Memory Analyzer 1.0 - Not Only New, but Noteworthy

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| 08 September 2010

Goal

- Learn how to diagnose problems given a heap dump and using the best new and old features of Memory Analyzer

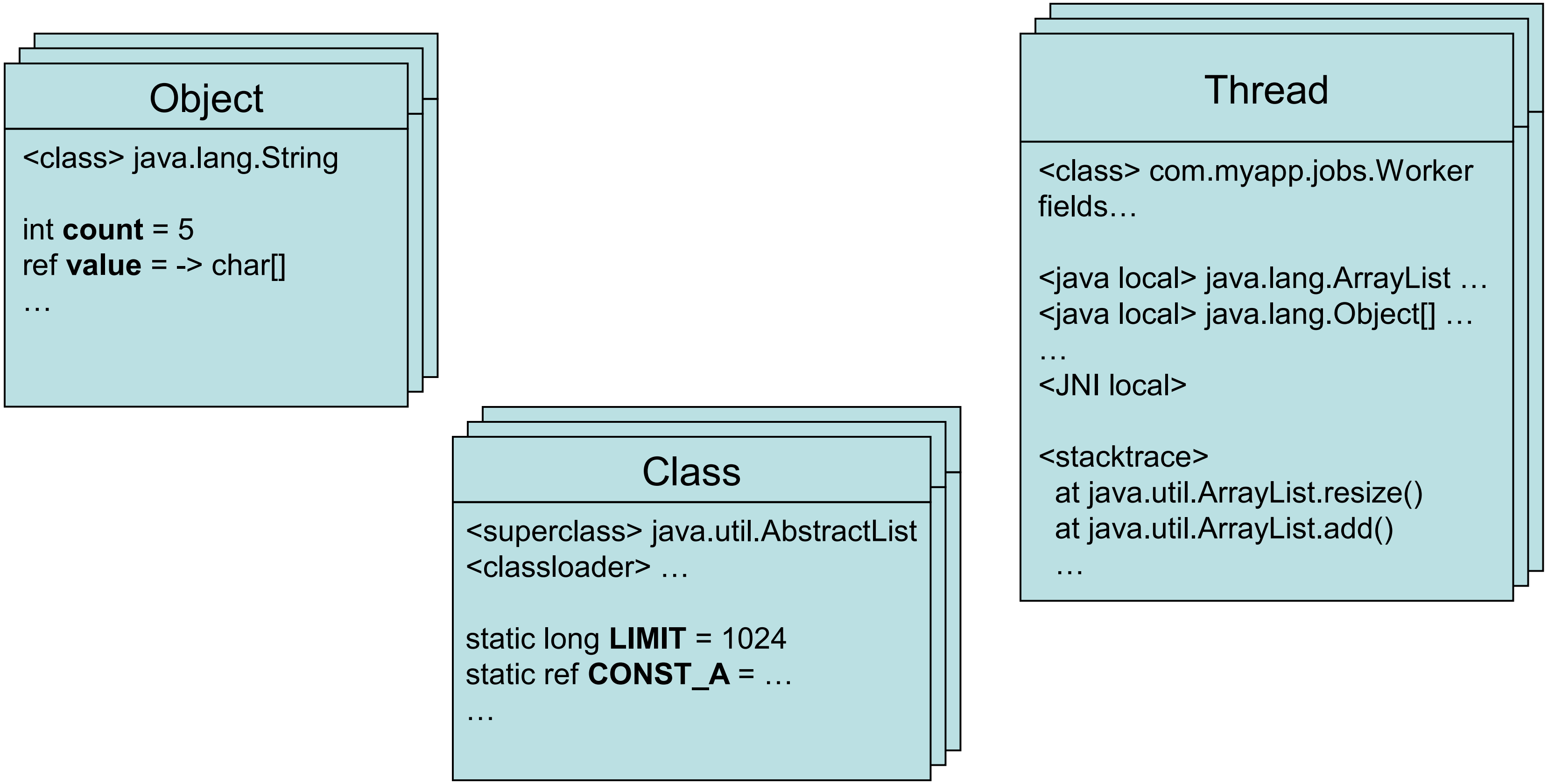
Agenda

- Heap Dumps
- Troubleshooting an OutOfMemoryError
- Inspecting Threads
- Comparing Objects
- Coming Next …
- Q & A

Memory Analyzer Works With Heap Dumps

- A heap dump is a snapshot of the memory of a Java process at a certain moment of time
- Memory Analyzer supports:
  - HPROF binary format
  - IBM system dumps (pre-processed with jextract)
  - IBM Portable Heap Dumps
- Memory Analyzer provides an API to plug-in parsers for other formats

