Eclipse Memory Analyzer

… and other Java stuff

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JVM Tool Interface

PROFILING IN THE JVM

JVM Tool Interface

- Comprehensive interface for programming and monitoring tools (≥ JDK 4; before: JVM PI + DI)

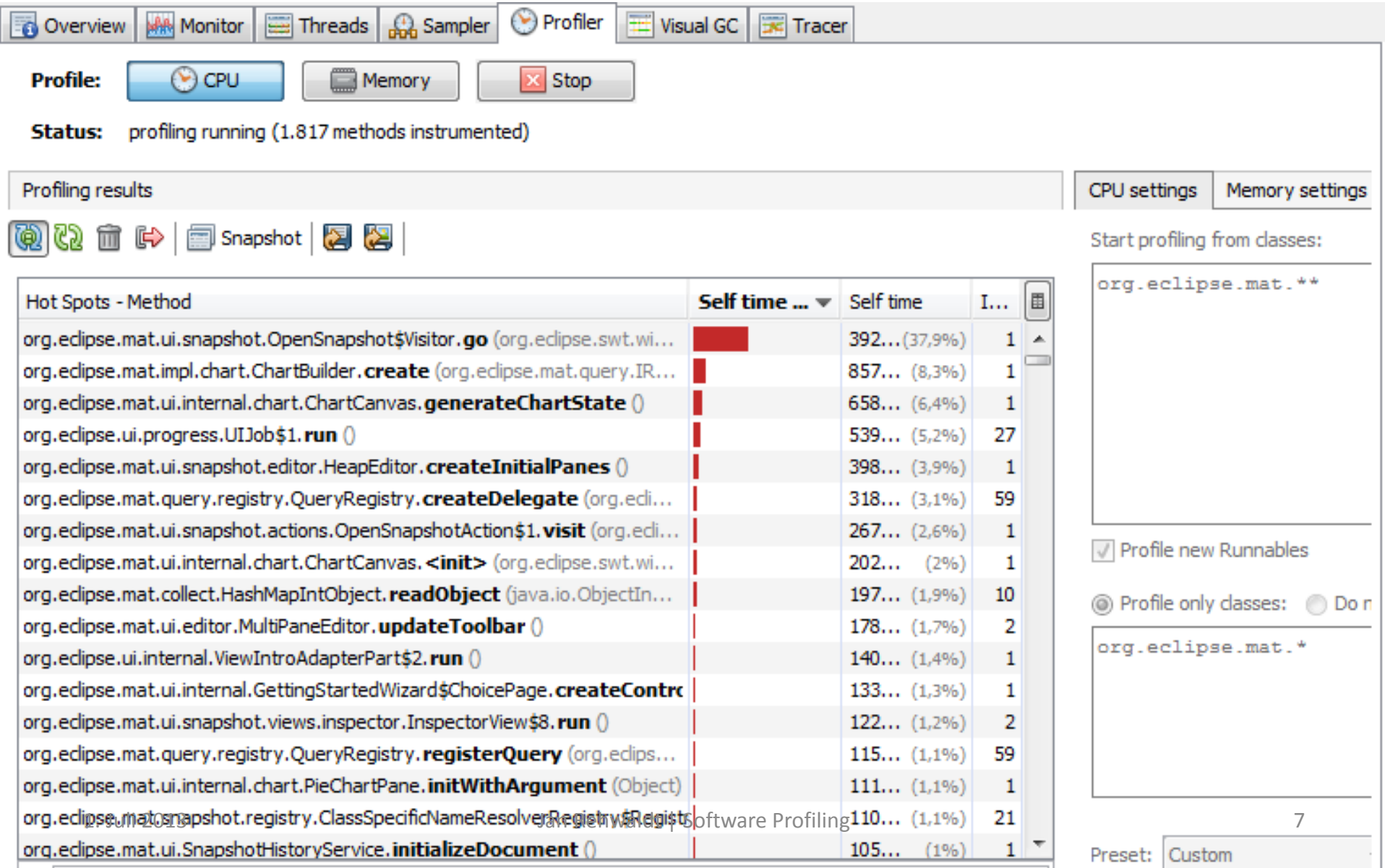
- Allows inspecting state and control execution of applications run in the JVM
- Support for profiling, debugging, monitoring, thread analysis, and coverage analysis tools, ...

