of "waiting" or "blocked".
- **Monitor ID**

  The ID of the monitor for identifying multiple events on a particular monitor instance.
- **Monitor class**

  The class of the monitor. If no Java object is associated with this monitor `[raw monitor]` is displayed.
- **Waiting thread**

  The thread that is or was waiting during the event.
- **Owning thread**

  The thread holding the monitor which is blocking the waiting thread is displayed. The owning thread is only relevant for the "blocked" event type. This column is not available if you profile with Java <=1.4 (JVMPI).

In the lower part of the split pane, the stack traces of the waiting thread and - if applicable - of the owning thread are displayed. Stack traces can only be displayed if CPU data is being recorded [p. 190] .

You can show any monitor in the heap walker [p. 158] by selecting the table row and choosing *Show Selection In Heap Walker* from the context menu. If a heap dump was already taken, you can choose to select the object in the current heap dump, otherwise a new heap dump will be taken.

Note that the selected monitor might not exist in the heap dump because the heap dump might have been taken before the monitor was allocated or after the monitor was garbage collected.

If you profile with Java <=1.4 (JVMPI), the monitor class names can only be displayed if they are recorded objects. You can enable "Record allocations on startup" in the session startup dialog [p. 103] to record all objects.

B.6.8.3.2 Current Monitors View

The current monitors view shows monitors that are currently involved in a waiting or blocking operation. Data in this view is available even if monitor events are not being recorded [p. 219] .

Otherwise, this view is explained by the common properties of monitor views [p. 224] .

B.6.8.3.3 Monitor History View

The monitor history view shows the sequence of waiting and blocking operations on monitors. Only recorded monitor events [p. 219] are shown.

Otherwise, this views is explained by the common properties of monitor views [p. 224] .

You can navigate from any row in the table to the corresponding event in the locking history graph [p. 221] by choosing *Show Selection In Locking History Graph* from the context menu. This will show the starting point of the selected monitor usage.

In the lower part of the split pane, the stack trace of the waiting thread and the owning thread are displayed. Stack traces can only be displayed if CPU data is being recorded [p. 190] . If you profile with Java 1.4 or lower (JVMPI), the stack trace for the waiting thread is not available.

B.6.8.3.4 Monitor History View Settings Dialog

The monitor history view view settings dialog is accessed by bringing the monitor history view [p. 225] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The following options are available:

- **Monitor blocking threshold**

  Select the minimum time threshold in microseconds (µs) for which a monitor contention (i.e. when a thread is blocking) is displayed in the monitor history view [p. 225] .
- **Monitor waiting threshold**

  Select the minimum time threshold in microseconds (µs) for which a monitor wait state (i.e. when a thread is waiting) is displayed in the monitor history view [p. 225] .

B.6.8.4 Monitor Usage Statistics

B.6.8.4.1 Monitor Usage Statistics

The monitor usage statistics view shows statically calculated statistics for monitor usage. Monitor usage statistics can only be calculated if monitor events have been recorded [p. 226] .

To calculate a statistics, click **Calculate statistics** in the tool bar or select *View->Calculate statistics* from JProfiler's main menu. If a statistics has been calculated, the context menu also provides access to this action.

Before a statistics is calculated, the monitor usage statistics options dialog [p. 226] is brought up. The resulting statistics table is static and can be re-calculated be executing **Calculate statistics** again. The statistics options dialog remembers your last selection.

The package level statistics table displays five columns:

- **Monitors/Threads/Classes**

  Displays the grouping criterion selected in the statistics dialog [p. 226] ,
- **Block count**

  Shows how often a block operation has been performed on the monitors grouped in this row.
- **Block duration**

  Shows the cumulative duration of all block operations performed on the monitors grouped in this row.
- **Wait count**

  Shows how often a waiting operation has been performed on the monitors grouped in this row.
- **Wait duration**

  Shows the cumulative duration of all waiting operations performed on the monitors grouped in this row.

B.6.8.4.2 Monitor Usage Statistics Options

The monitor usage statistics options dialog sets parameters for the output of the monitor usage statistics view [p. 226] . Select the criterion for which monitors will be cumulated, one of

- Monitors
- Threads
- Classes of monitors

B.6.9 VM Telemetry Views

B.6.9.1 Telemetry View Section

The telemetry view section shows a number of historic graphs which display cumulated information about the profiled JVM.

There are several views in this section:

- **Memory**

  Shows the maximum heap size and the amount of used and free space in it. This view can be displayed as a line graph or area graph.

  When you profile a Java 1.5+ JVM, the drop down list at the top offers all available memory pools. Please see the article on tuning garbage collection for more information on heap memory pools. In addition, there are several memory pools for non-heap data structures. The drop down list shows all available memory pools in a tree-like structure, so you can display the sum of all heap pools (the default selection) or the sum of all non-heap pools in the graph.
- **Recorded objects**

  Shows the total number of objects on the heap, divided into arrays and non-arrays. This view can be displayed as a line graph or area graph. Note that this view only displays recorded objects [p. 140] and is unavailable if no objects have been recorded so far. Objects that have been recorded are tracked even after recording has been stopped.
- **Recorded throughput**

  Shows how many objects are garbage collected and created. The plotted values are time rates, so the total numbers in a time interval are given by the area under the respective lines. Note that this view only displays recorded objects [p. 140] and is unavailable if no objects have been recorded so far. Objects that have been recorded are tracked even after recording has been stopped.
- **GC activity**

  Shows the garbage collector activity in percent of the elapsed time. This view is only available when profiling with a Java 1.5+ JVM. The combo box at the top allows you to show the activity for specific GC types. Sun JVMs implement a "Copy" and a "MarkSweepCompact" that apply to different object generations.
- **Classes**

  Shows the total number of classes loaded by the JVM, divided into CPU-profiled and non-CPU-profiled [p. 80] classes. This view can be displayed as a line graph or area graph.
- **Threads**

  Shows the total number of alive threads in the JVM, divided into the different thread states [p. 214] . This view can be displayed as a line graph or area graph.
- **CPU load**

  Shows the CPU load of the profiled process in percent of the elapsed time. This view is only available when profiling with a Java 1.5+ JVM.

Telemetries whose measurements are summable can be shown as a line graph and as an area graph. To change the graph type, choose *Line graph* or *Area graph* from the context or view menu. The graph type is a persistent view setting separate for each view and is also accessible through the view settings dialog.

When a view is shown as an area graph, the line which shows the total value is given by the upper bound of the filled area while the single contributions are shown as stacked area segments.

When you move the mouse across a telemetry view, the time at the position of the mouse cursor and the corresponding value on the vertical axis will be shown in JProfiler's status bar. The **current value** of each data line is always shown next to the corresponding legend entry.

Horizontal and vertical grid lines of the VM telemetry views can be configured in the view settings dialog.

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views.

Note that you can use a trigger [p. 91] and the "Start recording" and "Stop recording" actions [p. 95] to control VM telemetry recording for offline profiling [p. 259] .

B.6.9.2 VM Telemetry View Settings Dialog

The VM telemetry view settings dialog is accessed by bringing any VM telemetry [p. 227] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

View settings are saved separately for each VM telemetry.

The following options are available:

- **Scale to fit window**

  Determines whether the view operates in the "fixed time scale" or "scale to fit window" mode. These modes are described in the VM telemetry view help page [p. 227] .
- **Show bookmarks**

  Controls where bookmarks will be shown, one of

  - **None**

    No bookmarks will be shown in the VM telemetry view.
  - **In time scale**

    The vertical bookmark line will only be drawn in the time scale at the top of the view.
  - **In entire view**

    The vertical bookmark line will be drawn in the time scale and in the view itself.

- **Grid lines for time axis**

  Controls on what ticks grid lines will be shown along the time axis.
- **Grid lines for vertical axis**

  Controls on what ticks grid lines will be shown along the vertical axis.
- **Graph type**

  This option is only visible for telemetry view which allow the area graph display mode [p. 227] . Choose between `Line graph` and `Area graph`.

B.6.10 JEE & Probes

B.6.10.1 JEE & Probes

The JEE & Probes view shows the results of both built-in probes and custom probes. For background information on probes, see the corresponding help topic [p. 48] . Probes are configured on the probes tab [p. 99] of the session settings [p. 74] .

The probes view has a **probe selector** drop-down list at the top which shows all built-in probes as well as all custom probes that were detected in the profiled JVM. Custom probes can be defined in the session settings [p. 101] or registered on the command line with a reference to a `com.jprofiler.api.agent.probe.ProbeProvider`.

Unless the probe has been configured to record data at startup, you have to start recording data manually with the probe recording button next to the probe selector. Recording is switched on and off separately for each probe. By default, only the JEE built-in probes and custom probes are configured to start recording at startup. To change this behavior, select the corresponding option for built-in probes [p. 100] or call `metaData.recordOnStartup(false)` in the meta-data script of custom probes [p. 101] .

The tab-like view selector at the bottom provides access to the various views provided by the probe. The available views depend on what data is published by the selected probe. The following views are available:

- Time line [p. 233]

  Shows the life-time of control objects on a time-axis as horizontal bars colored with sampled control object states.
- Control objects [p. 234]

  Shows a table with information on control objects.
- Hot spots [p. 235]

  Shows a list of payload hot spots together with expandable back traces.
- Telemetries [p. 237]

  Shows telemetries published by the probe.
- Events [p. 237]

  Shows the single events that are recorded by the probe.
- Tracker [p. 238]

  Allows you to track selected control objects or hot spots and show their average times, counts and throughputs as graphs.

JProfiler features the following built-in probes:

- **JDBC**

  The control objects are database connections which can be in the following active states:

  - **Statement execution**

    A statement created via one of the `java.sql.Connection#createStatement(...)` methods is being executed.
  - **Prepared statement execution**

    A statement created via one of the `java.sql.Connection#prepareStatement(...)` or `java.sql.Connection#prepareCall(...)` methods is being executed.

  - **Batch execution**

    `java.sql.Statement#executeBatch()` is being executed on a statement.

  The probe annotates the SQL strings of statements into the call tree and shows them in the hot spots view.

  The following telemetries are provided:

  - **Executed statements**

    The number of executed statements per second.
  - **Average statement execution time**

    The average execution time in seconds for statements that completed in the last second.
  - **Recorded open connections**

    The number of open database connections at any time.

  By default, the probe records single events and starts recording at startup. There are special configuration options [p. 100] for this probe.

- **JPA/Hibernate**

  There are no control objects for this view, so the probe does not have time line and control objects views.

  The probe annotates the SQL strings of persistence operations into the call tree and shows them in the hot spots view.

  The following telemetries are provided:

  - **Entity Operation Count**

    The number of entity operations per second.
  - **Query Count**

    The number of executed queries per second.
  - **Query Duration**

    The average duration of queries in the last second.

  By default, the probe records single events and starts recording at startup. There are special configuration options [p. 100] for this probe.

- **JNDI**

  There are no control objects for this view, so the probe does not have time line and control objects views.

  The probe annotates JNDI query strings into the call tree and shows them in the hot spots view. Query strings are prepended with "[NAME]" and optionally have a "[FILTER]" part at the end for JNDI searches.

  By default, the probe records single events and starts recording at startup.

- **JMS**

  There are no control objects for this view, so the probe does not have time line and control objects views. There are two event types: "Synchronous message" and "Asynchronous message".

The probe annotates JMS message descriptions into the call tree and shows them in the hot spots view. The displayed JMS message description can be customized [p. 100] .

By default, the probe records single events and starts recording at startup.

- **Servlets**

  There are no control objects for this view, so the probe does not have time line and control objects views.

  The probe **splits the call the for each detected request URL** so you can analyze request separately in the call tree view [p. 192] . The URLs are also shown in the probe hot spots view. The way how distinct request URLs are determined can be customized [p. 100] .

  By default, the probe does not record single events and starts recording at startup.

- **RMI**

  There are no control objects for this view, so the probe does not have time line and control objects views. There are two event types: "Server call" and "Client call".

  The probe annotates RMI server calls into the call tree and shows RMI server and client calls in the hot spots view. RMI proxy classes are shown with their interface name in the call tree and their methods are shown with a special icon if the RMI probe is enabled.

  The following telemetries are provided:

  - **Client calls**

    How many outbound RMI calls were made by second.
  - **Server calls**

    How many inbound RMI calls were handled by second.
  - **Average client call duration**
  - **Average server call duration**

- **Wen services**

  There are no control objects for this view, so the probe does not have time line and control objects views. There are two event types: "Synchronous" and "Asynchronous". Most web service calls are synchronous.

  The probe shows web service client calls from JAX-WS-RI, Axis 2 and Apache CXF in the hot spots view. Web service proxy classes are shown with their interface name in the call tree and their methods are shown with a special icon if the web services probe is enabled.

