# How to Analyze verbosegc trace with IBM Pattern Modeling and Analysis Tool for IBM Java Garbage Collector

IBM Pattern Modeling and Analysis Tool Architect / Developer

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# Agenda

- What is PMAT?
- Features
- How does it work?
- Verbose garbage collection trace
- Prerequisite
- Definitions of headers in tables/charts
- Views
- How to run PMAT and analyze data
- Case Studies ( I, II and III )
- Q & A

# What is PMAT?

- Pattern Modeling and Analysis Tool for IBM Java Garbage Collector (PMAT) parses IBM SDK verbose Garbage Collect (GC) logs and provides statistics, charts, analysis, and recommendations for key Java™ heap configurations.
- PMAT parses the IBM verbose GC trace and provides a comprehensive analysis of the Java heap usage. It then recommends key configurations by first executing a diagnosis engine and then employing a pattern modeling algorithm in order to make recommendations to optimize the Java heap usage for a given JVM cycle.
- If there are any errors related with Java heap exhaustion or fragmentation in the verbose GC trace, PMAT can diagnose the root cause of failures. PMAT provides rich chart features that graphically display Java heap usage.

# Features

- Diagnoses Java heap potential problems by analyzing verbose GC traces.
- Recommends optimal heap configurations by employing a pattern modeling engine to track and evaluate historical trends.
- Includes a user-friendly graphical representation of Java heap usage.

# How does it work? (1/2)

- PMAT parses IBM SDK verbose garbage collector trace and retrieves Java heap usage, garbage collector time, mark phase time, sweep phase time, compact phase time, available Java heap size, freed Java heap size, and total Java heap size.

- It then calculates overhead ratio of each garbage collector cycle, runs a garbage collector diagnostics engine to report any problems recorded in the trace, and provides a root cause analysis of the problems (Java heap fragmentation, Java heap exhaustion, or too large a Java heap request).

- The garbage collector diagnostics engine analyzes patterns of historic data and provides diagnostic information based on patterns stored in a knowledge database.

# How does it work?(2/2)

- It also runs a pattern modeling engine based on historic Java heap usage and provides optimal Java heap configuration recommendations. For example, it can recommend optimal Java maximum heap size and allocation size for class blocks in kCluster.

- The pattern modeling engine uses historical activity data of the Java heap usage to predict future performance trends, thus avoiding potential memory leaks or memory consumption instability.

- For advanced users, graphical representations of the Java heap usage history and detailed elapsed time for each phase of the garbage collector cycles is generated.

# What is verbosegc?

- Verbose GC is a command-line option that you supply to the JVM at startup time. The format is: **-verbose:gc** or –verbosegc. This option switches on a substantial trace of every garbage collection cycle. The format for the generated information is not architected and therefore varies from platform to platform and release to release.

- This trace should allow you to see the gross heap usage in every garbage collection cycle. For example, you could monitor the output to see the changes in the free heap space and the total heap space. You can use this information to determine:

  Whether garbage collections are taking too long to run
  Whether too many garbage collections are occurring
  Whether the JVM crashed during garbage collection

# Sample verbosegc trace (Sov. JVM )

```
<AF[1]: Allocation Failure. need 1544 bytes, 0 ms since last AF>
<AF[1]: managing allocation failure, action=1 (0/3983128)
   (209640/209640)>
<GC(1): GC cycle started Tue Apr 24 10:49:58 2001>
<GC(1): freed 1421672 bytes, 38% free (1631312/4192768), in 9 ms>
<GC(1): mark: 8 ms, sweep: 1 ms, compact: 0 ms>
<GC(1): refs: soft 0 (age >= 32), weak 17, final 16, phantom 0>
<AF[1]: completed in 10 ms>
```

- **Notes:**

1. GC(1): The 1st garbage collection cycle in this JVM.
2. freed 1,421,672 bytes: An indication of the amount of activity since the last garbage collection cycle.

# Sample verbosegc trace ( J9 JVM )

```
<gc type="global" id="5" totalid="5" intervalms="18.880">
    <compaction movecount="9282" movebytes="508064"
   reason="forced compaction" />
     <expansion type="tenured" amount="1048576" newsize="3145728"
   timetaken="0.011" reason="insufficient free space following gc" />
    <refs_cleared soft="0" weak="0" phantom="0" /> <finalization
   objectsqueued="0" />
    <timesms mark="7.544" sweep="0.088" compact="9.992"
   total="17.737" />
    <tenured freebytes="1567256" totalbytes="3145728" percent="49" >
      <soa freebytes="1441816" totalbytes="3020288" percent="47" />
      <loa freebytes="125440" totalbytes="125440" percent="100" />
    </tenured>
</gc>
```

- **Notes:**

1. **Type=″global**″ indicates that this was a global collection (mark, sweep, possibly compact).

# Prerequisite

- Java 2 Runtime Environment 1.4.1 or higher
- Log files with verbose:gc enabled on IBM SDK 1.3.x and 1.4.x. (Log files taken from Non-IBM SDKs are not supported yet)

# Definitions in tables/charts (1/2)

- **Since** Time(millisecond) elapsed since last allocation failure.
- **Freed** Size(byte) of space that was freed during garbage collection.
- **Needed/Requested** Size(byte) of space that was requested during allocation failure.
- **Free** Size(byte) of space that was free after garbage collection.
- **Total** Size(byte) of Java heap after garbage collection.
- **Completed** Time(millisecond) spent during allocation failure.

# Definitions in tables/charts (2/2)

- **GC Completed or GC** Time(millisecond) spent during garbage collection.
- **Overhead** Time(%) spent in allocation failure
- **Mark** Time(millisecond) spent in mark phase
- **Sweep** Time(millisecond) spent in sweep phase.
- **Compact** Time(millisecond) spent in compact phase.
- **Exhausted** Whether there was insufficient space to satisfy allocation failure.