A Heap Dump Contains …



Object

<class> java.lang.String

int **count** = 5
ref **value** = -> char[]
…

Class

<superclass> java.util.AbstractList
<classloader> …

static long **LIMIT** = 1024
static ref **CONST_A** = …
…

Thread

<class> com.myapp.jobs.Worker
fields…

<java local> java.lang.ArrayList …
<java local> java.lang.Object[] …
…
<JNI local>

<stacktrace>
  at java.util.ArrayList.resize()
  at java.util.ArrayList.add()
  …

A Heap Dump Does NOT Tell You …

- where an object was allocated
- when an object was created
- how many objects were garbage collected

- It is indeed just a snapshot

A Heap Dump Can Help You …

- Easily analyze the reason for an OutOfMemoryError
- Analyze the memory footprint of an application
- Debug not only memory related problems

How to Get a Heap Dump …

… depends on the VM, but …

… most VMs can write a dump on OutOfMemoryError

… and most VMs provide tools to manually trigger one

- use the new Acquire Dialog in MAT
- jmap, JConsole, “kill -3 <pid>”, …

Details:

- http://wiki.eclipse.org/index.php/MemoryAnalyzer#Getting_a_Heap_Dump

Demo

Acquiring a heap dump and browsing through it

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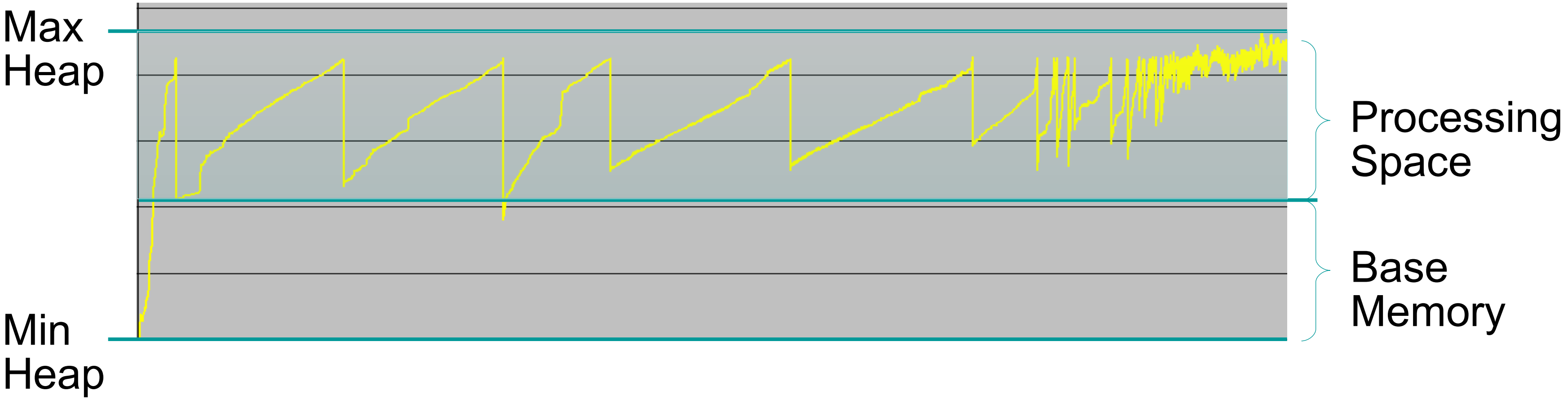
First, Collect Data for Analysis

- Enable heap dumps on OutOfMemoryError
  - This has no performance impact on the VM
  - For HPROF set -XX:+HeapDumpOnOutOfMemoryError
  - For IBM system dumps:
    –Xdump:system:events=systhrow,filter=java/lang/OutOfMemoryError

How to Get a “Good” Heap Dump



- When memory is exhausted the leak will occupy most of the processing space
- Ensure big enough processing space, this will make the leak easier to find

How to Analyze the Heap Dump

- Find the biggest objects
- Analyze why they are kept in memory
- Analyze what makes them big