Profiling in the JVM

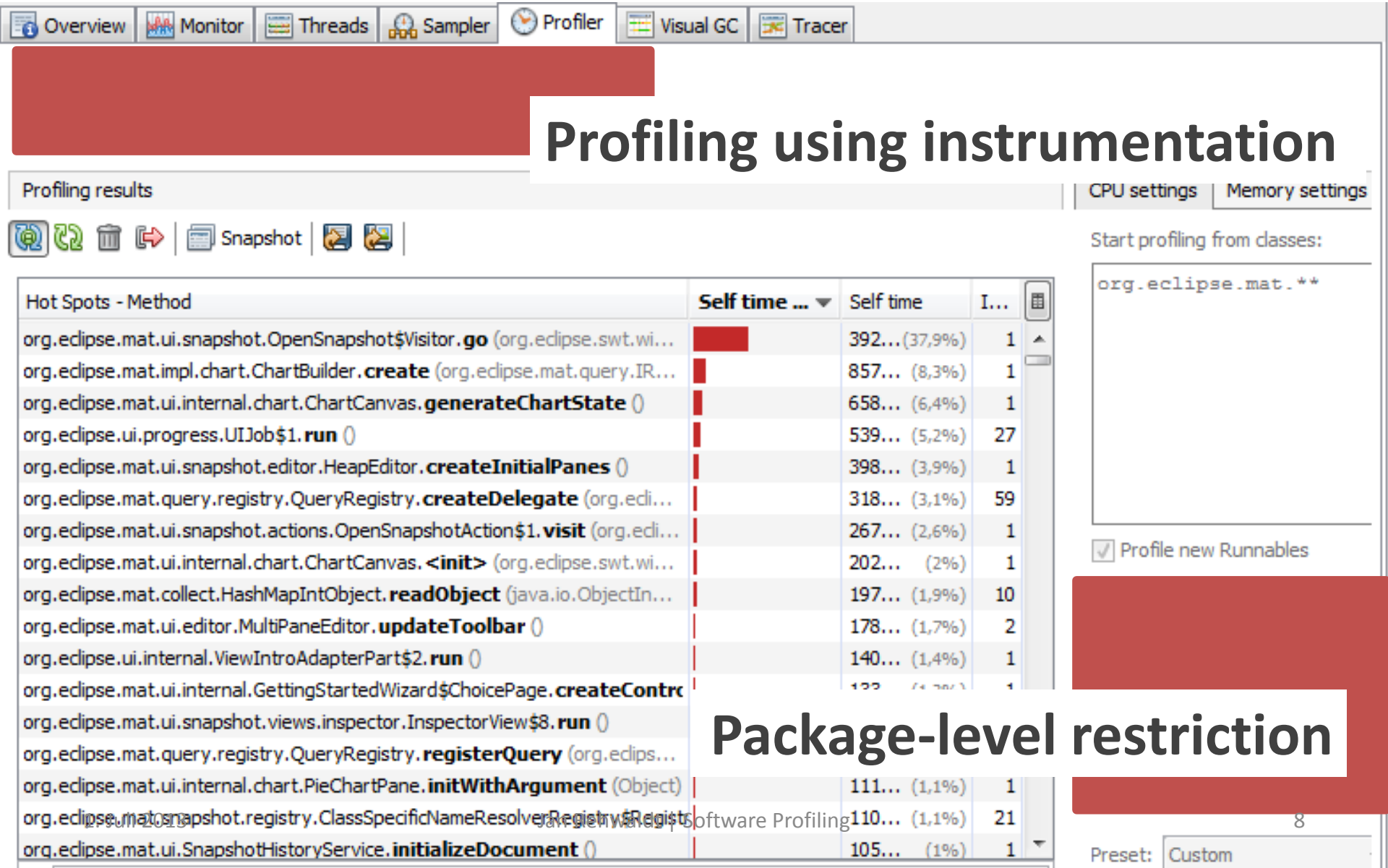
- JDK tools
  - jmap, jinfo, jps, jstack, jconsole, jvisualvm, ...
- Comprehensive Profiling Tools
  - VisualVM (free; included with ≥ JDK 6u7; lightwight)
  - NetBeans profiler (free; embedded in IDE)
  - YourKit (free for open-source projects)
  - JProfiler (free for open-source projects)
  - JProbe, Spring Insight, ...