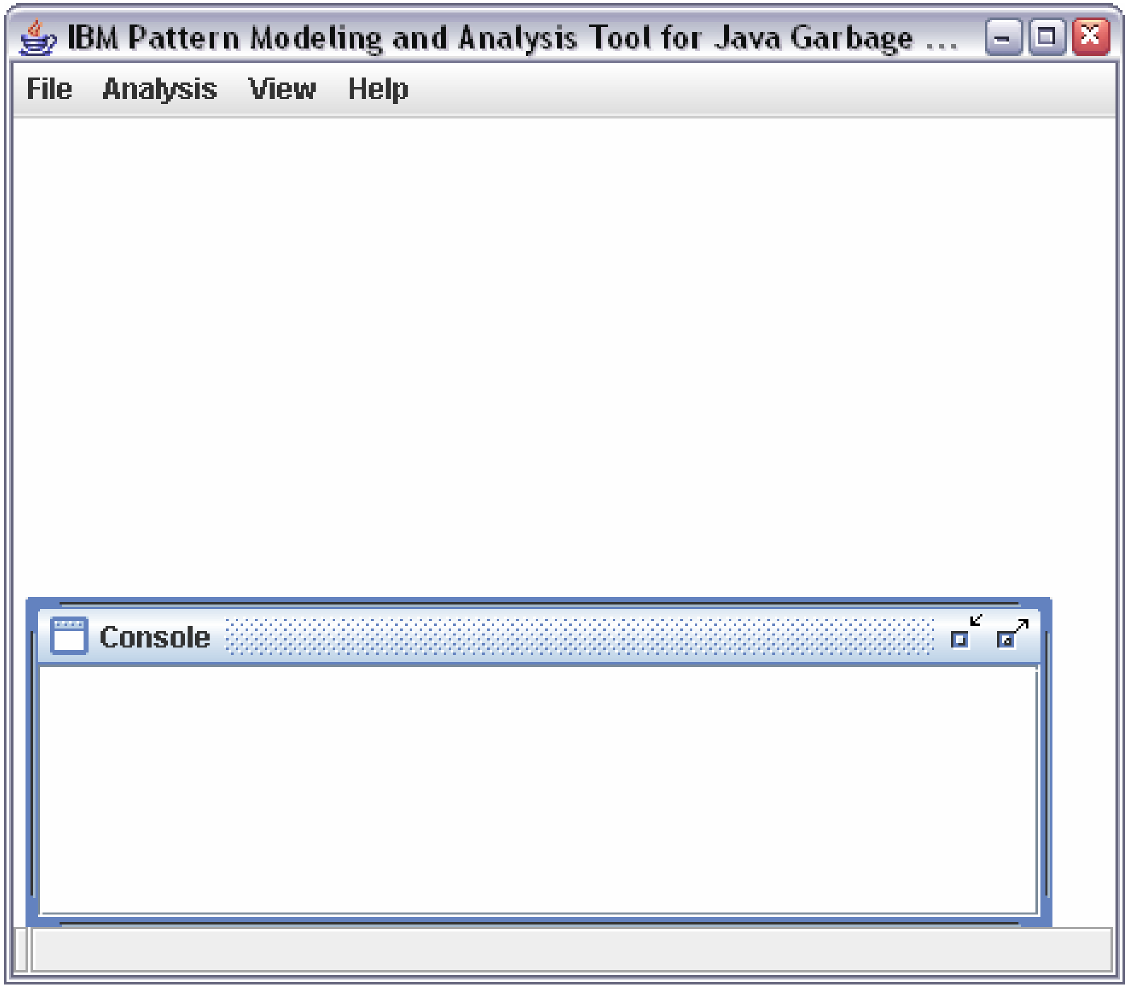
# Views

- GC analysis
- GC Table View
- AF summary
- GC usage summary
- GC duration summary
- GC Graph View
- GC trend analysis
- Zoom in/out/selection/center of graph view

# How to run PMAT

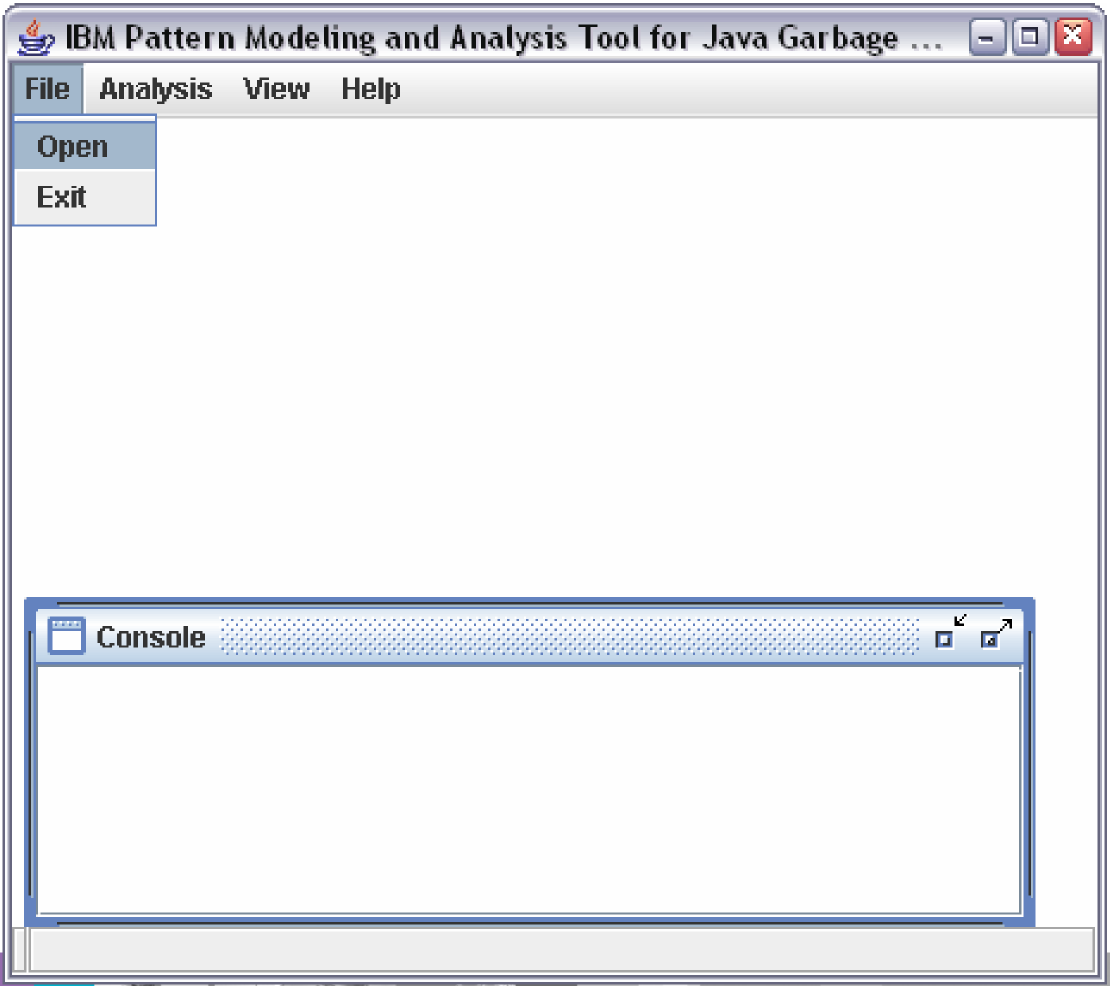
- You need to use the Java 2 Platform, Standard Edition version 1.4.1 or higher Java Runtime Environment (JRE) to run IBM PMAT.
- Usage <Java path>java –Xmx[heap size] –jar ga<PMAT version>.jar
- For example, java –Xmx1000m –jar ga10.jar
- If there's java.lang.OutOfMemoryError while you are processing verbosegc log, please try increasing the maximum heap size (-Xmx) value to give the JVM more memory.
- Maximum heap size should not be larger than the size of available physical memory size for this tool due to performance issue.