  The following telemetries are provided:

  - **Web service calls**

    How many outbound web service calls were made per minute.
  - **Call duration**

    The average duration of web service client calls.

- **Files**

  The control objects are files of the following types:

- **RandomAccessFile**

  A random access file which can be both read from and written to.
- **FileInputStream**

  A file input stream which can only be read from.
- **FileOutputStream**

  A file output stream which can only be written to.

They can be in the following active states:

- **Read**

  Data is being read from the file via the `java.io` package.
- **Write**

  Data is being written to the file via the `java.io` package.
- **Channel read**

  Data is being read from the file via the `java.nio` package (`java.nio.channels.FileChannel`).
- **Channel write**

  Data is being written to the file via the `java.nio` package (`java.nio.channels.FileChannel`).

If configured, the probe annotates the file names into the call tree and shows them in the hot spots view. The parent path of a file can be inspected in the nested property table in the control objects view.

The following telemetries are provided:

- **Invocation count**

  How many read and write operations were performed per second.
- **Throughput**

  How many bytes were read and written per second.
- **Open files**

  The number of open files at any time.

By default, the probe does not record single events and does not start recording at startup.

- **Sockets**

  The control objects are sockets of the following types:

  - **Socket**

    A socket from the `java.io` package.
  - **SocketChannel**

    A socket channel from the `java.nio` package.

  They can be in the following active states:

  - **Read**

    Data is being read from the socket.

  - **Write**

    Data is being written to the socket.

  If configured, the probe annotates the `toString()` values of the associated `java.net.SocketAddress` objects into the call tree and shows them in the hot spots view.

  The following telemetries are provided:

  - **Invocation count**

    How many read and write operations were performed per second.

  - **Throughput**

    How many bytes were read and written per second.

  - **Open sockets**

    The number of open sockets at any time.

  By default, the probe does not record single events and does not start recording at startup.

- **Processes**

  The control objects are processes which can be in the following active states:

  - **Read**

    Data is being read from the input stream provided by the `java.lang.Process` object.

  - **Write**

    Data is being written to the output stream provided by the `java.lang.Process` object.

  If configured, the probe annotates the full paths to the executables into the call tree and shows them in the hot spots view. Command line arguments, working directory, special environment variables and the exit code can be inspected in the nested property table in the control objects view.

  The following telemetries are provided:

  - **Live Processes**

    The number of live processes at any time.

  - **Process stream operations**

    How many read and write operations were made to the process streams per second.

  - **Process stream throughput**

    How many bytes were read from and written to the process streams per second.

  By default, the probe does not record single events and does not start recording at startup.

B.6.10.2 Probes Time Line

The time-line view is conceptually similar to the thread history view [p. 214] . The role of the threads is taken by the control objects and thread states are replaced by the active states of the control object. For example, the file probe has files as control objects and the available states describe if the file is being read or written. The 🟧 orange default state signifies that the control object is **idle** and no special action is being performed. For more information on control objects and states, see the probes overview [p. 229] .

At the top of the view, there is a **filter selector**. You can use it to restrict the displayed control objects by

- **Status**

  From the combo box you can choose if you wish to display open, closed or both open and closed control objects.

- **Name**

  In the text box you can enter the full name of a control object or only a part of it. Only control objects whose names begin with this fragment are displayed. You can also use wildcards ("*" and "?") to select groups of control objects. Please note that if you use wildcards, you have to manually append a trailing "*" if desired. You can display the union of multiple filters at the same time by separating multiple filter expressions with commas, e.g. `test-, MyTest-*-123`.

When you right-click a control-object name on the left side of the view, a context menu will be displayed that allows you to jump to the control objects view [p. 234] or the events view [p. 237] and display the single selected control object there.

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views.

Grid lines and background of the time line view can be configured in the view settings dialog.

B.6.10.3 Probe Control Objects

The control objects view shows tabular information on the control objects published by the selected probe. For built-in probes, the name of view reflects the name of the control object, for example "Connections" or "Files". Please see the probes overview [p. 229] for more information on the probe-specific control objects.

The available columns depend on the probe, the following columns are available for all probes:

- **ID**

  The numeric ID of the control object as assigned by JProfiler. This is is also displayed in the time line view [p. 233] and the events view [p. 237] and can be used there to filter for a specific control object.

- **Name**

  The name column contains the description of the control object, which depends on the probe. For built-in probes, the column is named more specifically, for example "File name" or "Command line".

- **Start time**

  This is the time when the control object was opened and corresponds to an "open" event in the events view [p. 237] . In the time line view [p. 233] , this is the beginning of the displayed horizontal bar for the control object.

- **End time**

  This is the time when the control object was closed and corresponds to a "close" event in the events view [p. 237] . In the time line view [p. 233] , this is the end of the displayed horizontal bar for the control object.

A probe can determine that certain properties are published in a **nested table**. This is done to reduce the information overload in the main table and give more space to table columns. If a nested table is present, such as for the file and process probes, each row has an expansion handle at the left side.

If you click on is a property-value table will be expanded in-place. All properties in that table are also available in the filter selector described below.

If a probe publishes several types of control objects, such as the files and socket probes, a "Type" column is added that shows the type of the control object. Please see the probe overview [p. 229] for the probe-specific types. If a nested table is present, the type will be added to the nested table.

Most probes publish summary information on measurements that are available on a per-event basis. For example, the number of bytes that are read or written for a socket event is summed for all events and published as columns in the control objects view. This information is also available if single event recording is disabled.

In general, for each available state

- a count column is added
- for each summable numeric column in the events view, a corresponding column is added

In addition, each probe can publish additional columns that describe the control object and its state, but are not part of its name. Please see the probe overview [p. 229] for more probe-specific information.

At the bottom the of the table, there is a special **total row** that sums all summable columns in the table, such as durations, counts and throughputs. Together with the filter selector described below, you can analyze the collected data for selected subsets of control objects.

At the top of the view, there is a **filter selector**. You can use it to restrict the displayed control objects by

- **Status**

  From the combo box you can choose if you wish to display open, closed or both open and closed control objects.
- **Name**

  In the text box you can enter the full name of a control object or only a part of it. Only control objects whose names begin with this fragment are displayed. You can also use wildcards ("*" and "?") to select groups of control objects. Please note that if you use wildcards, you have to manually append a trailing "*" if desired. You can display the union of multiple filters at the same time by separating multiple filter expressions with commas, e.g. `test-, MyTest-*-123`.

By default, the filter works on all available columns. In order to be more specific, you can select a particular column from the "Filter by" drop-down list. This is useful, for example, to show a control object with a particular ID without getting spurious matches from other columns.

When you right-click a control-object row, the context menu contains a ★ "Show events for selected control object" action that allows you to jump to the events view [p. 237] and display all events for the selected control object there.

The "Add Selection To Tracker" action creates a tracker graph in the probe tracker view [p. 238] . You can select multiple control objects to create a single tracker graph for the sum of their operations.

B.6.10.4 Probe Hot Spots

The hot spots view is conceptually similar to the CPU hot spots view [p. 197] . Instead of showing method hot spots, it shows **payload names** published by the selected probe. Payload names (such as the SQL string of a statement for the JDBC probe) have an associated duration, and the ones that take the most time result as the top hot spots.

Payloads are also connected with particular call stacks, so the hot spots view can show a merged tree of back traces. Even if sampling is enabled, JProfiler records the exact call traces for probe payloads by default. If you want to avoid this overhead, you can switch it off in the profiling settings [p. 88] .

For more information on the payload concept, please see the corresponding help topic [p. 48]

Every hot spot is described in several columns:

- The **hot spot** column shows the payload name. For an explanation of probe-specific payloads, please see the probe overview [p. 229] .
- the **inherent time**, i.e. how much time has been spent in the hot spot together with a bar whose length is proportional to this value.
- the **average time**, i.e. the inherent time (see above) divided by the invocation count (see below).
- the **invocation count** of the hot spot. In contrast to CPU profiling, this is also available if "Sampling" is selected as the method call recording type [p. 86] .

If you click on the ⚠ handle on the left side of a hot spot, a tree of backtraces will be shown. Every entry in the backtrace tree has textual information attached to it which depends on the view settings.

- a **percentage number** which is calculated with respect either to the total time or the called method.
- a **time measurement** in ms or µs of how much time has been contributed to the parent **hot spot** on this path. If enabled in the view settings, every node in the hot spot backtraces tree has a **percentage bar** whose length is proportional to this number.
- an **invocation count** which shows how often the **hot spot** has been invoked on this path.

  Note: This is **not** the number of invocations of this method.
- a **name** which depends on the aggregation level:
  - **methods**

    a method name that is either fully qualified or relative with respect to to the calling method.
  - **classes**

    a class name.
  - **packages**

    a package name.
  - **Java EE components**

    the display name of the Java EE component.
- a **line number** which is only displayed if
  - the aggregation level is set to "methods"
  - line number resolution has been enabled in the profiling settings [p. 86]
  - the calling class is unfiltered

  Note that the line number shows the line number of the invocation and not of the method itself.

For certain probes, such as the "JPA/Hibernate" probe, the top-level elements in the backtraces are 🔎 containers for ⭐ secondary hot spots (JDBC statements in the JPA/Hibernate case) and nodes for ⚑ direct and ⚑ deferred operations.

The back traces below a "deferred operations" node are not directly associated with the actual execution of the hot spot. They show

- where the entity has been **acquired**, if it already existed
- where the entity has been **persisted**, if it is newly created

In the **view filter** at the bottom of the tree you can enter the full name of a payload or only a part of it. Only payloads whose names begin with this fragment are displayed. You can also use wildcards ("*" and "?") to select groups of payloads. Please note that if you use wildcards, you have to manually append a trailing "*" if desired. You can display the union of multiple filters at the same time by separating multiple filter expressions with commas, e.g. `test-, MyTest-*-123`.

The "Add Selection To Tracker" action in the context menu and the tool bar creates a tracker graph in the probe tracker view [p. 238] . You can select multiple control objects to create a single tracker graph for the sum of their operations.

B.6.10.5 Probe Telemetries

The telemetries view is conceptually similar to the VM telemetry views [p. 227] . Each probe can publish one or more telemetries with one or more measurements that are shown in in the same telemetry. The telemetry selector drop-down list at the top offers all available telemetries for the selected probe. Please see the probe overview [p. 229] for more information on the probe-specific telemetries.

When you move the mouse across a telemetry view, the time at the position of the mouse cursor and the corresponding value on the vertical axis will be shown in JProfiler's status bar. The **current value** of each data line is always shown next to the corresponding legend entry.

Horizontal and vertical grid lines of the VM telemetry views can be configured in the view settings dialog.

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views.

B.6.10.6 Probe Tracker

The events view shows the **raw measurements** that form the basis for the more high-level probe views. Each measurement is called an "event" and is shown as a separate row in the table. Except for the JEE probes, single event recording is disabled by default. While the probe always processes all events, in this mode it discards them immediately after updating the higher-level measurements in order to minimize overhead. For example, a non-trivial compound file operation will quickly accumulate several hundred thousand single events.

For built-in probes, you can enable single event recording in the probe settings [p. 100] . For custom probes, call `metaData.events(true)` in the meta data script [p. 101] to enable event recording.

Each event is described by several columns which are common for all probes:

- **Start time**

  The time that marks the start of the selected event.
- **Event type**

  The type of the event. This includes all control object states as described in the probes overview [p. 229] as well as "open" and "close" events if the probe publishes control objects.
- **Duration**

  The duration of the event.
- **Control object ID**

  If the probe publishes control objects, this column contains the ID of the associated control object.

- **Description**

  The description of the event. If the probe publishes payload data, this is the same as the payload name displayed in the hot spots view.
- **Thread**

  The thread on which the event takes place. An event always takes place on a single thread.

Probes can publish additional columns in the events view. However, no built-in probes in JProfiler currently use this feature.

At the bottom the of the table, there is a special **total row** that sums all summable columns in the table. For the default columns this only includes the "Duration" column, Together with the filter selector described below, you can analyze the collected data for selected subsets of events.

Below the main table, the call stack of the selected event is shown. This is the call stack of the payload and forms the basis of the hot spot calculation.

For certain probes, such as the "JPA/Hibernate" probe, events can contain secondary events (JDBC statements in the JPA/Hibernate case) that can be opened with an expand control at the left side of the table row.

Some probes, such as the "JPA/Hibernate" probe have "deferred" and "direct" operations, this is indicated in the call stack with a top-level direct or deferred entry. See the probe hot spot [p. 235] view for more on this topic.

At the top of the view, there is a **filter selector**. You can use it to restrict the displayed control objects by

- **Status**

  From the combo box you can choose the event type that should be shown. Please see the probe overview [p. 229] for the probe-specific event types.
- **Name**

  In the text box you can enter the full name of a control object or only a part of it. Only control objects whose names begin with this fragment are displayed. You can also use wildcards ("*" and "?") to select groups of control objects. Please note that if you use wildcards, you have to manually append a trailing "*" if desired. You can display the union of multiple filters at the same time by separating multiple filter expressions with commas, e.g. `test-, MyTest-*-123`.