http://java-source.net/open-source/profilers

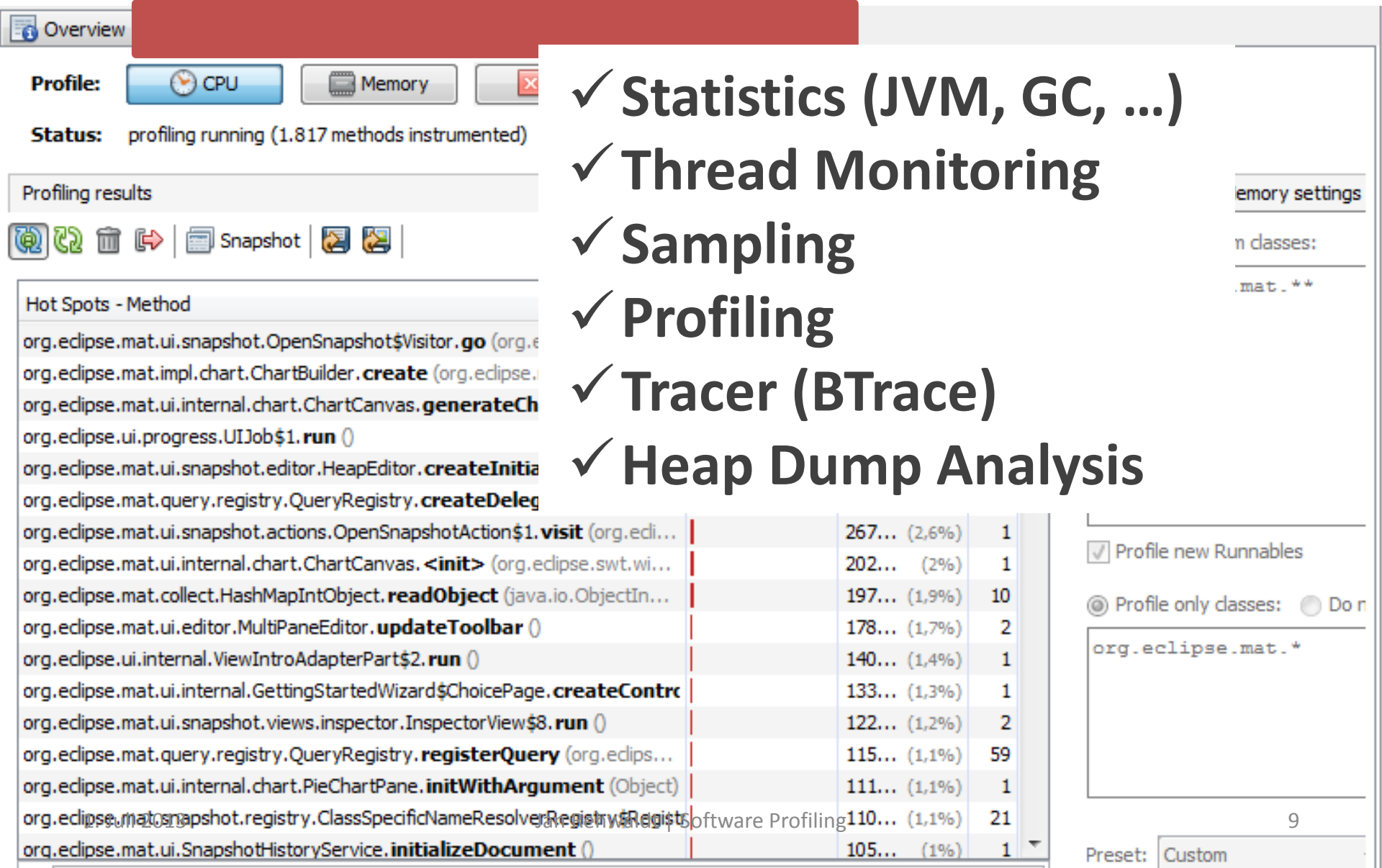
Profiling in the JVM: VisualVM



Profiling in the JVM: VisualVM



Profiling in the JVM: VisualVM