# Initial screen



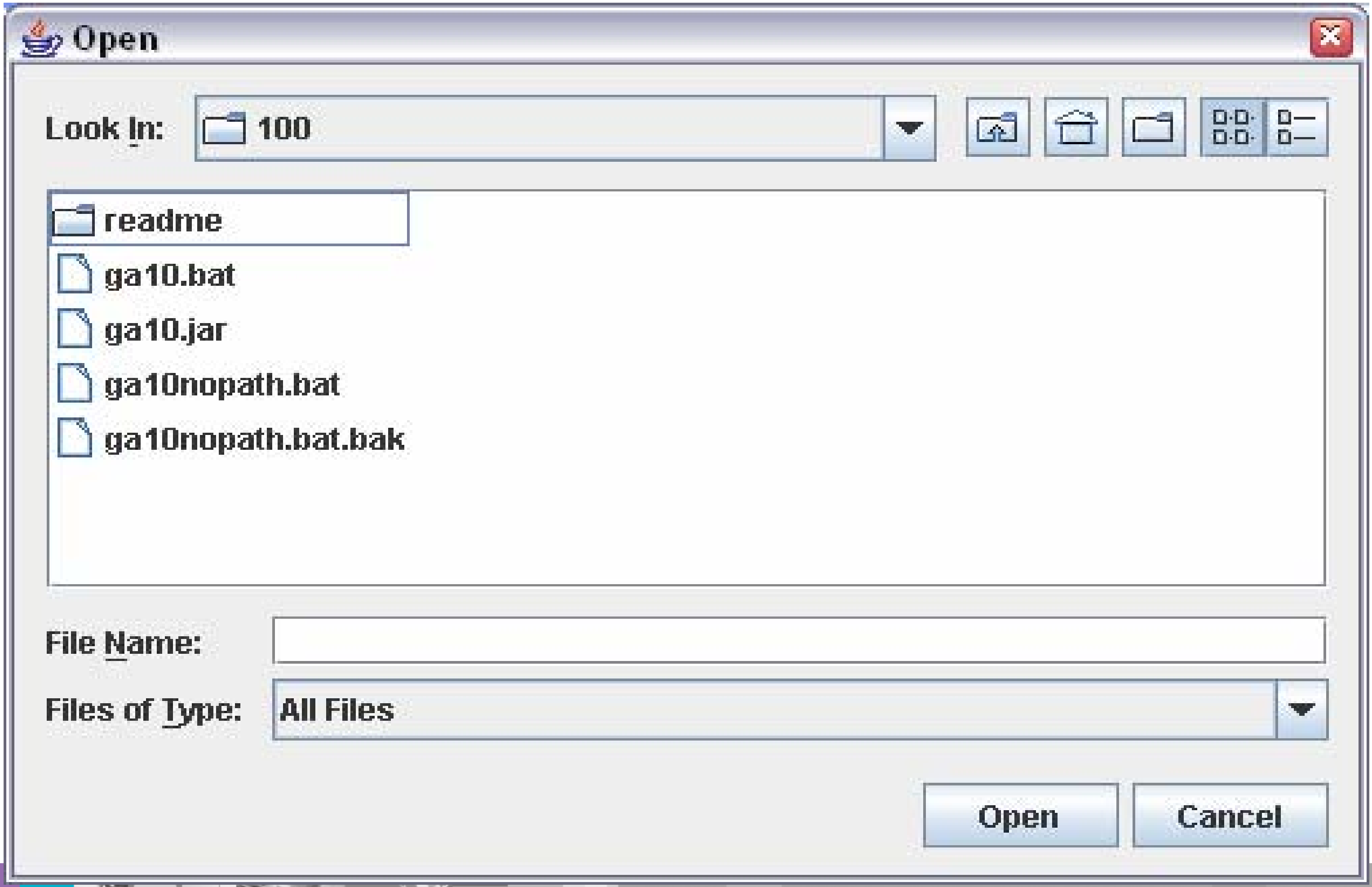
- IBM PMAT is displayed with console window.

# Open verbosegc log



- Open verbosegc log by clicking on File->Open

# Select verbosegc log



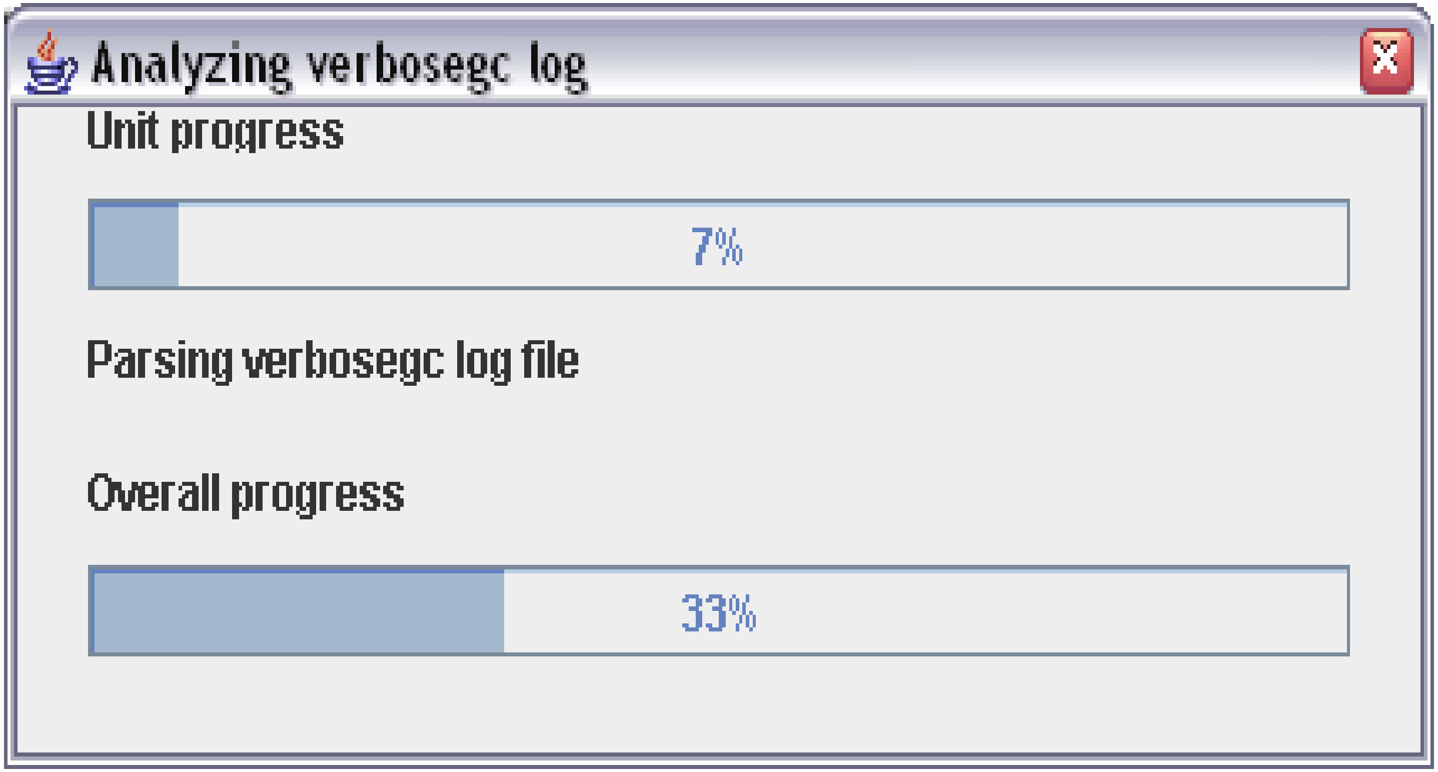
Look In: 100

readme
ga10.bat
ga10.jar
ga10nopath.bat
ga10nopath.bat.bak

File Name:

Files of Type: All Files

# Processing verbosegc log



Analyzing verbosegc log

Unit progress

7%

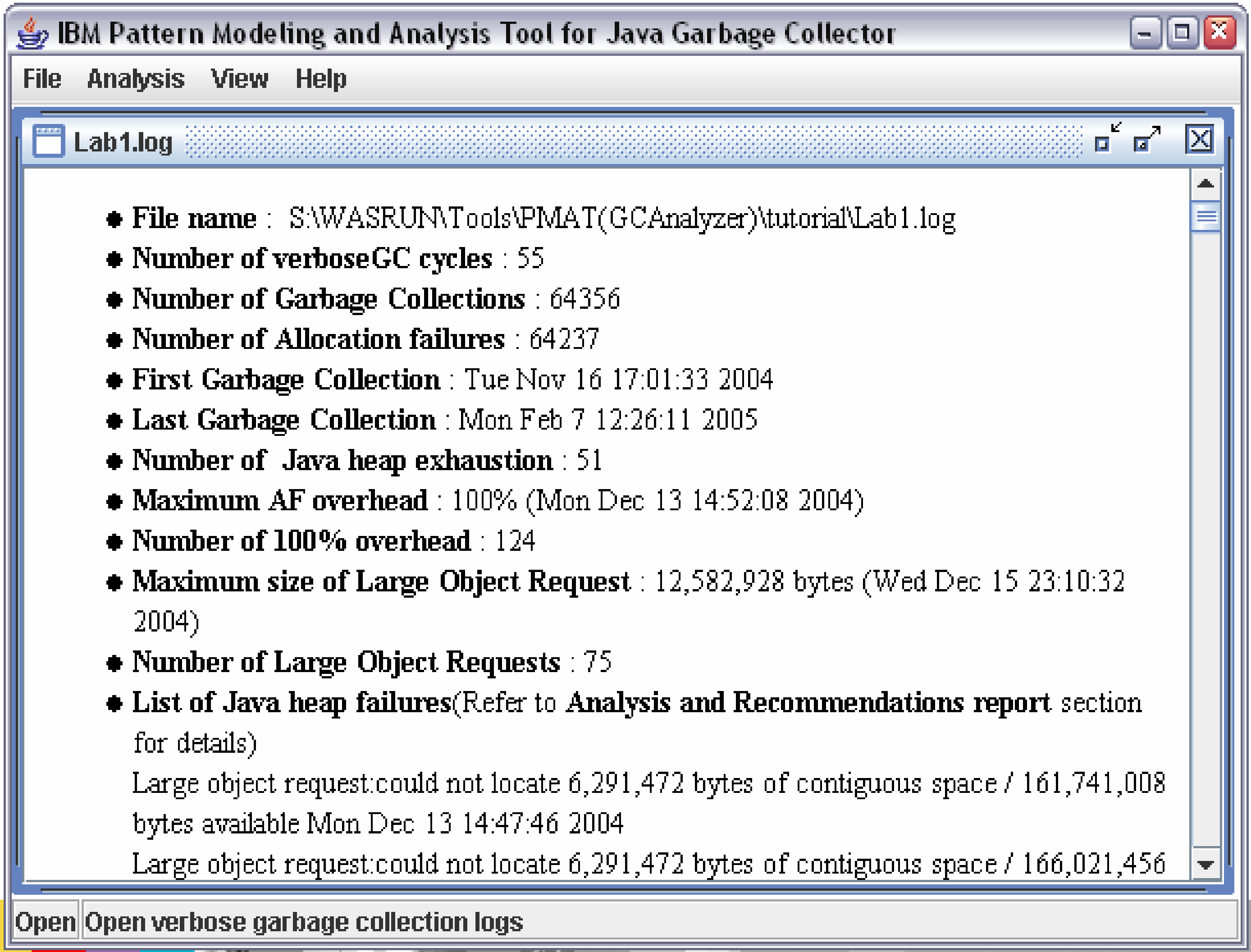
Parsing verbosegc log file

Overall progress

33%

- Progress bars are displayed while processing verbosegc log

# Analysis view (1/6)


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File Analysis View Help
Lab1.log

- **File name** : S:\WASRUN\Tools\PMAT(GCAnalyzer)\tutorial\Lab1.log
- **Number of verboseGC cycles** : 55
- **Number of Garbage Collections** : 64356
- **Number of Allocation failures** : 64237
- **First Garbage Collection** : Tue Nov 16 17:01:33 2004
- **Last Garbage Collection** : Mon Feb 7 12:26:11 2005
- **Number of Java heap exhaustion** : 51
- **Maximum AF overhead** : 100% (Mon Dec 13 14:52:08 2004)
- **Number of 100% overhead** : 124
- **Maximum size of Large Object Request** : 12,582,928 bytes (Wed Dec 15 23:10:32 2004)
- **Number of Large Object Requests** : 75
- **List of Java heap failures**(Refer to **Analysis and Recommendations report** section for details)

  Large object request:could not locate 6,291,472 bytes of contiguous space / 161,741,008 bytes available Mon Dec 13 14:47:46 2004