By default, the filter works on all available columns. In order to be more specific, you can select a particular column from the "Filter by" drop-down list. This is useful, for example, to show a control object with a particular ID without getting spurious matches from other columns.

When you right-click an event row, the context menu contains a "Show control object for selected event" action that allows you to jump to the control objects view [p. 234] and display the associated control object, if available.

B.6.10.7 Probe Tracker

This view allows you to track selected elements from other views and show graphs with a time axis to follow the chronological evolution of selected measurements.

When you click on the **[Record probe tracker data]** button, a dialog is shown that offers to track the following element types:

- **Control objects**

  If the current probe has control objects, you can select one or more control objects to create a graph in the tracker. The graph will show separate feeds for the average execution times of all different event types. For example, the "file" probe will show "Read", "Write", "Channel read" and "Channel write" feeds. The following measurements can be tracked:

  - **Event Times**

    The average duration of events for the selected control objects per second.
  - **Event Counts**

    The average event counts for the selected control objects per second.
  - **Event Throughputs**

    The average throughput for the selected control objects per second in bytes. This is only available for selected probes, e.g. for the "Files", "Sockets" and "Processes" probe.

- **Hot Spots**

  If the current probe has hot spots, you can select one or more hot spots to create a graph in the tracker. The graph will show separate feeds for the different time types:

  - Runnable
  - Waiting
  - Blocked
  - Net IO

  The following measurements can be tracked:

  - **Hot Spot Times**

    The average time for the execution of the selected hot spots per second.
  - **Hot Spot Counts**

    The average invocation counts for the execution of the selected hot spots per second.

Once you have at least one graph in the probe tracker view, you can use the ✚ **[Add]** button to show the selection dialog again and add more tracker graphs. The ✖ **[Remove]** button stops tracking for the currently displayed graph and removes the graph from the tracker view.

The drop-down list at the top allows you to switch between all tracker graphs that have been added in this profiling session.

Rather than selecting tracked elements directly in the tracker view, you can use the "add to tracker" actions in the control objects view [p. 234] and the probe hot spots view [p. 235] to add selected elements to the tracker. The actions are available in the tool bar, the *View* menu as well as the context menu.

Probe tracking can also be started programatically, either with

- the corresponding **probe tracker trigger actions** in a trigger [p. 95]
- the corresponding methods in the controller API

Please see the help on graphs with a time axis [p. 139] for help on common properties of graph views.

B.7 Snapshot Comparisons

B.7.1 Snapshot Comparisons Overview

In JProfiler, you can save profiling data to disk,

- either with the save action [p. 115] in JProfiler's main window [p. 127]
- or with the offline profiling API [p. 259]

To compare one or several of these snapshots, JProfiler offers a separate comparison window that you can access by

- Choosing `Compare multiple snapshots` from the **Snapshots** tab of the start center [p. 60] and clicking **[OK]**. If the current window is already used for a profiling session, you will be prompted whether a new frame should be opened, otherwise the current window will be exchanged with the snapshot comparison window.
- Choosing *Session->Compare snapshots in new window* from JProfiler's main menu.

Menu and toolbar of the snapshot window are focused on snapshot comparisons, you can access all other parts of JProfiler from a snapshot window by choosing *File->Show start center* from the main menu or clicking on the corresponding toolbar button. This can be necessary if you close all other windows. *File->New window* opens a new JProfiler window with the start center displayed.

Note: It is possible to create and export comparisons from the command line [p. 275] or an ant build file [p. 280] . This is especially useful for an automated quality assurance process.

The snapshot window contains a **snapshot selector at the left side** that lets you configure the snapshots which are available for creating a comparison. Before you create a comparison, you have to add the involved snapshots to the snapshot selector. If you open the snapshot comparison window without having saved any snapshots during the current JProfiler session, you will be prompted to select snapshot files.

The **order** of the snapshot files in the list is significant since all comparisons will assume that snapshots further down in the list have been recorded later.

Note: Snapshots are always compared to other snapshots, if you wish to compare a snapshot to a currently running profiling session, please save a snapshot first. The saved snapshot will automatically be shown in the snapshot selector.

The snapshot selector offers the following operations as toolbar buttons and context menu items:

- **add a new snapshot file** (`INS`). In the following file chooser select one or more `*.jps` files to add to the snapshot selector. New snapshots are always appended to the end of the list.
- **sort snapshot files**. In the following popup dialog, you can select whether to sort the snapshot files by creation time (i.e. the file modification time) or by name. Note that this is a one-time operation, new snapshots are always appended to the end of the list.
- **open snapshot files**. The selected snapshot files are opened in new windows, just like when you open them from the start center [p. 60] or with *Session->Open snapshot* from JProfiler's main menu.
- **remove snapshot files** (`DEL`). The currently selected snapshot files are removed from the snapshot selector. If any of the snapshot files to be removed are used in an existing comparison, those comparison will be closed as well after a confirmation dialog.

- **move snapshot files up in the list** (`ALT-UP`). If your selection is a single interval, the whole block of snapshot files will be moved.
- **move snapshot files down in the list** (`ALT-DOWN`). If your selection is a single interval, the whole block of snapshot files will be moved.

After you've added the involved snapshots, you can **create comparisons** with the **comparison wizards**. There are several comparison wizards that group comparisons in analogy to the view sections [p. 127] in the profiling window:

- the memory comparison wizard [p. 243]
- the CPU comparison wizard [p. 249]
- the telemetry comparison wizard [p. 253]
- the probe comparison wizard [p. 255]

The comparison wizards can be invoked from the *File* menu, from the toolbar as well as from the context menu of the snapshot selector.

If you wish to perform the comparison on a subset of the displayed snapshot files, it is easiest to first select the involved snapshots before invoking a comparison wizard. However, all snapshot wizards allow you to change this selection.

Comparisons are displayed as new tabs in the snapshot comparison window. They can be

- **renamed** by choosing *View->Rename* from the main menu while the view is active.
- **closed** by choosing *View->Close* from the main menu while the view is active. You can also click the tab with the middle mouse button to close it.

The above actions are also available in the context menu on the bottom of the tab.

The comparison wizards are optimized to quickly let you create new comparisons that are similar to previous comparisons. The wizards **remember all previous parameters**, so to create another comparison with the same parameters but different snapshots, just select new new snapshots in the snapshot selector on the left, invoke the wizard and click on "Finish".

To create another comparison with the same snapshots but different parameters, just invoke the wizard, click on "Next" to confirm the comparison type, then click on the step in the index where you wish to make a change and finally click on "Finish".

Most of the parameters that can be adjusted on the fly in the normal profiling views [p. 127] are selected in the comparison wizards and are fixed once the snapshot comparison has been created. These parameters are displayed in the **comparison header** which has the same layout for every comparison: In the first line you see the name of the comparison, the following lines are name value pairs of the selected parameters.

All comparisons have specific **view settings** that can be edited by choosing *View->View settings* from the main menu or the corresponding toolbar button when the comparison is active.

Common properties of comparisons include

- Exporting comparisons to HTML, CSV and XML [p. 133]
- Undocking comparisons from the main window [p. 133]
- Sorting tables [p. 134]

- Source and bytecode viewer [p. 137]
- Quick search capability [p. 133]

B.7.2 Memory Comparisons

B.7.2.1 Memory Snapshot Comparisons Overview

All memory snapshot comparisons are created by invoking the memory comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

In the first step of the memory comparison wizard, you select the desired comparison type:

- Objects comparison [p. 243]
- Allocation hot spot comparison [p. 245]
- Allocation tree comparison [p. 246]

The additional steps are described on the help pages linked above.

B.7.2.2 Objects Comparison

B.7.2.2.1 Objects Comparison

The objects comparison is one of the memory comparisons [p. 243] . It is created by invoking the memory comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following additional steps:

- **Select snapshots**

  The objects comparison compares two snapshot files. In this step, you select the first and the second snapshot file for the comparison. The combo boxes contain all snapshot files that have been added to the snapshot selector [p. 240] . The first and second snapshot files must be different.
- **Recording type**

  In this step, you choose whether you want to compare

  - **All objects**

    This option only yields results if both compared snapshots were profiled with Java 1.5 or higher (JVMTI). If one of the compared snapshots was profiled with Java 1.4 or lower (JVMPI), selecting this option will generate an empty comparison.
  - **Recorded objects**

    Only objects that were recorded [p. 140] will be compared when this option is selected.
  - **Heap snapshot objects**

    All objects that were captured in a heap snapshot taken in the heap walker [p. 158] will be compared when this option is selected. Heap snapshot must be present in both selected snapshots to yield meaningful results. This is the only option that works for HPROF heap dumps.

- **View parameters**

  In this steps you can select aggregation and liveness mode (only for recorded objects), just as for the all objects view [p. 141] and the recorded objects view [p. 143] .

Each row in the objects comparison has the following columns:

- the name of the class
- the size in the second snapshot file minus the size in the first snapshot file
- the instances in the second snapshot file minus the instances in the first snapshot file

The second column incorporates a bidirectional bar chart. Increases are painted in red and to the right, while decreases are painted in green and to the left. In the view settings dialog [p. 244] you can choose whether you want this bar chart to display absolute changes or the percentage of the change. The other value is displayed in parentheses. This setting also determines how this column is sorted. The second column can show either size or instances. This is configurable in the view settings dialog [p. 244] and is called the **primary measure**.

By default, only classs that have changed from one snapshot file to the other are displayed. You can change this behavior in the view settings dialog [p. 244] .

At the bottom of the objects comparison is a view filter selector [p. 137] that filters data for specific package or class names.

The context menu and the *View* menu provide actions for creating an allocation call tree comparison [p. 246] or an allocation hot spot comparison [p. 245] for the selected class.

Please note that if the current comparison compares "All objects" (see above), the numbers will likely not correspond with the object comparison since the allocation comparisons only compare recorded objects.

At the bottom of the objects comparison is a view filter selector [p. 137] that filters data for specific package or class names.

B.7.2.2.2 Objects Comparison View Settings Dialog

The objects comparison view settings dialog is accessed by bringing any objects comparison [p. 243] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a size scale mode for all displayed sizes:

- **Automatic**

  Depending on the size value, it's displayed in MB, kB or bytes, in such a way that 3 significant digits are retained.
- **Megabytes (MB)**
- **Kilobytes (kB**
- **Bytes**

The **primary measure** defines which measurement will be shown in the second column of the objects view. That column shows its values graphically with a histogram, has percentages attached and is the default sort column. By default, the primary measure is the instance count. Alternatively, you can work with the shallow size, which is especially useful if you're looking at arrays.

The **differences of primary measure** options determine how differences in the primary measure column are displayed and how that column is sorted.

- **Sort and display type**

  The sort and display type can be one of

  - **Sort by values**

    The bar chart in the primary measure column displays absolute differences. When this column is sorted, it is sorted by absolute differences. Percentages are displayed in parentheses.
  - **Sort by percentages**

    The bar chart in the primary measure column displays percentages. When this column is sorted, it is sorted by absolute percentages. Absolute differences are displayed in parentheses.

- **Show zero difference values**

  If this option is not checked, the objects comparison does not display hot spots that have not changed between the first and the second snapshot.

B.7.2.3 Allocation Hot Spot Comparison

B.7.2.3.1 Allocation Hot Spot Comparison

The allocation hot spot comparison is one of the memory comparisons [p. 243] . It is created by invoking the memory comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following additional steps:

- **Select snapshots**

  The allocation hot spot comparison compares two snapshot files. In this step, you select the first and the second snapshot file for the comparison. The combo boxes contain all snapshot files that have been added to the snapshot selector [p. 240] . The first and second snapshot files must be different.
- **Class selection**

  In this step, you choose for which class or package the comparison should be made. By default all classed are selected, you can restrict the class selection to a single class or a single package.
- **View parameters**

  In this steps you can select aggregation level, liveness mode and filtered classes handling, just as for the allocation hot spots view [p. 150] .

Each row in the allocation hot spot comparison has the following columns:

- the name of the allocation hot spot
- the size in the second snapshot file minus the size in the first snapshot file
- the allocations in the second snapshot file minus the allocations in the first snapshot file

The second column incorporates a bidirectional bar chart. Increases are painted in red and to the right, while decreases are painted in green and to the left. In the view settings dialog [p. 245] you can choose whether you want this bar chart to display absolute changes or the percentage of the change. The other value is displayed in parentheses. This setting also determines how this column is sorted.

By default, only allocation hot spots that have changed from one snapshot file to the other are displayed. You can change this behavior in the view settings dialog [p. 245] .