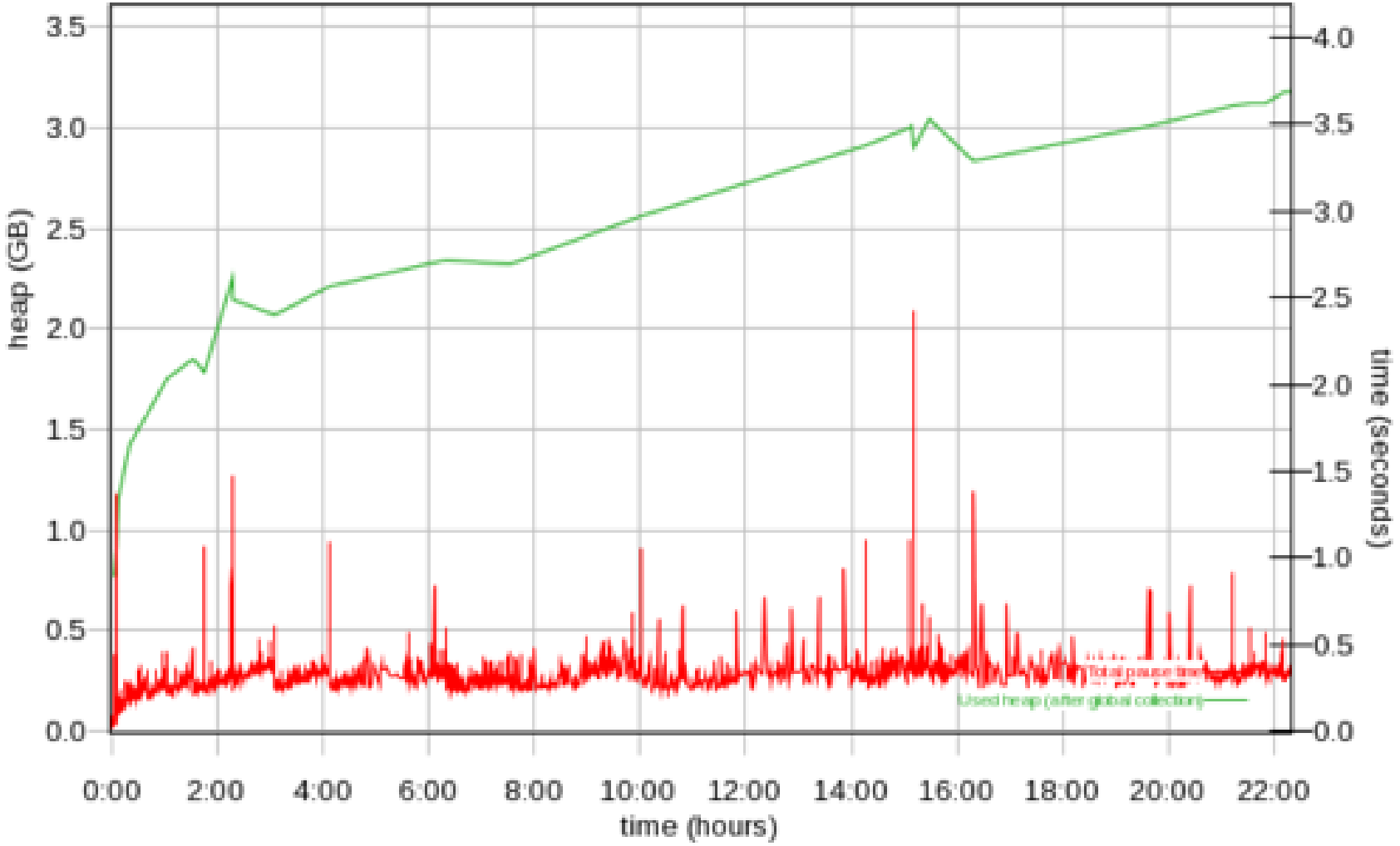
- ✓ Statistics (JVM, GC, …)
- ✓ Thread Monitoring
- ✓ Sampling
- ✓ Profiling
- ✓ Tracer (BTrace)
- ✓ Heap Dump Analysis