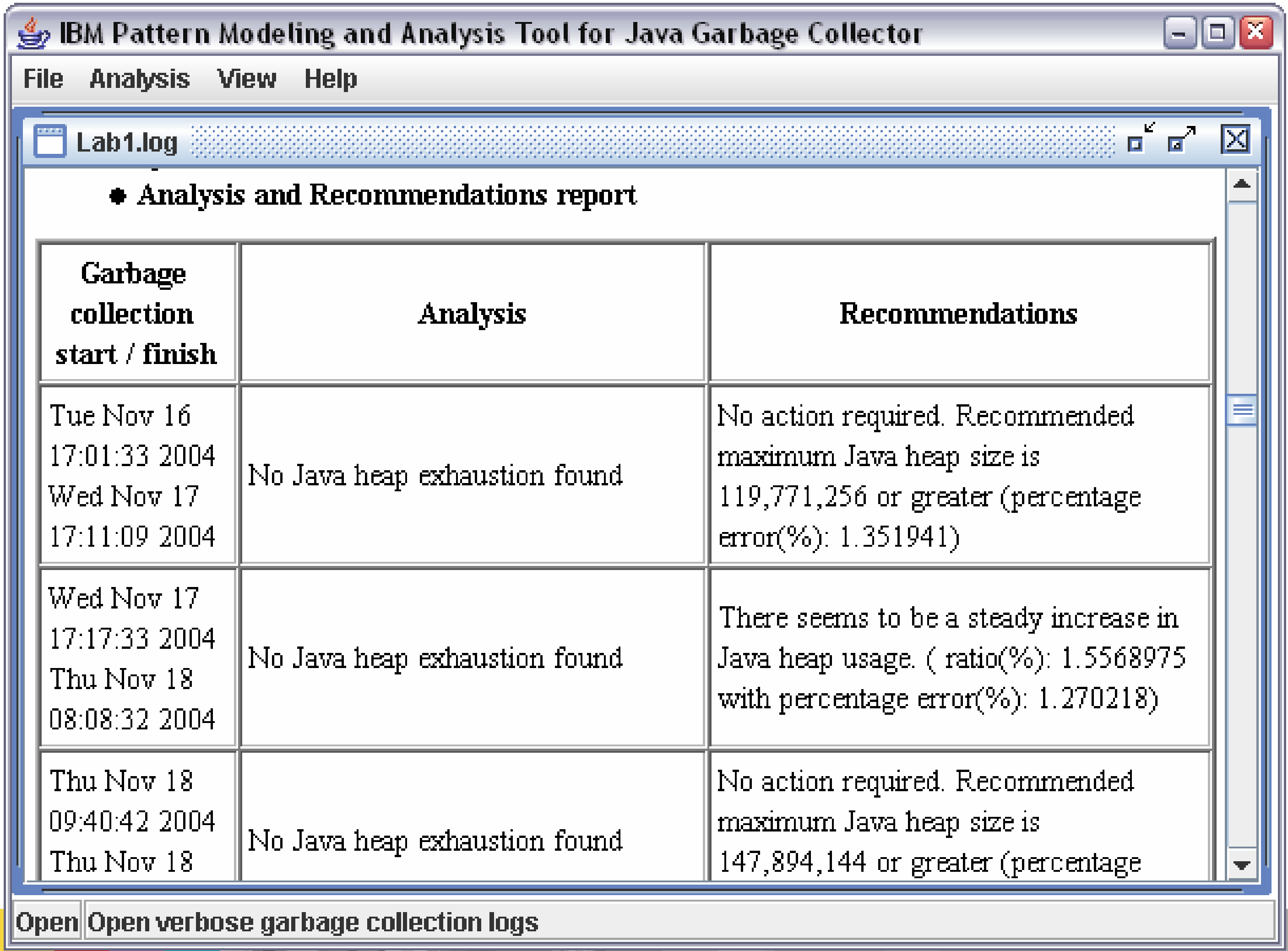
  Large object request:could not locate 6,291,472 bytes of contiguous space / 166,021,456

- Statistics of verbosegc data is displayed as well as analysis of each errors.

# Analysis view (2/6)

- **File name** : Location and file name of verbosegc trace
- **Number of verboseGC cycles** : Number of JVM restart
- **Number of Garbage Collections** : GC frequency
- **Number of Allocation failures** : AF frequency
- **First Garbage Collection** : Timestamp of the first GC
- **Last Garbage Collection** : Timestamp of the last GC
- **Number of Java heap exhaustion** : Number of OutOfMemoryError
- **Maximum AF overhead** : Ratio of time spent in AF and time between AFs
- **Number of 100% overhead** : Number of AF overhead 100%
- **Maximum size of Large Object Request** : The largest object request and timestamp
- **Number of Large Object Requests** : Number of object request (>900KB)
- **List of Java heap failure** : Timestamp, Requested Java heap size, Type of failure and available Java heap size.

# Analysis view (3/6)



IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File Analysis View Help
Lab1.log

- Analysis and Recommendations report

| Garbage collection start / finish | Analysis | Recommendations |
|---|---|---|
| Tue Nov 16 17:01:33 2004<br>Wed Nov 17 17:11:09 2004 | No Java heap exhaustion found | No action required. Recommended maximum Java heap size is 119,771,256 or greater (percentage error(%): 1.351941) |
| Wed Nov 17 17:17:33 2004<br>Thu Nov 18 08:08:32 2004 | No Java heap exhaustion found | There seems to be a steady increase in Java heap usage. ( ratio(%): 1.5568975 with percentage error(%): 1.270218) |
| Thu Nov 18 09:40:42 2004<br>Thu Nov 18 | No Java heap exhaustion found | No action required. Recommended maximum Java heap size is 147,894,144 or greater (percentage |

- **Analysis and Recommendations report** provides analysis and recommendations for each JVM runtime

# Analysis view (4/6)

**Analysis and Recommendations report**

- **Garbage collection start / finish** : Timestamps of JVM start and stop
- **Analysis** :
  Type of Java heap issue is displayed if there's any problem with Java heap.
  No Java heap exhaustion found is displayed if there's no Java heap exhaustion.

# Analysis view (5/6)

**Analysis and Recommendations report**

- **Recommendations** :
  If there’s no Java heap issue, optimal maximum heap size is provided by usage analysis.

  If there’s any possibility that Java heap usage might increase, IBM PMAT provides a ratio(%) based on Java Heap Occupancy Model.

  Ratio of 100% means Java heap occupancy could go up to L x 2 bytes at the time of T0 + (T1 – T0) x 2 where L (bytes) is Java heap occupancy at the time of T1 (T0:JVM start time T1:JVM stop time)

  Ratio of 0% means Java heap occupancy could stay L bytes at the time of T0 + (T1 – T0) x 2 where L (bytes) is Java heap occupancy at the time of T1 (T0:JVM start time T1:JVM stop time)