At the bottom of the allocation hot spot comparison is a view filter selector [p. 137] that filters data for specific package or class names.

B.7.2.3.2 Allocation Hot Spot Comparison View Settings Dialog

The allocation hot spot comparison view settings dialog is accessed by bringing any allocation hot spot comparison [p. 245] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a size scale mode for all displayed sizes:

- **Automatic**

  Depending on the size value, it's displayed in MB, kB or bytes, in such a way that 3 significant digits are retained.

- **Megabytes (MB)**
- **Kilobytes (kB**
- **Bytes**

The **node description** options control the amount of information that is presented in the description of the call.

- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear in the hot spot list.

  Only applicable if the aggregation level has been set to "methods".

The **size differences** options determine how differences in the allocated memory column are displayed and how that column is sorted.

- **Sort and display type**

  The sort and display type can be one of

  - **Sort by values**

    The bar chart in the allocated memory column displays absolute differences. When this column is sorted, it is sorted by absolute differences. Percentages are displayed in parentheses.
  - **Sort by percentages**

    The bar chart in the allocated memory column displays percentages. When this column is sorted, it is sorted by absolute percentages. Absolute differences are displayed in parentheses.

- **Show zero difference values**

  If this option is not checked, the hot spot comparison does not display hot spots that have not changed between the first and the second snapshot.

B.7.2.4 Allocation Tree Comparison

B.7.2.4.1 Allocation Tree Comparison

The allocation tree comparison is one of the memory comparisons [p. 243] . It is created by invoking the memory comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following additional steps:

- **Select snapshots**

  The allocation tree comparison compares two snapshot files. In this step, you select the first and the second snapshot file for the comparison. The combo boxes contain all snapshot files that have been added to the snapshot selector [p. 240] . The first and second snapshot files must be different.
- **Class selection**

  In this step, you choose for which class or package the comparison should be made. By default all classed are selected, you can restrict the class selection to a single class or a single package.
- **View parameters**

  In this steps you can select aggregation level and liveness mode, just as for the allocation tree view [p. 146] .

Each node in the tree has the same format as in the allocation tree view [p. 146] , except that the size and allocations are the differences between the second and the first snapshot.

Each node has an optional bar chart at the beginning, Increases are painted in red, while decreases are painted in green. In the view settings dialog [p. 247] you can choose whether you want this bar chart to display absolute changes or the percentage of the change. The other value is displayed in parentheses. This setting also determines how sibling nodes are sorted.

By default, only call stacks that are present in both snapshot files and that have changed from one snapshot file to the other are displayed. You can change this behavior in the view settings dialog [p. 247] .

At the bottom of the allocation tree comparison is a view filter selector [p. 137] that filters data for specific package or class names.

B.7.2.4.2 Allocation Tree Comparison View Settings Dialog

The allocation tree comparison view settings dialog is accessed by bringing any allocation tree comparison [p. 246] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The view mode can be toggled with the **cumulate allocations** checkbox. This sets whether differences should be calculated of the allocations cumulated for all descendant nodes or just for the current node.

You can select a size scale mode for all displayed sizes:

- **Automatic**

  Depending on the size value, it's displayed in MB, kB or bytes, in such a way that 3 significant digits are retained.
- **Megabytes (MB)**
- **Kilobytes (kB**
- **Bytes**

The **node description** options control the amount of information that is presented in the description of the call.

- **Show percentage bar**

  If this option is checked, a percentage bar will be displayed whose length is proportional to the size difference of objects allocated in this node including all descendant nodes. Depending on the sort and display type view setting (see below), these differences are either absolute differences or percentages. Positive differences are painted in red, while negative differences are painted in green.
- **Always show fully qualified names**

  If this option is not checked (default), class name are omitted in intra-class method calls which enhances the conciseness of the display.

  Only applicable if the aggregation level has been set to "methods".
- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear on the same level.

  Only applicable if the aggregation level has been set to "methods".

The **size differences** options determine how size differences are displayed and how sibling nodes are sorted.

- **Sort and display type**

  The sort and display type can be one of

  - **Sort by values**

    The bar chart on each node displays absolute differences. Sibling nodes are sorted by absolute differences. Percentages are displayed in parentheses.

  - **Sort by percentages**

    The bar chart on each node displays percentages. Sibling nodes are sorted by absolute percentages. Absolute differences are displayed in parentheses.

- **Show zero difference values**

  If this option is not checked, the call tree view does not display call stacks that have not changed between the first and the second snapshot.

- **Only show call stacks that appear in both snapshots**

  If this option is not checked, the allocation tree comparison does not display call stacks that appear in only one of the compared snapshots.

B.7.3 CPU Comparisons

B.7.3.1 CPU Snapshot Comparisons Overview

All CPU snapshot comparisons are created by invoking the CPU comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

In the first step of the CPU comparison wizard, you select the desired comparison type:

- Hot spot comparison [p. 249]
- Call tree comparison [p. 250]

The additional steps are described on the help pages linked above.

B.7.3.2 Hot Spot Comparison

B.7.3.2.1 Hot Spot Comparison

The hot spot comparison is one of the CPU comparisons [p. 249] . It is created by invoking the CPU comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following additional steps:

- **Select snapshots**

  The hot spot comparison compares two snapshot files. In this step, you select the first and the second snapshot file for the comparison. The combo boxes contain all snapshot files that have been added to the snapshot selector [p. 240] . You can use the same snapshot file for the first and second snapshot file, in which case the thread selections in the next step must be different.
- **Thread selection**

  In this step, you choose for which threads the comparison should be made. By default all threads are selected, you can restrict the thread selection to single thread groups or single threads.
- **View parameters**

  In this steps you can select thread status, aggregation level and filtered classes handling, just as for the hot spots view [p. 197] . In addition, you can choose whether to calculate differences of total call times or of average call times (total time divided by invocation count). Note that if "Sampling" was used as the method call recording type [p. 86] , the invocation count is not available and this setting will not have any effect.

Each row in the hot spot comparison has the following columns:

- the name of the hot spot
- the inherent time in the second snapshot file minus the inherent time in the first snapshot file
- the invocations in the second snapshot file minus the invocations in the first snapshot file

The second column incorporates a bidirectional bar chart. Increases are painted in red and to the right, while decreases are painted in green and to the left. In the view settings dialog [p. 250] you can choose whether you want this bar chart to display absolute changes or the percentage of the change. The other value is displayed in parentheses. This setting also determines how this column is sorted.

By default, only hot spots that have changed from one snapshot file to the other are displayed. You can change this behavior in the view settings dialog [p. 250] .

At the bottom of the hot spot comparison is a view filter selector [p. 137] that filters data for specific package or class names.

B.7.3.2.2 Hot Spot Comparison View Settings Dialog

The hot spot comparison view settings dialog is accessed by bringing any hot spot comparison [p. 249] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a time scale mode for all displayed times:

- **Automatic**

  Depending on the time value, it's displayed in seconds, millseconds or microseconds, in such a way that 3 significant digits are retained.
- **Seconds**
- **Millseconds**
- **Microseconds**

The **node description** options control the amount of information that is presented in the description of the call.

- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear in the hot spot list.

  Only applicable if the aggregation level has been set to "methods".

The **time differences** options determine how differences in the inherent time column are displayed and how that column is sorted.

- **Sort and display type**

  The sort and display type can be one of

  - **Sort by values**

    The bar chart in the inherent time column displays absolute differences. When this column is sorted, it is sorted by absolute differences. Percentages are displayed in parentheses.
  - **Sort by percentages**

    The bar chart in the inherent time column displays percentages. When this column is sorted, it is sorted by absolute percentages. Absolute differences are displayed in parentheses.

- **Show zero difference values**

  If this option is not checked, the hot spot comparison does not display hot spots that have not changed between the first and the second snapshot.

B.7.3.3 Call Tree Comparison

B.7.3.3.1 Call Tree Comparison

The call tree comparison is one of the CPU comparisons [p. 249] . It is created by invoking the CPU comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following additional steps:

- **Select snapshots**

  The call tree comparison compares two snapshot files. In this step, you select the first and the second snapshot file for the comparison. The combo boxes contain all snapshot files that have been added to the snapshot selector [p. 240] . You can use the same snapshot file for the first and second snapshot file, in which case the thread selections in the next step must be different.
- **Thread selection**

  In this step, you choose for which threads the comparison should be made. By default all threads are selected, you can restrict the thread selection to single thread groups or single threads.
- **View parameters**

  In this steps you can select thread status and aggregation level, just as for the call tree view [p. 192] . In addition, you can choose whether to calculate differences of total call times or of average call times (total time divided by invocation count). Note that if "Sampling" was used as the method call recording type [p. 86] , the invocation count is not available and this setting will not have any effect.

Each node in the tree has the same format as in the call tree view [p. 192] , except that the time and invocations are the differences between the second and the first snapshot.

Each node has an optional bar chart at the beginning, Increases are painted in red, while decreases are painted in green. In the view settings dialog [p. 251] you can choose whether you want this bar chart to display absolute changes or the percentage of the change. The other value is displayed in parentheses. This setting also determines how sibling nodes are sorted.

By default, only call stacks that are present in both snapshot files and that have changed from one snapshot file to the other are displayed. You can change this behavior in the view settings dialog [p. 251] .

At the bottom of the call tree comparison is a view filter selector [p. 137] that filters data for specific package or class names.

B.7.3.3.2 Call Tree Comparison View Settings Dialog

The call tree comparison view settings dialog is accessed by bringing any call tree comparison [p. 250] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a time scale mode for all displayed times:

- **Automatic**

  Depending on the time value, it's displayed in seconds, millseconds or microseconds, in such a way that 3 significant digits are retained.
- **Seconds**
- **Millseconds**
- **Microseconds**

The **node description** options control the amount of information that is presented in the description of the call.

- **Show percentage bar**

  If this option is checked, a percentage bar will be displayed whose length is proportional to the time difference spent in this node including all descendant nodes. Depending on the sort and display type view setting (see below), these differences are either absolute differences or percentages. Positive differences are painted in red, while negative differences are painted in green.

- **Always show fully qualified names**

  If this option is not checked (default), class name are omitted in intra-class method calls which enhances the conciseness of the display.

  Only applicable if the aggregation level has been set to "methods".
- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear on the same level.

  Only applicable if the aggregation level has been set to "methods".

The **time differences** options determine how time differences are displayed and how sibling nodes are sorted.

- **Sort and display type**

  The sort and display type can be one of

  - **Sort by values**

    The bar chart on each node displays absolute differences. Sibling nodes are sorted by absolute differences. Percentages are displayed in parentheses.
  - **Sort by percentages**

    The bar chart on each node displays percentages. Sibling nodes are sorted by absolute percentages. Absolute differences are displayed in parentheses.

- **Show zero difference values**

  If this option is not checked, the call tree view does not display call stacks that have not changed between the first and the second snapshot.
- **Only show call stacks that appear in both snapshots**

  If this option is not checked, the call tree comparison does not display call stacks that appear in only one of the compared snapshots.

B.7.4 VM Telemetry Comparisons

B.7.4.1 VM Telemetry Comparisons Overview

All telemetry snapshot comparisons are created by invoking the telemetry comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following steps:

- **Choose comparison type**

  In the first step of the telemetry comparison wizard, you select the desired comparison type, which compares values from the corresponding VM telemetry view [p. 227] :

  - **Heap comparison**
  - **Recorded objects comparison**
  - **Classes comparison**
  - **Threads comparison**

- **Select snapshots**

  The telemetry comparisons compare two or more snapshot files. In this step, you select whether you want to compare the snapshots that you have selected in the snapshot selector [p. 240] , or whether all snapshot files should be compared. The default selection depends on whether you have selected more than one snapshot in the snapshot selector.

- **Memory type**

  This screen is only shown for the "Heap comparison" and lets you choose a memory pool for comparison as explained on the help page of the VM telemetry views [p. 227] . Only memory pools are shown that are contained in all compared snapshots.

- **Comparison type**

  Each snapshot file contributes one value to the comparison graph. That value can be the

  - **current value**

    This is the value when the snapshot was saved, i.e. the rightmost point in the telemetry view and the value that is displayed next to the legend entries there.

  - **maximum value**

    This is the maximum value during the entire time that the telemetry view was recording data. The maximum value is evaluated separately for each snapshot file.

  - **value at a bookmark**

    In JProfiler, you can set bookmarks [p. 135] for specific points in time. In addition, there are automatic bookmarks for recording events. If all compared snapshots contain a bookmark with the same name, you can compare values at those times. If you choose this option you have to select a bookmark from the combo box below. Only bookmarks that are contained in all snapshots are displayed.