ECLIPSE MEMORY ANALYZER

Eclipse Memory Analyzer

- Show memory structure of Java programs
- Not while runtime, but generally based on heap dumps
  - often post-mortem
  - hprof file generated by Oracle JVM (experimental format)
  - phd file generated by IBM JVM
- Donated by SAP; Contributed to by IBM

Eclipse Memory Analyzer – when?



Heap dump

- jmap (included in JDK)
  - jmap -dump:format=b <pid>
- Aquire heap dump (inside Eclipse Memory Analyzer; uses jmap)

- On OutOfMemory (flag: -XX:+HeapDumpOnOutOfMemoryError)
- On [Ctrl]+[Break] (flag: -XX:+HeapDumpOnCtrlBreak; ≥ JDK 5u7)

Eclipse Memory Analyzer – when?

- Helps:
  - Find memory wasting datastructures
  - Indicate misuse of Java datatypes
  - Find memory leaks
  - Improve code by checking impacts of refactorings by comparing heap dumps
  - Understand memory consumption of code

Eclipse Memory Analyzer – when not?

- Does not help:
  - Threading issues, wrong / missing variable assignments and other debuggable problems: No debugging or stepping
  - Where has an object been created?
  - Analyze JVM‘s memory footprint.

Demo: MAT Roundtrip

#ID	Sex	Culture	Forename	Surname	Address	…
1	M	Unk	Jan	Rehwaldt	Pusemukkel 4	…
2	M	Eng	James	Albright		…
3	F	Rus	Svetlana	Dyakonova	Newski Prospekt 106	…
4	M	Est	Epp	Sibul	Uus 20	…
5	F	Rus	Sveta	D.	Newskoi P. 106	…
6		Usa	Mr.	Nobel Prize	NSA Headquarter	…
7	J	Usa	Mr.	Obama	The White House	…
8		Eng	Jamie	Albritt	Unknown	…
9	M	Por	Sebastian	Serano	Rosa Carreras	…
10	F	Por	Ana	Abílio	Heaven 9	…
11	F	Ger	Jahn	Rehfeld	Pusem. 4a	…
12	F	Eng	Rita	Brown	Trafalgar Square 13	
13	M	Unk	M			
…	…	…	…	…	…	…
1Mio.	F	Ukr	Susanne	Mirkowitsch	Dom Spasibo ul.	