# Analysis view (6/6)

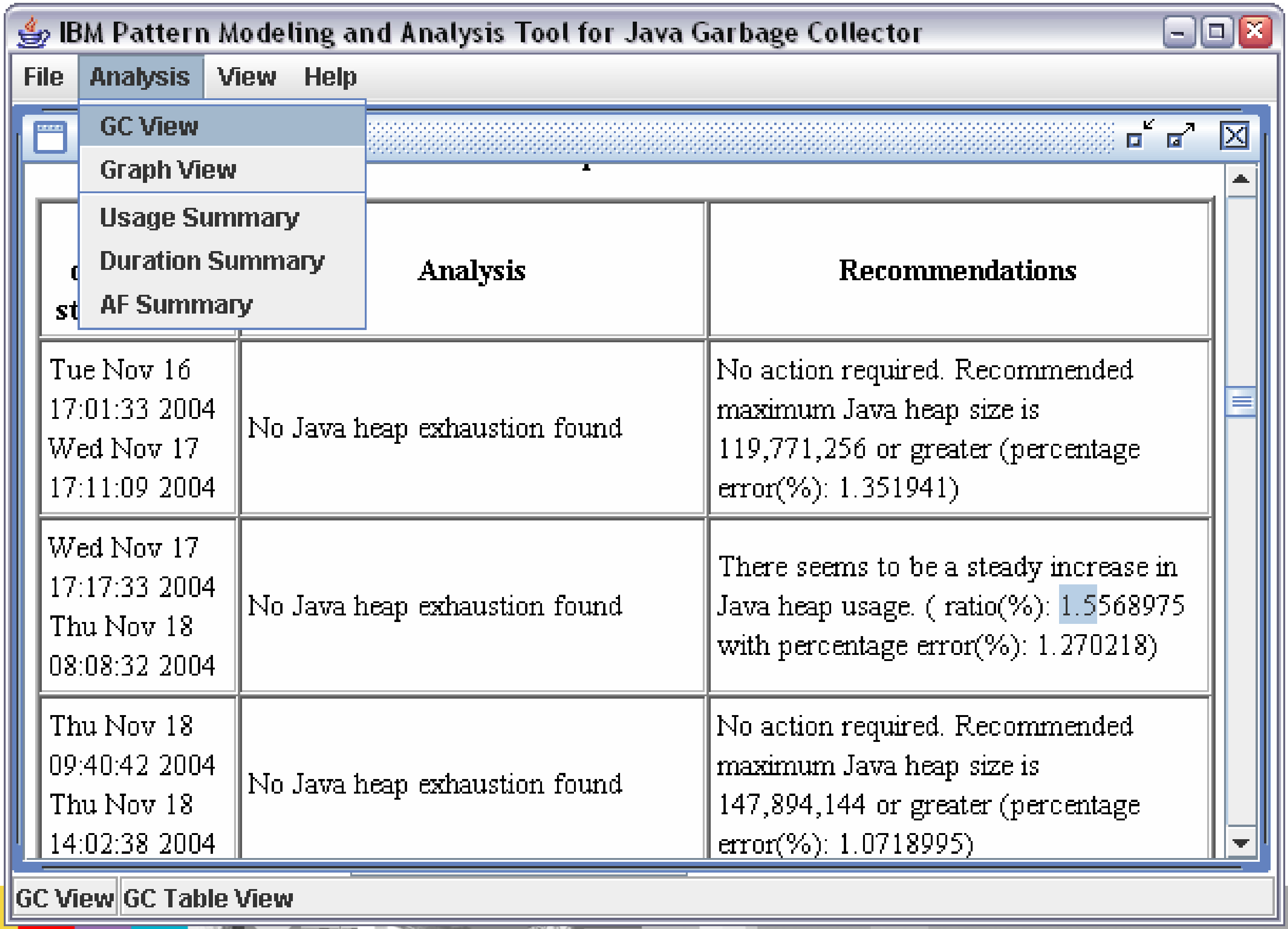
**Analysis and Recommendations report**

- **Recommendations** :
  If the ratio is close to 0, Java heap usage is stable based on model in the specific JVM runtime.
  If the ratio is non-zero, Java heap usage could increase over time.

  The percentage error is calculated by comparing Java Heap Occupancy Model with current data.
- Note
  If there's not enough activities in a JVM runtime cycle, the model might not fully represent actual JVM.

  The percentage error does not represent accuracy of the ratio.
  If percentage error is large(>50%), the model might not be reliable.

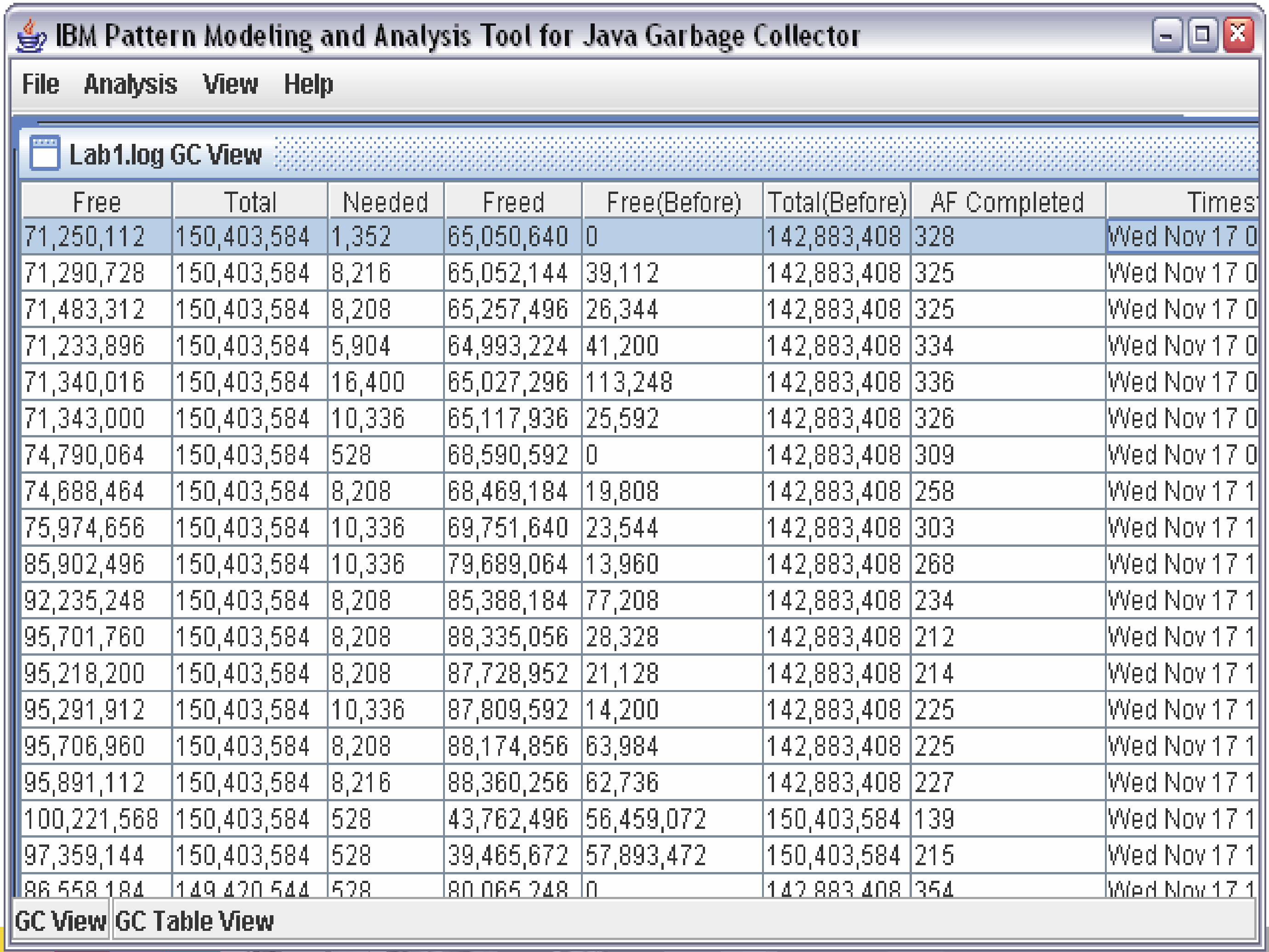
# GC View



| | Analysis | Recommendations |
|---|---|---|
| Tue Nov 16 17:01:33 2004 Wed Nov 17 17:11:09 2004 | No Java heap exhaustion found | No action required. Recommended maximum Java heap size is 119,771,256 or greater (percentage error(%): 1.351941) |
| Wed Nov 17 17:17:33 2004 Thu Nov 18 08:08:32 2004 | No Java heap exhaustion found | There seems to be a steady increase in Java heap usage. ( ratio(%): 1.5568975 with percentage error(%): 1.270218) |
| Thu Nov 18 09:40:42 2004 Thu Nov 18 14:02:38 2004 | No Java heap exhaustion found | No action required. Recommended maximum Java heap size is 147,894,144 or greater (percentage error(%): 1.0718995) |