- **Compared measurements**

  In this step you select which of the measurements from the corresponding VM telemetry view [p. 227] should be compared. You can select any combination of measurements, for each telemetry comparison there's one preferred measurement that's compared by default. The available measurements are:

  - **Heap comparison**

  Maximum, free and used heap size (default)

  - **Recorded objects comparison**

    Total number of objects (default), non-arrays, arrays
  - **Classes comparison**

    Total number of classes (default), filtered classes, unfiltered classes
  - **Threads comparison**

    Total number of threads (default), inactive threads, active threads

Any telemetry comparison behaves similarly to the VM telemetry views [p. 227] themselves, on the horizontal axis you see the snapshot numbers from the snapshot selector, the vertical axis remains the same. Effectively, the time axis from the VM telemetry views is replaced by an ordinal snapshot file axis.

There are several view settings [p. 254] that influence the display of the comparison. Please see the help on the VM telemetry views [p. 227] for more information.

B.7.4.2 VM Telemetry Comparisons View Settings Dialog

The VM telemetry comparison view settings dialog is accessed by bringing any VM telemetry comparison [p. 253] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The following settings are configurable:

- **Scale to fit window**

  Determines whether the view operates in the "fixed time scale" or "scale to fit window" mode described in the help on graphs with a time axis [p. 139] .
- **Grid lines for vertical axis**

  Controls on what ticks grid lines will be shown along the vertical axis.
- **Symbol for snapshot point**

  Controls which symbol is painted for each measurement of a snapshot file. Choose between `None`, `Hollow rectangle` and `Filled circle` (default).

B.7.5 Probe Comparisons

B.7.5.1 Probe Comparisons Overview

All memory snapshot comparisons are created by invoking the memory comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

In the first step of the probe comparison wizard, you select the desired comparison type:

- Probe hot spot comparison [p. 255]
- Probe telemetry comparison [p. 257]

The additional steps are described on the help pages linked above.

B.7.5.2 Hot Spot Comparison

B.7.5.2.1 Probe Hot Spot Comparison

The probe hot spot comparison is one of the probes comparisons [p. 255] . It is created by invoking the probes comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following additional steps:

- **Select snapshots**

  The probe hot spot comparison compares two snapshot files. In this step, you select the first and the second snapshot file for the comparison. The combo boxes contain all snapshot files that have been added to the snapshot selector [p. 240] . You can use the same snapshot file for the first and second snapshot file, in which case the thread selections in the next step must be different.
- **Probe selection**

  In this step, you choose for which probe the comparison should be made. If you select the "custom probe" option, all snapshots are analyzed to find out which custom probe are present in all snapshots.
- **Thread selection**

  In this step, you choose for which threads the comparison should be made. By default all threads are selected, you can restrict the thread selection to single thread groups or single threads.
- **View parameters**

  In this steps you can select thread status and aggregation level, just as for the probe hot spots view [p. 235] . In addition, you can choose whether to calculate differences of total call times or of average call times (total time divided by invocation count).

Each row in the probe hot spot comparison has the following columns:

- the name of the payload hot spot
- the inherent time in the second snapshot file minus the inherent time in the first snapshot file
- the invocations in the second snapshot file minus the invocations in the first snapshot file

The second column incorporates a bidirectional bar chart. Increases are painted in red and to the right, while decreases are painted in green and to the left. In the view settings dialog [p. 256] you can choose whether you want this bar chart to display absolute changes or the percentage of the change. The other value is displayed in parentheses. This setting also determines how this column is sorted.

By default, only payload hot spots that have changed from one snapshot file to the other are displayed. You can change this behavior in the view settings dialog [p. 256] .

At the bottom of the probe hot spot comparison is a view filter selector [p. 137] that filters data for specific package or class names.

B.7.5.2.2 Probe Hot Spot Comparison View Settings Dialog

The probe hot spot comparison view settings dialog is accessed by bringing any probe hot spot comparison [p. 255] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

You can select a time scale mode for all displayed times:

- **Automatic**

  Depending on the time value, it's displayed in seconds, millseconds or microseconds, in such a way that 3 significant digits are retained.
- **Seconds**
- **Millseconds**
- **Microseconds**

The **node description** options control the amount of information that is presented in the description of the call.

- **Always show signature**

  If this option is not checked, method signatures are shown only if two methods with the same name appear in the hot spot list.

  Only applicable if the aggregation level has been set to "methods".

The **time differences** options determine how differences in the inherent time column are displayed and how that column is sorted.

- **Sort and display type**

  The sort and display type can be one of

  - **Sort by values**

    The bar chart in the inherent time column displays absolute differences. When this column is sorted, it is sorted by absolute differences. Percentages are displayed in parentheses.
  - **Sort by percentages**

    The bar chart in the inherent time column displays percentages. When this column is sorted, it is sorted by absolute percentages. Absolute differences are displayed in parentheses.

- **Show zero difference values**

  If this option is not checked, the probe hot spot comparison does not display hot spots that have not changed between the first and the second snapshot.

B.7.5.3 Telemetry Comparison

B.7.5.3.1 Probe Telemetry Comparison

The probe telemetry comparison is one of the probes comparisons [p. 255] . It is created by invoking the probes comparison wizard. For more information on snapshot comparisons, please see the snapshot comparison overview [p. 240] .

The wizard has the following steps:

- **Select snapshots**

  The telemetry comparisons compare two or more snapshot files. In this step, you select whether you want to compare the snapshots that you have selected in the snapshot selector [p. 240] , or whether all snapshot files should be compared. The default selection depends on whether you have selected more than one snapshot in the snapshot selector.
- **Probe selection**

  In this step, you choose for which probe the comparison should be made. If you select the "custom probe" option, all snapshots are analyzed to find out which custom probe are present in all snapshots.
- **Telemetry group**

  In this step, you choose for which telemetry group the comparison should be made. Probes can publish one or more telemetry groups with multiple measurements each.
- **Comparison type**

  Each snapshot file contributes one value to the comparison graph. That value can be the

  - **current value**

    This is the value when the snapshot was saved, i.e. the rightmost point in the telemetry view and the value that is displayed next to the legend entries there.
  - **maximum value**

    This is the maximum value during the entire time that the telemetry view was recording data. The maximum value is evaluated separately for each snapshot file.
  - **value at a bookmark**

    In JProfiler, you can set bookmarks [p. 135] for specific points in time. In addition, there are automatic bookmarks for recording events. If all compared snapshots contain a bookmark with the same name, you can compare values at those times. If you choose this option you have to select a bookmark from the combo box below. Only bookmarks that are contained in all snapshots are displayed.

- **Compared measurements**

  In this step you select which of the measurements from the selected telemetry group that should be compared. You can select any combination of measurements.

Any telemetry comparison behaves similarly to the probe telemetry views [p. 237] themselves, on the horizontal axis you see the snapshot numbers from the snapshot selector, the vertical axis remains the same. Effectively, the time axis from the VM telemetry views is replaced by an ordinal snapshot file axis.

There are several view settings [p. 258] that influence the display of the comparison. Please see the help on the probe telemetry views [p. 237] for more information.

B.7.5.3.2 Probe Telemetry Comparisons View Settings Dialog

The probe telemetry comparison view settings dialog is accessed by bringing any probe telemetry comparison [p. 257] to front and choosing *View->View settings* from JProfiler's main menu or clicking on the corresponding toolbar button.

The following settings are configurable:

- **Scale to fit window**

  Determines whether the view operates in the "fixed time scale" or "scale to fit window" mode described in the help on graphs with a time axis [p. 139] .

- **Grid lines for vertical axis**

  Controls on what ticks grid lines will be shown along the vertical axis.

- **Symbol for snapshot point**

  Controls which symbol is painted for each measurement of a snapshot file. Choose between `None`, `Hollow rectangle` and `Filled circle` (default).

B.8 Offline Profiling

B.8.1 Offline Profiling

JProfiler's offline profiling capability allows you to run profiling sessions from the command line without the need for starting JProfiler's GUI front end. Offline profiling makes sense if you want to

- perform profiling runs from a scripted environment (e.g. an ant build file)
- save snapshots on a regular basis for QA work
- profile server components on remote machines via slow network connections

Performing an offline profiling run for your application is analogous to remote profiling [p. 105] with special library parameters passed to the profiling agent VM parameter `-Xrunjprofiler` for Java <=1.4.2 (JVMPI) or `-agentpath:[path to jprofilerti library]` for Java >=1.5.0 (JVMTI):

- **offline switch**

  Passing `offline` as a library parameter enables offline profiling. In this case, a connection with JProfiler's GUI is not possible.
- **session ID**

  In order for JProfiler to set the correct profiling settings, a corresponding session has to be configured in JProfiler's GUI front end. The ID of that session has to passed as a library parameter: `id=nnnn`. Your settings in the profiling settings dialog [p. 85] are used for offline profiling. The session ID can be seen in the top right corner of the application settings dialog [p. 75] .
- **config file location (optional)**

  The config file that is read for extracting the session with the specified ID has to be passed via `config={path to config.xml}`. The config file is located in the *`.jprofiler7`* directory in your user home directory (on Windows, the user home directory is typically *`c:\Documents and Settings\$USER`*). If you leave out this parameter, JProfiler will try to detect the config file location automatically.

A summary of all library parameters is available in the remote session invocation table [p. 108] .

If you profile on a machine where JProfiler is not installed, you will need to transfer the contents of the *`bin/{your platform}`* directory as well as the JAR file *`bin/agent.jar`* and the config file *`{User home directory}/.jprofiler7/config.xml`*.

Example:

A typical invocation for offline profiling with Java >=1.5 (JVMTI) will look like this:

```
        java "-agentpath:C:\Program
Files\jprofiler7\bin\windows\jprofilerti.dll=offline,id=109,config=C:\Users\bob\.jprofiler7\config.xml"

        "-Xbootclasspath/a:C:\Program Files\jprofiler7\bin\agent.jar"
        -classpath myapp.jar com.mycorp.MyApp
```

Please study the remote session invocation table [p. 108] to generate the correct invocation for your JVM. Also, please don't forget that the platform-specific native library path has to be modified, just like for remote profiling [p. 105] .

With the command line utility `bin/jpenable`, you can start offline profiling in any running JVM with a version of 1.6 or higher. With command line arguments you can automate the process so that it requires no user input. The supported arguments are:

```
  Usage: jpenable [options]

  jpenable starts the profiling agent in a selected local JVM, so you can connect
```

```
to it from a different computer. If the JProfiler GUI is running locally, you
can attach directly from the JProfiler GUI instead of running this executable.

* if no argument is given, jpenable attempts to discover local JVMs that
  are not being profiled yet and asks for all required input on the command
  line.
* with the following arguments you can partially or completely supply all
  user input on the command line:

  -d  --pid=PID      The PID of the JVM that should be profiled
  -n  --noinput      Do not ask for user input under any circumstances

  GUI mode: (default)
  -g  --gui          The JProfiler GUI will be used to attach to the JVM
  -p  --port=nnnnn   The port no which the profiling agent should listen for a
                     connection from the JProfiler GUI

  Offline mode:
  -o  --offline      The JVM will be profiled in offline mode
  -c  --config=PATH  Path to the config file that holds the profiling settings
  -i  --id=ID        ID of the session in the config file. Not required, if
                     the config file holds only a single session.

Note that the JVM has to be running as the same user as jpenable, otherwise
JProfiler cannot connect to it.
An exception are Windows services running under the local system account if you
list them interactively with jpenable.
```

If the generated snapshots have heap dumps in them, you can use the `jpanalyze` executable to prepare the heap dump analysis in advance [p. 120] . Opening the snapshot in the JProfiler GUI will then be very fast. The executable is named *`jpanalyze.exe`* on Windows and *`jpanalyze`* on Unix-based operating systems and is located in the *`bin`* directory of a JProfiler installation. If you execute it with the **-help** option, you will get help on its usage:

```
Usage: jpanalyze [options] "snapshot file" ["snapshot file" ...]

where "snapshot file" is a snapshot file with a .jps, .hprof, or .dat extension
      [options] is a list of options in the format -option=value

Options:
    -format=dir|tar|tgz
        The format in which the analysis data should be stored. Defaults to
        dir.
    -removeUnreferenced=true|false
        If unreferenced or weakly referenced objects should be removed.
    -retained=true|false
        Calculate retained sizes (biggest objects). removeUnreferenced will be
        set to true.
```

The `removeUnreferenced` and the `retained` command line options correspond to the options in the heap walker options dialog [p. 159] .

If you start your application from an ant build file, you can use the ant task [p. 262] to easily profile your application in offline mode.

If you already have a launched "Application" session defined, you can generate a start script for offline profiling with the **local to offline conversion wizard** on the "Convert" tab of the start center [p. 60] or by selecting *Session->Conversion wizards->Convert application session to offline* from the main menu.