Demo

- Analysis of an OutOfMemoryError

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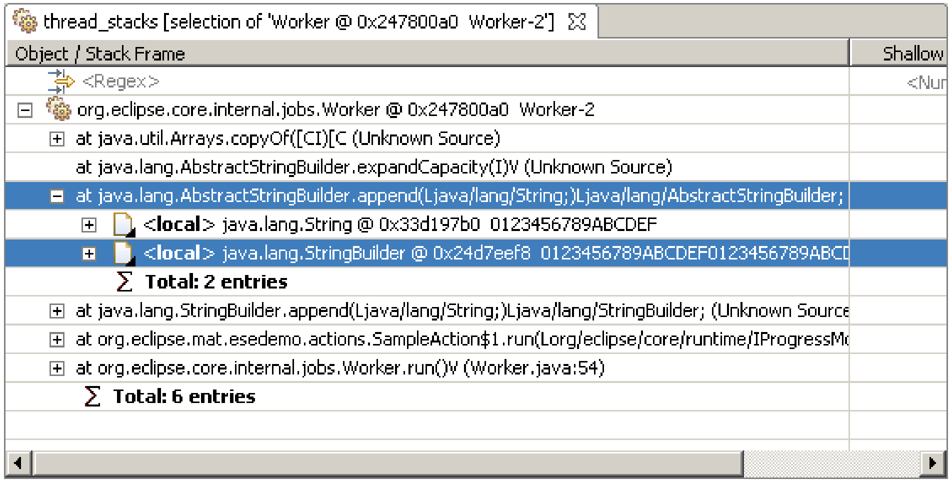
Once More, What Do We Know About Threads?

- In heap dumps one can find
  - The call-stack (stack trace) of a thread
  - The local objects for each method
- The information is available in
  - IBM system dumps
  - HPROF dumps

    (since JDK 6 Update 14)



thread_stacks [selection of 'Worker @ 0x247800a0 Worker-2']

Object / Stack Frame	Shallow
<Regex>	<Nur
⊟ org.eclipse.core.internal.jobs.Worker @ 0x247800a0 Worker-2	
⊞ at java.util.Arrays.copyOf([CI)[C (Unknown Source)	
at java.lang.AbstractStringBuilder.expandCapacity(I)V (Unknown Source)	
⊟ at java.lang.AbstractStringBuilder.append(Ljava/lang/String;)Ljava/lang/AbstractStringBuilder;	
⊞ **<local>** java.lang.String @ 0x33d197b0 0123456789ABCDEF	
⊞ **<local>** java.lang.StringBuilder @ 0x24d7eef8 0123456789ABCDEF0123456789ABCD	
Σ **Total: 2 entries**	
⊞ at java.lang.StringBuilder.append(Ljava/lang/String;)Ljava/lang/StringBuilder; (Unknown Source	
⊞ at org.eclipse.mat.esedemo.actions.SampleAction$1.run(Lorg/eclipse/core/runtime/IProgressM	
⊞ at org.eclipse.core.internal.jobs.Worker.run()V (Worker.java:54)	
Σ **Total: 6 entries**	

Inspecting the Threads Details One Can …

- Analyze a “heavy request” type of OutOfMemoryError
  - What was the name of the job of a worker thread
  - Which HTTP request a server thread was processing
  - Which SQL statement was processed
- Analyze why an application is not responding
- On IBM VMs analyze an arbitrary exception
  - java -Xdump:system:events=throw,filter=java/lang/ArrayIndexOutOfBoundsException MyApplication

Demo

- Exploring threads
- Finding the job that caused an OutOfMemoryError

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Comparison in MAT Before

- Objects addresses change during GC – difficult to find recognize the same object in a second dump
- Comparison only possible on the “global” class histogram of two heap dumps
- Criticized for limited functionality

Comparison in MAT 1.0

- Objects still have no stable IDs, this will stay the same
- Enable comparison of any two or more tables
  - From one and the same heap dump
  - From different heap dumps
- The user can
  - Define the order in which the tables are compared
  - Select the columns to be compared
  - Select between displaying absolute values and deltas
- STILL WORK IN PROGRESS – feedback is appreciated!
  - https://bugs.eclipse.org/bugs/show_bug.cgi?id=298078

What Are the New Features Useful For?

- Some examples:
  - Compare the retained sets of different versions of an application
  - Compare the retained heap of the session for userA and userB (both within the same heap dump) and see why one is bigger than the other
  - Compare several “Group By Value” results and find which Strings appear in one set and are missing in another one, how the number of occurrence changes, etc

Demo

- Comparison features in Memory Analyzer 1.0

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Coming Next …

- RAP version of Memory Analyzer
- Developer guides and code samples for extending MAT
- Improved comparison features

- See MAT at Eclipse Summit Europe
- See MAT at JavaOne:
  - S313773 Going Beyond Memory Leaks: Debugging Java from Dumps, Using Memory Analyzer
  - S313949 Java Unleashed: Java Virtual Machine Tuning from the Pros

Infos & Download

Eclipse Home Page

www.eclipse.org/mat/

Forum

http://www.eclipse.org/forums/eclipse.memory-analyzer

Blog

dev.eclipse.org/blogs/memoryanalyzer

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