Address Deduplication

Demo: MAT Roundtrip

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1	M	Unk	Jan	Rehwaldt	Pusemukkel 4	…
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4	M	Est	Epp	Sibul	Uus 20	…
5	F	Rus	Sveta	D.	Newskoi P. 106	…
6		Usa	Mr.	Nobel Prize	NSA Headquarter	…
7	J	Usa	Mr.	Obama	The White House	…
8		Eng	Jamie	Albritt	Unknown	…
9	M	Por	Sebastian	Serano	Rosa Carreras	…
10	F	Por	Ana	Abílio	Heaven 9	…
11	F	Ger	Jahn	Rehfeld	Pusem. 4a	…
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…	…	…	…	…	…	…
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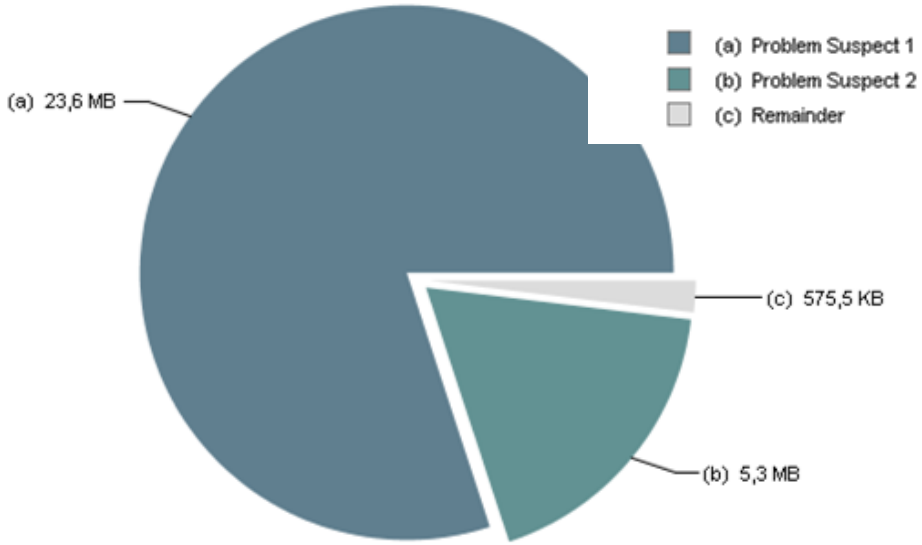
Grouping Approach

Leak Suspect



Total: 29,4 MB

Problem Su

The thread **java.lang.Thread @ 0x26f105b8 main** keeps local variables with total size **24.705.288 (80,04%)** bytes.

The memory is accumulated in one instance of **"java.lang.Thread"** loaded by **"<system class loader>"**.

The stacktrace of this Thread is available. See stacktrace.

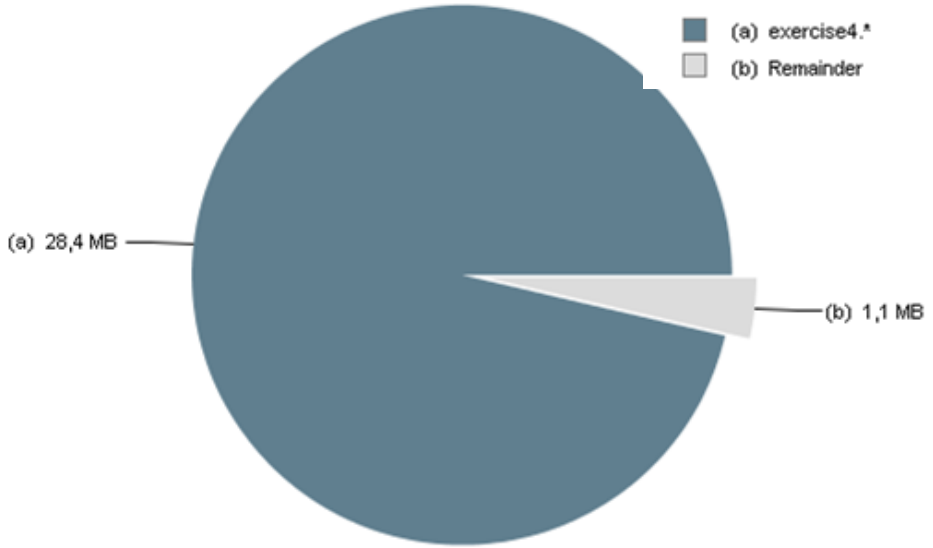
Keywords
java.lang.Thread
Details »