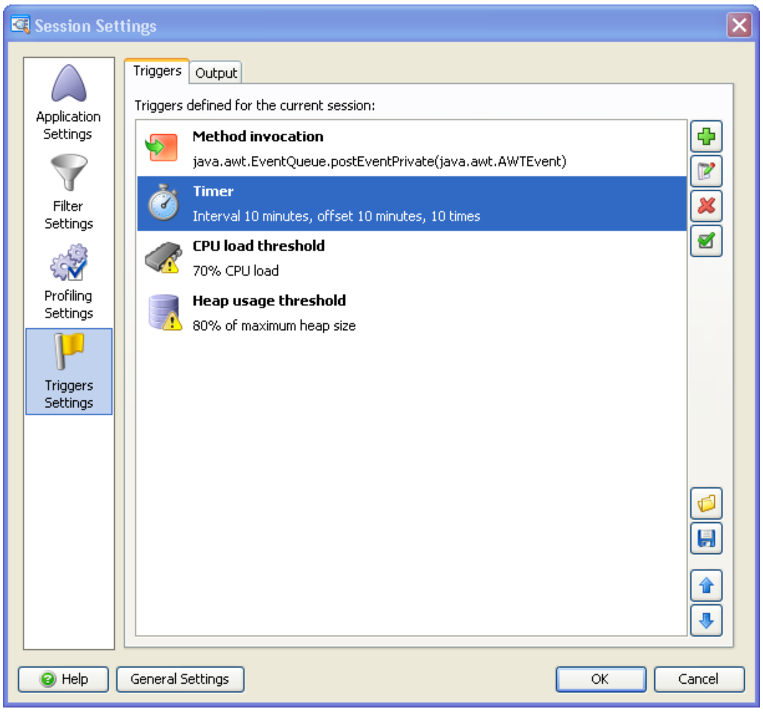
To control CPU profiling, triggering of heap dumps and saving of snapshots during an offline profiling session, you can use the

- **Profiling API**

JProfiler's profiling API [p. 264] allows you to control the profiling agent from your own code. An example on how to use the offline profiling API is available in the *$JPROFILER_HOME/api/samples/offline* directory.

- **Triggers**

  With triggers [p. 91] , you can define all profiling actions in the JProfiler GUI.



Triggers defined for the current session:

Method invocation
java.awt.EventQueue.postEventPrivate(java.awt.AWTEvent)

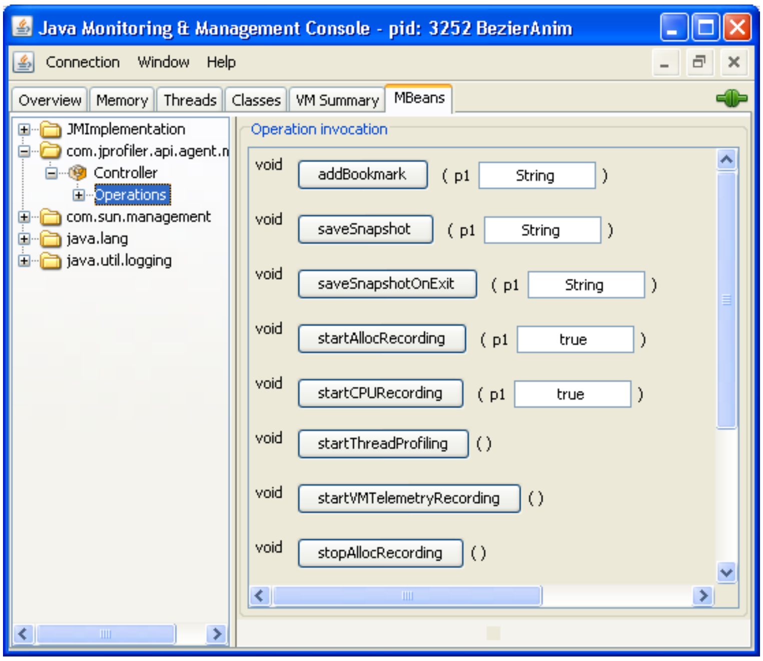
Timer
Interval 10 minutes, offset 10 minutes, 10 times

CPU load threshold
70% CPU load

Heap usage threshold
80% of maximum heap size

- **JProfiler MBean**

  On Java 1.5+, the profiling agent registers an MBean that gives access to all profiling actions. MBeans are configurable in jconsole:



void addBookmark (p1 String)
void saveSnapshot (p1 String)
void saveSnapshotOnExit (p1 String)
void startAllocRecording (p1 true)
void startCPURecording (p1 true)
void startThreadProfiling ( )
void startVMTelemetryRecording ( )
void stopAllocRecording ( )

Most methods of the `com.jprofiler.api.agent.Controller` are reflected in the MBean. For documentation of the MBean operations, please see the javadoc of `com.jprofiler.api.agent.mbean.RemoteControllerMBean`.

The MBean may also be accessible via configuration facilities of an application server or other tools.

- **Command line controller**

  With Java 1.5+, you can use the command line controller tool [p. 262] to interactively record profiling data and save snapshots in a convenient way without having to use a separate MBean viewer.

If wish to analyze profiling information at run-time, you can use the **profiling platform** that is part of JProfiler. Please see the javadoc in *`$JPROFILER_HOME/api/javadoc`* and the sample in *`$JPROFILER_HOME/api/samples/platform`* for more information.

B.8.2 Command Line Controller

For offline profiling [p. 259] , JProfiler also offers the possibility to attach to the profiled JVM with a command line application in order to interactively start and stop recording and save snapshots. All operations that are supported by the JProfiler MBean, are also supported by this command line tool. Since MBean technology is used, this command line application does not work with 1.4 JVMs.

When you start the `jpcontroller` executable without arguments, it attempts to connect to a profiled JVM on the local machine. If multiple profiled JVMs were discovered, you can select one from a list. Since the discovery mechanism uses the attach API of the Sun/Oracle JVM, this only works for Sun/Oracle JVMs 1.6 and above.

For 1.5 JVMs and other JVM vendors, you have to pass the VM parameter `-Djprofiler.jmxServerPort=[port]` to the profiled JVM. An MBean server will be published on that port and you can specify the chosen port as an argument to `jpcontroller`. With the additional VM parameter `-Djprofiler.jmxPasswordFile=[file]` you can specify a properties file with key value pairs of the form `user=password` to set up authentication. Note that these VM parameters are overridden by the default `com.sun.management.jmxremote.port` VM parameter.

With the explicit setup of the JMX server, you can use the command line controller to connect to a remote server. Invoking `jpcontroller host:port` will try to make a connection to the remote host `host`. If the remote computer is only reachable via an IP address, please add `-Djava.rmi.server.hostname=[IP address]` as a VM parameter to the remote VM, otherwise the connection cannot be established.

The supported arguments of jpcontroller are described below:

```
Usage: jpcontroller [host:port] | [pid]

* if no argument is given, jpcontroller attempts to discover local JVMs that
   are being profiled
* if a single number is specified, jpcontroller attempts to connect to the JVM
   with process ID [pid]. If that JVM is not profiled, jpcontroller cannot
   connect. In that case, use the jpenable utility first.
* otherwise, jpcontroller connects to "host:port", where port is the value
   that has been specified in the VM parameter -Djprofiler.jmxServerPort=[port]
   for the profiled JVM.
```

B.8.3 Using JProfiler With Ant

Integrating JProfiler with your ant script (read about ant at ant.apache.org) is easy. Just use the `profile` task that is provided in *`{JProfiler installation directory}/bin/ant.jar`* instead of the `java` task. The profile task drop in replacement for the the `java` as it supports all its attributes and nested tasks. In addition, it has a number of additional attributes that govern how the application is profiled.

Note: At least ant 1.6.3 is required for the profile task to work.

To make the `profile` task available to ant, you must first insert a `taskdef` element that tells ant where to find the task definition. Here is an example of using the task in an ant build file:

```
<taskdef name="profile"
         classname="com.jprofiler.ant.ProfileTask"
         classpath="C:\Program Files\jprofiler7\bin\ant.jar"/>

<target name="profile">
  <profile classname="MyMainClass" offline="true" sessionid="80">
    <classpath>
      <fileset dir="lib" includes="*.jar" />
    </classpath>
  </profile>
</target>
```

The `taskdef` definition must occur only once per ant-build file and can appear anywhere on the top level below the `project` element.

Note: it is **not possible** to copy the *`ant.jar`* archive to the *`lib`* folder of your ant distribution. You have to reference a full installation of JProfiler in the task definition.

Besides the attributes of the `java` task, the `profile` task supports the following additional attributes:

Attribute	Description	Required
offline	Whether the profiling run should be in offline mode [p. 259] . Corresponds to the **offline** library parameter [p. 108] . Either `true` or `false`.	No, offline and nowait cannot **both** be `true`
nowait	Whether profiling should start immediately or whether the profiled JVM should wait for a connection from the JProfiler GUI. Corresponds to the **nowait** library parameter [p. 108] . Either `true` or `false`.	
sessionid	Defines the session id from which profiling settings should be taken. Has no effect if neither nowait nor offline are set because in that case the profiling session is selected in the GUI. Corresponds to the **id** library parameter [p. 108] .	Required if • offline is set • nowait is set and the profiled JVM has a version of 1.5 or earlier
configfile	Defines the config file from which the profiling settings should be read. If not set or empty, the default config file location will be taken ($HOME/.jprofiler7/config.xml). Has no effect if neither nowait nor offline are set because in that case the profiling session is selected in the GUI. Corresponds to the **config** library parameter [p. 108] .	No
port	Defines the port number on which the profiling agent should listen for a connection from the JProfiler GUI. This must be the same as the port configured in the remote session configuration. If not set or zero, the default port (8849) will be	No

	used. Has no effect if offline is set because in that case there's no connection from the GUI. Corresponds to the **port** library parameter [p. 108] .	
usejvmpifor15	Use the deprecated JVMPI interface for 1.5 JREs. Either `true` or `false`. Default is `false` which means that the new JVMTI interface will be used.	No
useinterpreted	Profile in interpreted mode. Either `true` or `false`. Default is `false`.	No

If the generated snapshots have heap dumps in them, you can then use the `analyze` ant task to prepare the heap dump analysis in advance [p. 120] . This is an alternative to calling the `jpanalyze` executable directly as described for offline profiling [p. 259] .

Here is an example of using the task in an ant build file:

```
<taskdef name="analyze"
         classname="com.jprofiler.ant.AnalyzeTask"
         classpath="C:\Program Files\jprofiler7\bin\ant.jar"/>

<target name="analyze">
  <analyze>
    <fileset dir="output" includes="*.jps" />
  </analyze>
</target>
```

This will prepare heap dump analyses for all snapshot files in the "output" directory.

Besides the file set for the snapshot files to by analyzed, the `analyze` task supports the following additional attributes:

Attribute	Description	Required
format	One of "dir", "tar" or "tgz". By default, the directory format is used. These options correspond to the heap dump analysis saving options [p. 120] in the general settings.	No
removeunreferenced	Corresponds to the "Remove unreferenced and weakly referenced objects" option in the heap walker options dialog [p. 159] . Either `true` or `false`.	No
retained	Corresponds to the "Calculate retained sizes" option in the heap walker options dialog [p. 159] . Either `true` or `false`. If set to `true`, `removeunreferenced` will be set to to `true` as well.	No

B.8.4 Profiling API

JProfiler provides a profiling API that allows you to control certain aspects of profiling at run time. The profiling API is contained in *`bin/agent.jar`* in your JProfiler installation. If the profiling API is used during a normal execution of your application, the API calls will just quietly do nothing.

For offline profiling [p. 259] , **you will need to save a snapshot at some point** in order to evaluate the data of the profiling run with JProfiler's GUI front end later on. The `saveSnapshot` and `saveSnapshotOnExit` methods in JProfiler's profiling API do that job. For interactive use, these method calls will do nothing.

In addition, you can optionally switch on CPU profiling a a suitable point and trigger heap dumps with the profiling API.

B.9 Command Line Export

B.9.1 Snapshots

B.9.1.1 Command Line Export

JProfiler's command line export facility allows you to take a saved snapshot and export a number of views as HTML, CSV or XML. This is especially convenient if you use offline profiling [p. 259] and wish to generate reports in an automated fashion. Views with an interactive selection process like the heap walker or the method graph cannot be exported with this method.

There are two ways to use the command line export:

- with the special command line executable [p. 266]
- with the ant task [p. 273]

In both cases you specify a number of view names together with a set of options. Each view has its own set of options. The options can be used to adjust the presentation and the displayed data. For each GUI component in JProfiler that lets you choose the displayed data, like aggregation level or thread selection, an option is provided that allows you to perform the same selection for the command line export.

Most views in JProfiler support multiple output formats. By default, the output format is deduced from the extension of the output file:

- **.html**

  export as HTML file. Note that a directory named `jprofiler_images` will be created that contains images used in the HTML page.
- **.csv**

  export as CSV data, the first line contains the column names.