- Display GC table view by clicking on Analysis -> GC View

# GC View

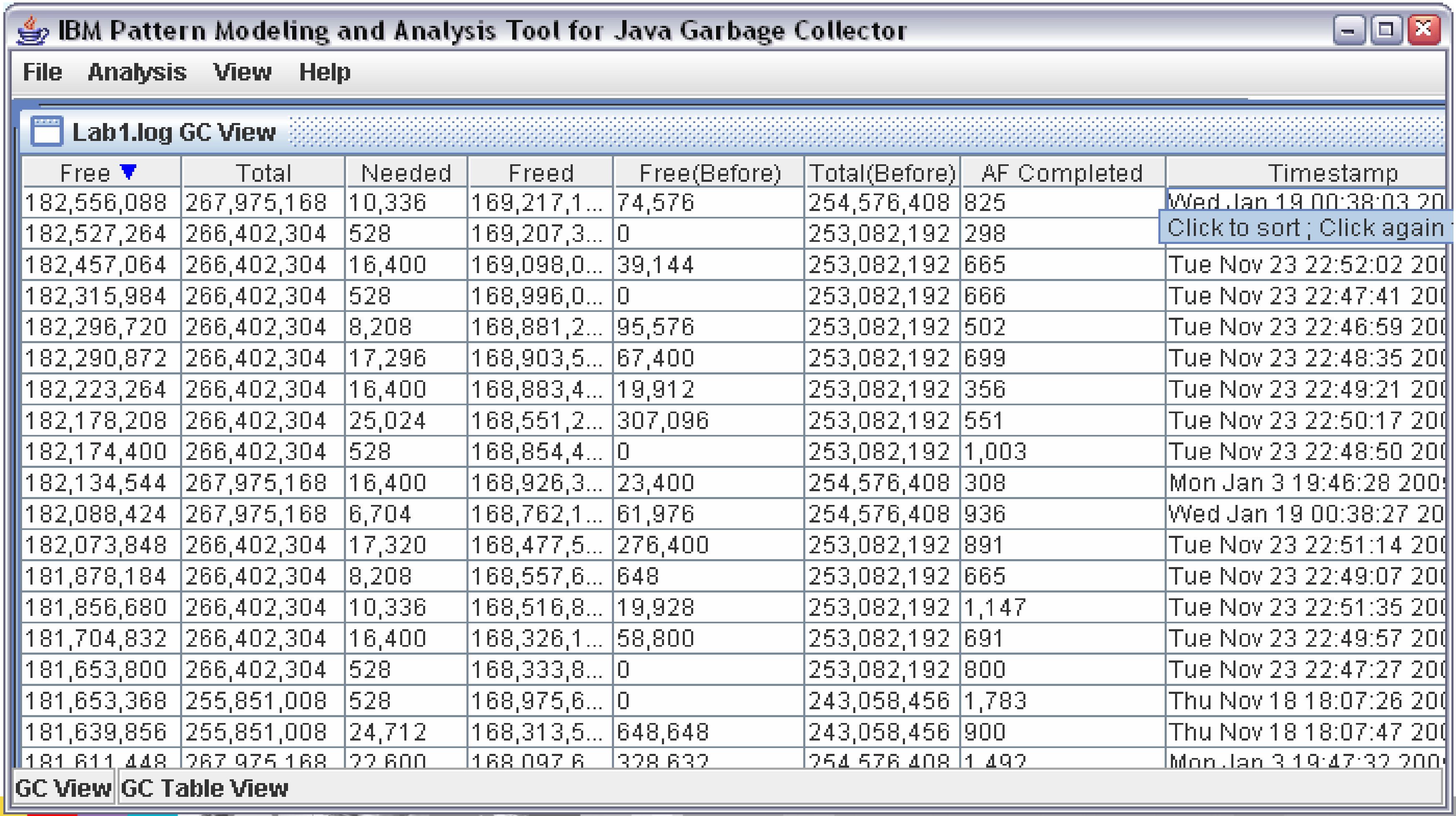


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
Lab1.log GC View
GC View
GC Table View

| Free | Total | Needed | Freed | Free(Before) | Total(Before) | AF Completed | Times |
|---|---|---|---|---|---|---|---|
| 71,250,112 | 150,403,584 | 1,352 | 65,050,640 | 0 | 142,883,408 | 328 | Wed Nov 17 0 |
| 71,290,728 | 150,403,584 | 8,216 | 65,052,144 | 39,112 | 142,883,408 | 325 | Wed Nov 17 0 |
| 71,483,312 | 150,403,584 | 8,208 | 65,257,496 | 26,344 | 142,883,408 | 325 | Wed Nov 17 0 |
| 71,233,896 | 150,403,584 | 5,904 | 64,993,224 | 41,200 | 142,883,408 | 334 | Wed Nov 17 0 |
| 71,340,016 | 150,403,584 | 16,400 | 65,027,296 | 113,248 | 142,883,408 | 336 | Wed Nov 17 0 |
| 71,343,000 | 150,403,584 | 10,336 | 65,117,936 | 25,592 | 142,883,408 | 326 | Wed Nov 17 0 |
| 74,790,064 | 150,403,584 | 528 | 68,590,592 | 0 | 142,883,408 | 309 | Wed Nov 17 0 |
| 74,688,464 | 150,403,584 | 8,208 | 68,469,184 | 19,808 | 142,883,408 | 258 | Wed Nov 17 1 |
| 75,974,656 | 150,403,584 | 10,336 | 69,751,640 | 23,544 | 142,883,408 | 303 | Wed Nov 17 1 |
| 85,902,496 | 150,403,584 | 10,336 | 79,689,064 | 13,960 | 142,883,408 | 268 | Wed Nov 17 1 |
| 92,235,248 | 150,403,584 | 8,208 | 85,388,184 | 77,208 | 142,883,408 | 234 | Wed Nov 17 1 |
| 95,701,760 | 150,403,584 | 8,208 | 88,335,056 | 28,328 | 142,883,408 | 212 | Wed Nov 17 1 |
| 95,218,200 | 150,403,584 | 8,208 | 87,728,952 | 21,128 | 142,883,408 | 214 | Wed Nov 17 1 |
| 95,291,912 | 150,403,584 | 10,336 | 87,809,592 | 14,200 | 142,883,408 | 225 | Wed Nov 17 1 |
| 95,706,960 | 150,403,584 | 8,208 | 88,174,856 | 63,984 | 142,883,408 | 225 | Wed Nov 17 1 |
| 95,891,112 | 150,403,584 | 8,216 | 88,360,256 | 62,736 | 142,883,408 | 227 | Wed Nov 17 1 |
| 100,221,568 | 150,403,584 | 528 | 43,762,496 | 56,459,072 | 150,403,584 | 139 | Wed Nov 17 1 |
| 97,359,144 | 150,403,584 | 528 | 39,465,672 | 57,893,472 | 150,403,584 | 215 | Wed Nov 17 1 |
| 86,558,184 | 149,420,544 | 528 | 80,065,248 | 0 | 142,883,408 | 354 | Wed Nov 17 1 |