Problem Suspect 2

Dominator Tree

Class Name	Shallow Heap	Retained Heap	Percentage
<Regex>	<Numeric>	<Numeric>	<Numeric>
java.lang.Thread @ 0x26f105b8 main Thread	104	24.705.288	80,04%
java.util.HashMap$KeyIterator @ 0x28bb0028	32	9.849.968	31,91%
java.util.ArrayList @ 0x28ba7870	24	563.560	1,83%
exercise4.partitions.WindowPartition @ 0x27a9b728	24	40.192	0,13%
exercise4.partitions.GroupingPartition @ 0x279d4098	32	3.168	0,01%
java.util.ArrayList @ 0x27a7a7b8	24	3.040	0,01%
java.util.ArrayList$SubList$1 @ 0x28c51320	32	64	0,00%
java.util.ArrayList$ListItr @ 0x28c77fd0	32	32	0,00%
Σ Total: 3 entries			
exercise4.partitions.GroupingPartition @ 0x279d4138	32	3.168	0,01%
exercise4.partitions.GroupingPartition @ 0x27a7af68	32	3.168	0,01%
exercise4.partitions.GroupingPartition @ 0x279d3d98	32	2.168	0,01%
exercise4.partitions.GroupingPartition @ 0x279d3db8	32	2.168	0,01%
exercise4.partitions.GroupingPartition @ 0x279d3dd8	32	2.168	0,01%
exercise4.partitions.GroupingPartition @ 0x279d4038	32	2.168	0,01%
Σ+ Total: 25 of 13.279 entries; 13.254 more			
class java.lang.System @ 0x38b068b8 System Class	32	60.192	0,20%
sun.misc.Launcher$AppClassLoader @ 0x26f100e8	80	53.576	0,17%
java.util.jar.JarFile @ 0x26f55010	56	38.864	0,13%
class java.lang.CharacterData00 @ 0x28c0ccf8 System Class	32	30.992	0,10%
class java.nio.charset.Charset @ 0x38b0b498 System Class	40	14.712	0,05%

Component Report



Possible Memory

Duplicate Strings

Found 583 occurrences of char[] with at least 10 instances having identical content. Total size is 1.072.464 bytes.

Top elements include:

- 13.628 × (16 bytes)
- 4.453 × **f** (16 bytes)
- 2.091 × **nsw** (24 bytes)
- 1.546 × **vic** (24 bytes)
- 1.363 × **usa** (24 bytes)

Details »

Empty Collections

No excessive usage of empty collections found.

Details »

Possible Memory Waste

Possible Memory Waste

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Details »

Empty Collections

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Details »

Collection Fill Ratios

Detected the following collections with fill ratios below 20%:

- 8.265 instances of **java.util.ArrayList** retain **>= 16.860.600** bytes.

Details »

Miscellaneous

Soft Reference Statistics

Object Query Language (OQL)

```
SELECT *
    FROM exercise4.partitions.GroupingPartition p
    WHERE (p.partition.size <= p.partition.elementData.@length * 0.20)
```

All GroupingPartitions with a partition filled max. 20%

Class Name		
exercise4.pa		
exercise4.partitions.GroupingPartition @ 0x28b8fe00	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8f5e8	32	2.168
exercise4.partitions.GroupingPartition @ 0x28b8edd0	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8e5b8	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8dda0	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8d588	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8cd70	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8c558	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8bd40	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8b528	32	2.072
exercise4.partitions.GroupingPartition @ 0x28b8ad10	32	2.072
Total: 31 of 8.265 entries; 8.234 more		

Pros and Cons

- Pros
  - Very (most?!) powerful and comprehensive
  - Provides hints for memory wastes
- Cons
  - Very complicated handling
  - A lot of memory required

Sources

- http://eclipsesource.com/blogs/2013/01/21/10-tips-for-using-the-eclipse-memory-analyzer/
- http://docs.oracle.com/javase/tutorial/java/nutsandbolts/datatypes.html
- MAT Tutorials & Cheat Sheet
- Trail & Error