  Note: When using Microsoft Excel, CSV is not a stable format. Microsoft Excel on Windows takes the separator character from the regional settings. JProfiler uses a semicolon as the separator in locales that use a comma as a decimal separator and a comma in locales that use a dot as a decimal separator. If you need to override the CSV separator character you can do so by setting -Djprofiler.csvSeparator in `bin/export.vmoptions`.
- **.xml**

  export as XML data. The data format is self-descriptive.

If you would like to use different extensions, you can use the **format** option to override the choice of the output format.

When you save a snapshot, the session configuration is saved in the snapshot file. The snapshot loses the connection to the session configuration under which is was recorded. For this reason, you cannot edit the view settings in the original session to change presentation aspects of the HTML export. With the global **session** option, you can specify a session id whose view settings should be used for the export. The session id can be found in the application settings next to the session name.

The export will fail if

- the specified snapshot file does not exist
- you specify an unrecognized option
- you specify an unrecognized view name
- the output file cannot be written

- an option has an invalid value
- an option leads to an invalid selection in JProfiler, e.g. if a class cannot be found

You can choose to ignore errors by using the global **ignoreerrors** option.

B.9.1.2 Command Line Export Executable

The command line export executable can be used to export views from a saved snapshot. For more information please consult the overview [p. 265] .

The export executable is named *`jpexport.exe`* on Windows and *`jpexport`* on Unix-based operating systems and is located in the *`bin`* directory of a JProfiler installation. If you execute it with the **-help** option, you will get help on the available view names and view options:

```
Usage: jpexport "snapshot file" [global options]
              "view name" [options] "output file"
              "view name" [options] "output file" ...

where "snapshot file" is a snapshot file with a .jps, .hprof, or .dat extension
      [global options] is a list of options in the format -option=value
      "view name" is one of the view names listed below
      [options] is a list of options in the format -option=value
      "output file" is the output file for the export

Global options:
    -outputdir=[output directory]
        Base directory to be used when the output file for a view is a
        relative file.
    -ignoreerrors=true|false
        Ignore errors that occur when options for a view cannot be set and
        continue with the next view. The default value is "false", i.e. the
        export is terminated, when the first error occurs.
    -session=[session id]
        An alternate session from which the view settings should be taken. The
        session id can be found in the application settings next to the
        session name. By default, the view settings are taken from the session
        that is embedded inside the snapshot file.

Available view names and options:
* AllObjects
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -aggregation=class|package|component
        Selects the aggregation level for the export. The default value is
        classes.
    -expandpackages=true|false
        Expand package nodes in the package aggregation level to show
        contained classes. The default value is "false". Has no effect for
        other aggregation levels.

* RecordedObjects
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
```

```
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -aggregation=class|package|component
        Selects the aggregation level for the export. The default value is
        classes.
    -expandpackages=true|false
        Expand package nodes in the package aggregation level to show
        contained classes. The default value is "false". Has no effect for
        other aggregation levels.
    -liveness=live|gc|all
        Selects the liveness mode for the export, i.e. whether to display live
        objects, garbage collected objects or both. The default value is live
        objects.

* AllocationTree
  options:
    -format=html|xml
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -aggregation=method|class|package|component
        Selects the aggregation level for the export. The default value is
        methods.
    -viewmode=tree|treemap
        Selects the view mode for the export. The default value is "tree".
    -width=[number of pixels]
        Minimum width of the tree map in pixels. The default value is 800.
        Only relevant if "viewmode" is set to "tree".
    -height=[number of pixels]
        Minimum height of the tree map in pixels. The default value is 600.
        Only relevant if "viewmode" is set to "tree".
    -class=[fully qualified class name]
        Specifies the class for which the allocation data should be
        calculated. If empty, allocations of all classes will be shown. Cannot
        be used together with the package option.
    -package=[fully qualified package name]
        Specifies the package for which the allocation data should be
        calculated. If empty, allocations of all packages will be shown.
        Cannot be used together with the class option.
    -liveness=live|gc|all
        Selects the liveness mode for the export, i.e. whether to display live
        objects, garbage collected objects or both. The default value is live
        objects.

* AllocationHotSpots
  options:
    -format=html|csv|xml
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -aggregation=method|class|package|component
        Selects the aggregation level for the export. The default value is
        methods.
    -class=[fully qualified class name]
        Specifies the class for which the allocation data should be
        calculated. If empty, allocations of all classes will be shown. Cannot
        be used together with the package option.
    -package=[fully qualified package name]
        Specifies the package for which the allocation data should be
        calculated. If empty, allocations of all packages will be shown.
        Cannot be used together with the class option.
    -liveness=live|gc|all
        Selects the liveness mode for the export, i.e. whether to display live
        objects, garbage collected objects or both. The default value is live
        objects.
    -filteredclasses=separately|addtocalling
        Selects if filtered classes should be shown separately or be added to
        the calling class. The default value is to show filtered classes
        separately.
    -expandbacktraces=true|false
        Expand backtraces in HTML or XML format. The default value is "false".

* ClassTracker
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* CallTree
  options:
    -format=html|xml
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -aggregation=method|class|package|component
        Selects the aggregation level for the export. The default value is
        methods.
    -viewmode=tree|treemap
        Selects the view mode for the export. The default value is "tree".
    -width=[number of pixels]
        Minimum width of the tree map in pixels. The default value is 800.
        Only relevant if "viewmode" is set to "tree".
    -height=[number of pixels]
        Minimum height of the tree map in pixels. The default value is 600.
        Only relevant if "viewmode" is set to "tree".
    -threadgroup=[name of thread group]
        Selects the thread group for the export. If you specify thread as well
        , the thread will only be searched in this thread group, otherwise the
        entire thread group will be shown.
    -thread=[name of thread]
        Selects the thread for the export. By default, the call tree is merged
        for all threads.
    -threadstatus=all|running|waiting|blocking|netio
        Selects the thread status for the export. The default value is the
        runnable state.

* HotSpots
  options:
    -format=html|csv|xml
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -aggregation=method|class|package|component
        Selects the aggregation level for the export. The default value is
        methods.
    -threadgroup=[name of thread group]
        Selects the thread group for the export. If you specify thread as well
        , the thread will only be searched in this thread group, otherwise the
        entire thread group will be shown.
    -thread=[name of thread]
        Selects the thread for the export. By default, the call tree is merged
        for all threads.
    -threadstatus=all|running|waiting|blocking|netio
        Selects the thread status for the export. The default value is the
        runnable state.
    -expandbacktraces=true|false
        Expand backtraces in HTML or XML format. The default value is "false".
    -filteredclasses=separately|addtocalling
        Selects if filtered classes should be shown separately or be added to
        the calling class. The default value is to show filtered classes
        separately.

* ThreadHistory
  options:
    -format=html
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* ThreadMonitor
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.

* CurrentMonitorUsage
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.

* MonitorUsageHistory
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.

* MonitorUsageStatistics
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -type=monitors|threads|classes
```

```
        Selects the entity for which the monitor statistics should be
        calculated. The default value is "monitors".

* TelemetryHeap
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* TelemetryObjects
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* TelemetryThroughput
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* TelemetryGC
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* TelemetryClasses
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* TelemetryThreads
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* TelemetryCPU
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* Bookmarks
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.

* ProbeTimeLine
  options:
    -probeid
        The internal ID of the probe that should be exported. Run "jpexport
        -listProbes" to list all available built-in probes and for an
        explanation of custom probe names.
    -format=html
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.

* ProbeControlObjects
  options:
    -probeid
        The internal ID of the probe that should be exported. Run "jpexport
        -listProbes" to list all available built-in probes and for an
        explanation of custom probe names.
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.

* ProbeHotSpots
  options:
    -probeid
        The internal ID of the probe that should be exported. Run "jpexport
        -listProbes" to list all available built-in probes and for an
        explanation of custom probe names.
    -format=html|csv|xml
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
```

```
            file.
        -viewfilters=[comma-separated list]
            Sets view filters for the export. If you set view filters, only the
            specified packages and their sub-packages will be displayed by the
            exported view.
        -aggregation=method|class|package|component
            Selects the aggregation level for the export. The default value is
            methods.
        -threadgroup=[name of thread group]
            Selects the thread group for the export. If you specify thread as well
            , the thread will only be searched in this thread group, otherwise the
            entire thread group will be shown.
        -thread=[name of thread]
            Selects the thread for the export. By default, the call tree is merged
            for all threads.
        -threadstatus=all|running|waiting|blocking|netio
            Selects the thread status for the export. The default value is the
            runnable state.
        -expandbacktraces=true|false
            Expand backtraces in HTML or XML format. The default value is "false".

  * ProbeTelemetry
    options:
      -probeid
          The internal ID of the probe that should be exported. Run "jpexport
          -listProbes" to list all available built-in probes and for an
          explanation of custom probe names.
      -telemetrygroup
          Sets the one-based index of the telemetry group that should be
          exported. This refers to the the entries that you see in the drop-down
          list above the probe telemetry view. The default value is "1".
      -format=html|csv
          Determines the output format of the exported file. If not present, the
          export format will be determined from the extension of the output
          file.
      -minwidth=[number of pixels]
          Minimum width of the graph window in pixels. The default value is 800.
      -minheight=[number of pixels]
          Minimum height of the graph window in pixels. The default value is
          600.

  * ProbeEvents
    options:
      -probeid
          The internal ID of the probe that should be exported. Run "jpexport
          -listProbes" to list all available built-in probes and for an
          explanation of custom probe names.
      -format=html|csv
          Determines the output format of the exported file. If not present, the
          export format will be determined from the extension of the output
          file.
```

Examples of using the export executable are:

```
jpexport test.jps TelemetryHeap heap.html
```

```
jpexport test.jps RecordedObjects -aggregation=package -expandpackages=true objects.html
```

```
jpexport test.jps -ignoreerrors=true -outputdir=/tmp/export
         RecordedObjects objects.csv
         AllocationTree -class=java.lang.String allocations.xml
```

B.9.1.3 Export Ant Task

The export ant task can be used to export views from a saved snapshot. For more information please consult the overview [p. 265] .

You can integrate the command line export with your ant script (read about ant at ant.apache.org) by using the `export` task that is provided in *`{JProfiler installation directory}/bin/ant.jar`*.

To make the `export` task available to ant, you must first insert a `taskdef` element that tells ant where to find the task definition. Here is an example of using the task in an ant build file:

```
<taskdef name="export"
         classname="com.jprofiler.ant.ExportTask"
         classpath="C:\Program Files\jprofiler4\bin\ant.jar"/>

<target name="export">
  <export snapshotfile="c:\home\ingo\test.jps">
    <view name="CallTree" file="calltree.html"/>
    <view name="HotSpots" file="hotspots.html">
      <option name="expandbacktraces" value="true"/>
      <option name="aggregation" value="class"/>
    </view>
  </export>
</target>
```

The `taskdef` definition must occur only once per ant-build file and can appear anywhere on the top level below the `project` element.

Note: it is **not possible** to copy the *`ant.jar`* archive to the *`lib`* folder of your ant distribution. You have to reference a full installation of JProfiler in the task definition.

The `export` task supports the following attributes:

Attribute	Description	Required
snapshotfile	The path to the snapshot file. This must be a file with a *`.jps`* extension.	Yes
session	An alternate session from which the view settings should be taken. The session id can be found in the application settings next to the session name. By default, the view settings are taken from the session that is embedded inside the snapshot file.	No
ignoreerrors	Ignore errors that occur when options for a view cannot be set and continue with the next view. The default value is "false", i.e. the export is terminated, when the first error occurs.	No

The export task contains a list of **view** elements with the following attributes:

Attribute	Description	Required
name	The view name. For a list of available view names, please see the help page on the command line executable [p. 266] . extension.	Yes
file	The output file name. The process for the output format selection is described in the overview [p. 265] .	Yes

The view element can optionally contain a list of **option** elements with the following attributes:

Attribute	Description	Required

name	The option name. Each view has its own set of options. For a list of available view names and the corresponding options, please see the help page on the command line executable [p. 266] .	Yes
value	The value of the option.	Yes

B.9.2 Comparisons

B.9.2.1 Command Line Comparisons

JProfiler's command line comparison facility allows you to export a number of snapshot comparisons as HTML, CSV or XML. This is especially convenient if you use offline profiling [p. 259] and wish to generate comparisons in an automated fashion.

There are two ways to programmatically generate comparisons:

- with the special command line executable [p. 275]
- with the ant task [p. 280]

In both cases you specify a number of snapshots and a number of comparison names together with a set of options for each comparison. Each comparison has its own set of options. The options can be used to adjust the presentation and the displayed data. For each selection step in the comparison wizards, an option is provided that allows you to perform the same selection for the command line comparison.

Most comparisons in JProfiler support multiple output formats. By default, the output format is deduced from the extension of the output file:

- **.html**

  export as HTML file. Note that a directory named *jprofiler_images* will be created that contains images used in the HTML page.
- **.csv**

  export as CSV data, the first line contains the column names.

  Note: When using Microsoft Excel, CSV is not a stable format. Microsoft Excel on Windows takes the separator character from the regional settings. JProfiler uses a semicolon as the separator in locales that use a comma as a decimal separator and a comma in locales that use a dot as a decimal separator. If you need to override the CSV separator character you can do so by setting -Djprofiler.csvSeparator in *bin/export.vmoptions*.
- **.xml**

  export as XML data. The data format is self-descriptive.

If you would like to use different extensions, you can use the **format** option to override the choice of the output format.

The export will fail if

- one of the specified snapshot files does not exist
- you specify an unrecognized option
- you specify an unrecognized comparison name
- the output file cannot be written
- an option has an invalid value

- an option leads to an invalid selection in JProfiler, e.g. if a class cannot be found

You can choose to ignore errors by using the global **ignoreerrors** option.

B.9.2.2 Command Line Comparison Executable

The command line comparison executable can be used to generate comparisons from a number of saved snapshot. For more information please consult the overview [p. 274] .

The comparison executable is named *`jpcompare.exe`* on Windows and *`jpcompare`* on Unix-based operating systems and is located in the *`bin`* directory of a JProfiler installation. If you execute it with the **-help** option, you will get help on the available comparison names and comparison options:

```
Usage: jpcompare "snapshot file"[,"snapshot file",...] [global options]
              "comparison name" [options] "output file"
              "comparison name" [options] "output file" ...

where "snapshot file" is a snapshot file with a .jps, .hprof, or .dat extension
      [global options] is a list of options in the format -option=value
      "comparison name" is one of the comparison names listed below
      [options] is a list of options in the format -option=value
      "output file" is the output file for the export

Global options:
    -outputdir=[output directory]
        Base directory to be used when the output file for a comparison is a
        relative file.
    -ignoreerrors=true|false
        Ignore errors that occur when options for a comparison cannot be set
        and continue with the next comparison. The default value is "false",
        i.e. the export is terminated, when the first error occurs.
    -sortbytime=false|true
        Sort the specified snapshot files by modification time. The default
        value is false.
    -listfile=[filename]
        Read a file that contains the paths of the snapshot files, one
        snapshot file per line.

Available comparison names and options:
* Objects
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -objects=all|recorded|heapwalker
        Compare all objects (JVMTI only) or recorded objects, or objects in
        the heap walker. The default is all objects for .jps files and
        heapwalker for HPROF files.
    -liveness=live|gc|all
        Selects the liveness mode for the export, i.e. whether to display live
        objects, garbage collected objects or both. The default value is live
        objects.
    -aggregation=class|package|component
        Selects the aggregation level for the export. The default value is
        classes.

* AllocationHotSpots
  options:
    -format=html|csv
```

```
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -classselection
        Calculate the comparison for a specific class or package. Specify a
        package with a wildcard, like 'java.awt.*'.
    -liveness=live|gc|all
        Selects the liveness mode for the export, i.e. whether to display live
        objects, garbage collected objects or both. The default value is live
        objects.
    -aggregation=method|class|package|component
        Selects the aggregation level for the export. The default value is
        methods.
    -filteredclasses=separately|addtocalling
        Selects if filtered classes should be shown separately or be added to
        the calling class. The default value is to show filtered classes
        separately.

* AllocationTree
  options:
    -format=html|xml
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -classselection
        Calculate the comparison for a specific class or package. Specify a
        package with a wildcard, like 'java.awt.*'.
    -liveness=live|gc|all
        Selects the liveness mode for the export, i.e. whether to display live
        objects, garbage collected objects or both. The default value is live
        objects.

* HotSpots
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -firstthreadselection
        Calculate the comparison for a specific thread or thread group.
        Specify thread groups like 'group.*' and threads in specific thread
        groups like 'group.thread'. Escape dots in thread names with
        backslashes.
    -secondthreadselection
        Calculate the comparison for a specific thread or thread group. Only
        available if 'firstthreadselection' is set. If empty, the same value
        as for 'firstthreadselection' will be used. Specify thread groups like
        'group.*' and threads in specific thread groups like 'group.thread'.
        Escape dots in thread names with backslashes.
    -threadstatus=all|running|waiting|blocking|netio
        Selects the thread status for the export. The default value is the
        runnable state.
    -aggregation=method|class|package|component
```

```
        Selects the aggregation level for the export. The default value is
        methods.
    -differencecalculation=total|average
        Selects the difference calculation method for call times. The default
        value is total times.
    -filteredclasses=separately|addtocalling
        Selects if filtered classes should be shown separately or be added to
        the calling class. The default value is to show filtered classes
        separately.

* CallTree
  options:
    -format=html|xml
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -firstthreadselection
        Calculate the comparison for a specific thread or thread group.
        Specify thread groups like 'group.*' and threads in specific thread
        groups like 'group.thread'. Escape dots in thread names with
        backslashes.
    -secondthreadselection
        Calculate the comparison for a specific thread or thread group. Only
        available if 'firstthreadselection' is set. If empty, the same value
        as for 'firstthreadselection' will be used. Specify thread groups like
        'group.*' and threads in specific thread groups like 'group.thread'.
        Escape dots in thread names with backslashes.
    -threadstatus=all|running|waiting|blocking|netio
        Selects the thread status for the export. The default value is the
        runnable state.
    -aggregation=method|class|package|component
        Selects the aggregation level for the export. The default value is
        methods.
    -differencecalculation=total|average
        Selects the difference calculation method for call times. The default
        value is total times.

* TelemetryHeap
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.
    -valuetype=current|maximum|bookmark
        Type of the value that is calculated for each snapshot. Default is the
        current value.
    -bookmarkname
        If valuetype is set to 'bookmark', the name of the bookmark for which
        the value should be calculated.
    -measurements=maximum,free,used
        Measurements that are shown in the comparison graph. Concatenate
        multiple values with commas. The default value is 'used'.
    -memorytype=heap|nonheap
        Type of the memory that should be analyzed. Default is 'heap'.
    -memorypool
        If a special memory pool should be analyzed, its name can be specified
```

```
      with this parameter. The default is empty, i.e. no special memory
      pool.

* TelemetryObjects
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.
    -valuetype=current|maximum|bookmark
        Type of the value that is calculated for each snapshot. Default is the
        current value.
    -bookmarkname
        If valuetype is set to 'bookmark', the name of the bookmark for which
        the value should be calculated.
    -measurements=total,nonarrays,arrays
        Measurements that are shown in the comparison graph. Concatenate
        multiple values with commas. The default value is 'total'.

* TelemetryClasses
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.
    -valuetype=current|maximum|bookmark
        Type of the value that is calculated for each snapshot. Default is the
        current value.
    -bookmarkname
        If valuetype is set to 'bookmark', the name of the bookmark for which
        the value should be calculated.
    -measurements=total,filtered,unfiltered
        Measurements that are shown in the comparison graph. Concatenate
        multiple values with commas. The default value is 'total'.

* TelemetryThreads
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.
    -valuetype=current|maximum|bookmark
        Type of the value that is calculated for each snapshot. Default is the
        current value.
    -bookmarkname
        If valuetype is set to 'bookmark', the name of the bookmark for which
        the value should be calculated.
    -measurements=total,runnable,waiting,netio,waiting
        Measurements that are shown in the comparison graph. Concatenate
        multiple values with commas. The default value is 'total'.
```

```
* ProbeHotSpots
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -viewfilters=[comma-separated list]
        Sets view filters for the export. If you set view filters, only the
        specified packages and their sub-packages will be displayed by the
        exported view.
    -firstthreadselection
        Calculate the comparison for a specific thread or thread group.
        Specify thread groups like 'group.*' and threads in specific thread
        groups like 'group.thread'. Escape dots in thread names with
        backslashes.
    -secondthreadselection
        Calculate the comparison for a specific thread or thread group. Only
        available if 'firstthreadselection' is set. If empty, the same value
        as for 'firstthreadselection' will be used. Specify thread groups like
        'group.*' and threads in specific thread groups like 'group.thread'.
        Escape dots in thread names with backslashes.
    -threadstatus=all|running|waiting|blocking|netio
        Selects the thread status for the export. The default value is the
        runnable state.
    -aggregation=method|class|package|component
        Selects the aggregation level for the export. The default value is
        methods.
    -differencecalculation=total|average
        Selects the difference calculation method for call times. The default
        value is total times.
    -probeid
        The internal ID of the probe that should be exported. Run "jpexport
        -listProbes" to list all available built-in probes and for an
        explanation of custom probe names.

* ProbeTelemetry
  options:
    -format=html|csv
        Determines the output format of the exported file. If not present, the
        export format will be determined from the extension of the output
        file.
    -minwidth=[number of pixels]
        Minimum width of the graph window in pixels. The default value is 800.
    -minheight=[number of pixels]
        Minimum height of the graph window in pixels. The default value is
        600.
    -valuetype=current|maximum|bookmark
        Type of the value that is calculated for each snapshot. Default is the
        current value.
    -bookmarkname
        If valuetype is set to 'bookmark', the name of the bookmark for which
        the value should be calculated.
    -measurements
        The one-based indices of the measurements in the telemetry group that
        are shown in the comparison graph. Concatenate multiple values with
        commas, like "1,2". The default value is to show all measurements.
    -probeid
        The internal ID of the probe that should be exported. Run "jpexport
        -listProbes" to list all available built-in probes and for an
        explanation of custom probe names.
    -telemetrygroup
        Sets the one-based index of the telemetry group that should be
        exported. This refers to the the entries that you see in the drop-down
        list above the probe telemetry view. The default value is "1".
```

Examples of using the comparison executable are:

```
 jpcompare test1.jps,test2.jps,test3.jps TelemetryHeap heap.html

jpcompare test1.jps,test2.jps -sortbytime Objects -objects=recorded -aggregation=package
objects.html

 jpcompare -listfile=snapshots.txt -ignoreerrors=true -outputdir=/tmp/export
           Objects objects.csv
           AllocationTree -class=java.lang.String allocations.xml
```

B.9.2.3 Comparison Ant Task

The comparison ant task can be used to generate comparisons from a number of saved snapshots. For more information please consult the overview [p. 274] .

You can integrate the command line comparison with your ant script (read about ant at ant.apache.org) by using the `compare` task that is provided in *`{JProfiler installation directory}/bin/ant.jar`*.

To make the `compare` task available to ant, you must first insert a `taskdef` element that tells ant where to find the task definition. Here is an example of using the task in an ant build file:

```
<taskdef name="compare"
         classname="com.jprofiler.ant.CompareTask"
         classpath="C:\Program Files\jprofiler7\bin\ant.jar"/>

<target name="compare">
  <compare sortbytime="true">
    <fileset dir=".">
      <include name="*.jps" />
    </fileset>
    <comparison name="TelemetryHeap" file="heap.html"/>
    <comparison name="TelemetryThreads" file="threads.html">
      <option name="measurements" value="inactive,active"/>
      <option name="valuetype" value="bookmark"/>
      <option name="bookmarkname" value="test"/>
    </comparison>
  </compare>
</target>
```

The `taskdef` definition must occur only once per ant-build file and can appear anywhere on the top level below the `project` element.

Note: it is **not possible** to copy the *`ant.jar`* archive to the *`lib`* folder of your ant distribution. You have to reference a full installation of JProfiler in the task definition.

The `compare` task supports the following attributes:

Attribute	Description	Required
listfile	An file that contains a list of snapshot files that should be compared, one snapshot per line. The snapshot from a nested fileset will be prepended.	Only if no nested fileset is specified
sortbytime	Sort all supplied snapshot files by their file modification time.	No
ignoreerrors	Ignore errors that occur when options for a comparison cannot be set and continue with the next comparison. The default value is "false", i.e. the export is terminated, when the first error occurs.	No

The compare task can contain nested **fileset** elements to specify the snapshots that should be compared. If no fileset is specified, the **listfile** attribute of the compare task must be set.

The compare task contains a list of **comparison** elements with the following attributes:

Attribute	**Description**	**Required**
name	The comparison name. For a list of available comparison names, please see the help page on the command line executable [p. 275] . extension.	Yes
file	The output file name. The process for the output format selection is described in the overview [p. 274] .	Yes

The comparison element can optionally contain a list of **option** elements with the following attributes:

Attribute	**Description**	**Required**
name	The option name. Each comparison has its own set of options. For a list of available comparison names and the corresponding options, please see the help page on the command line executable [p. 275] .	Yes
value	The value of the option.	Yes