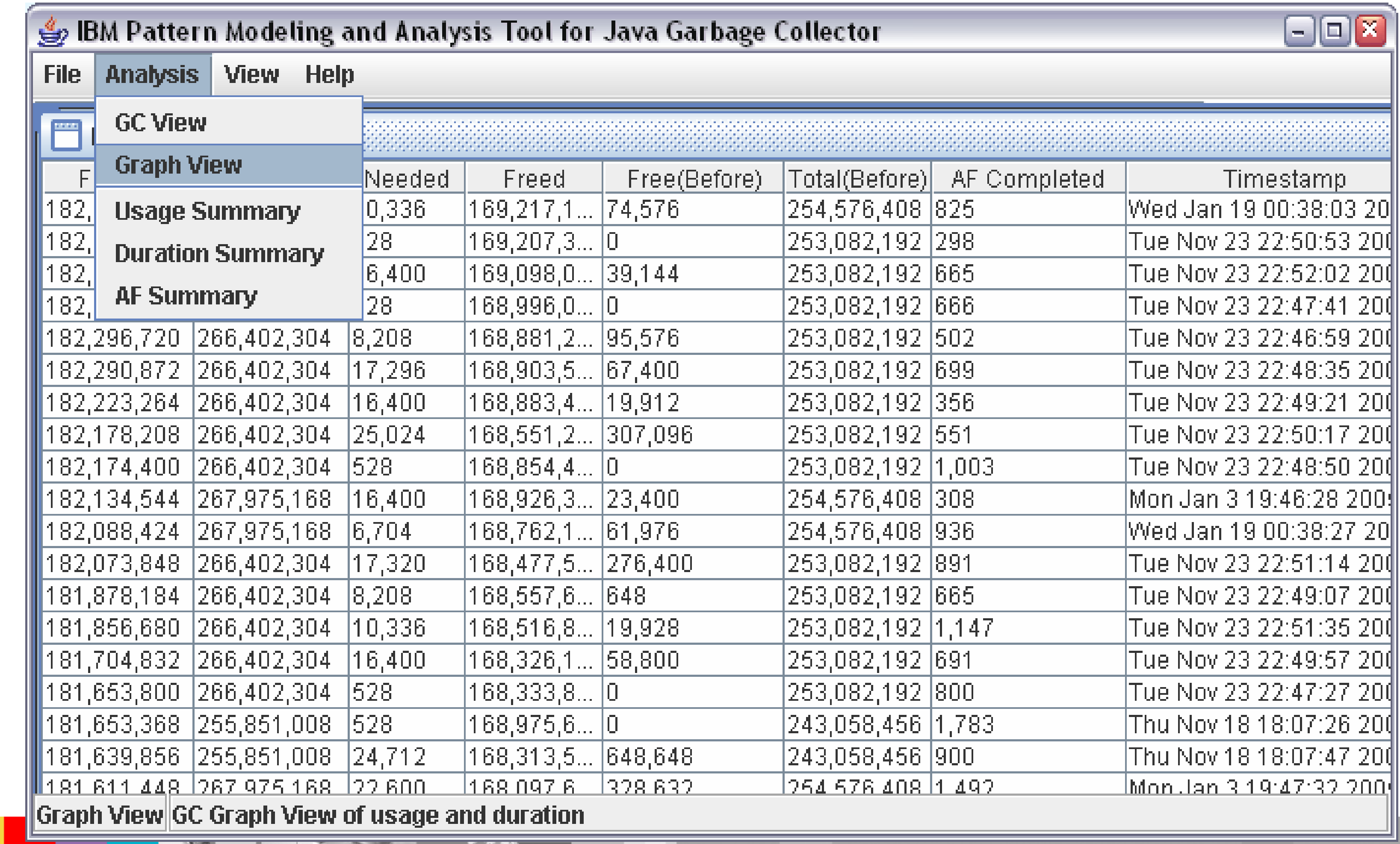
- You can sort each column by clicking on column header.

# GC View sorted by Free


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
Lab1.log GC View
Click to sort ; Click again
GC View
GC Table View

| Free ▼ | Total | Needed | Freed | Free(Before) | Total(Before) | AF Completed | Timestamp |
|---|---|---|---|---|---|---|---|
| 182,556,088 | 267,975,168 | 10,336 | 169,217,1... | 74,576 | 254,576,408 | 825 | Wed Jan 19 00:38:03 20 |
| 182,527,264 | 266,402,304 | 528 | 169,207,3... | 0 | 253,082,192 | 298 | |
| 182,457,064 | 266,402,304 | 16,400 | 169,098,0... | 39,144 | 253,082,192 | 665 | Tue Nov 23 22:52:02 200 |
| 182,315,984 | 266,402,304 | 528 | 168,996,0... | 0 | 253,082,192 | 666 | Tue Nov 23 22:47:41 200 |
| 182,296,720 | 266,402,304 | 8,208 | 168,881,2... | 95,576 | 253,082,192 | 502 | Tue Nov 23 22:46:59 200 |
| 182,290,872 | 266,402,304 | 17,296 | 168,903,5... | 67,400 | 253,082,192 | 699 | Tue Nov 23 22:48:35 200 |
| 182,223,264 | 266,402,304 | 16,400 | 168,883,4... | 19,912 | 253,082,192 | 356 | Tue Nov 23 22:49:21 200 |
| 182,178,208 | 266,402,304 | 25,024 | 168,551,2... | 307,096 | 253,082,192 | 551 | Tue Nov 23 22:50:17 200 |
| 182,174,400 | 266,402,304 | 528 | 168,854,4... | 0 | 253,082,192 | 1,003 | Tue Nov 23 22:48:50 200 |
| 182,134,544 | 267,975,168 | 16,400 | 168,926,3... | 23,400 | 254,576,408 | 308 | Mon Jan 3 19:46:28 200 |
| 182,088,424 | 267,975,168 | 6,704 | 168,762,1... | 61,976 | 254,576,408 | 936 | Wed Jan 19 00:38:27 20 |
| 182,073,848 | 266,402,304 | 17,320 | 168,477,5... | 276,400 | 253,082,192 | 891 | Tue Nov 23 22:51:14 200 |
| 181,878,184 | 266,402,304 | 8,208 | 168,557,6... | 648 | 253,082,192 | 665 | Tue Nov 23 22:49:07 200 |
| 181,856,680 | 266,402,304 | 10,336 | 168,516,8... | 19,928 | 253,082,192 | 1,147 | Tue Nov 23 22:51:35 200 |
| 181,704,832 | 266,402,304 | 16,400 | 168,326,1... | 58,800 | 253,082,192 | 691 | Tue Nov 23 22:49:57 200 |
| 181,653,800 | 266,402,304 | 528 | 168,333,8... | 0 | 253,082,192 | 800 | Tue Nov 23 22:47:27 200 |
| 181,653,368 | 255,851,008 | 528 | 168,975,6... | 0 | 243,058,456 | 1,783 | Thu Nov 18 18:07:26 200 |
| 181,639,856 | 255,851,008 | 24,712 | 168,313,5... | 648,648 | 243,058,456 | 900 | Thu Nov 18 18:07:47 200 |
| 181,611,448 | 267,975,168 | 22,600 | 168,097,6... | 328,632 | 254,576,408 | 1,492 | Mon Jan 3 19:47:32 200 |

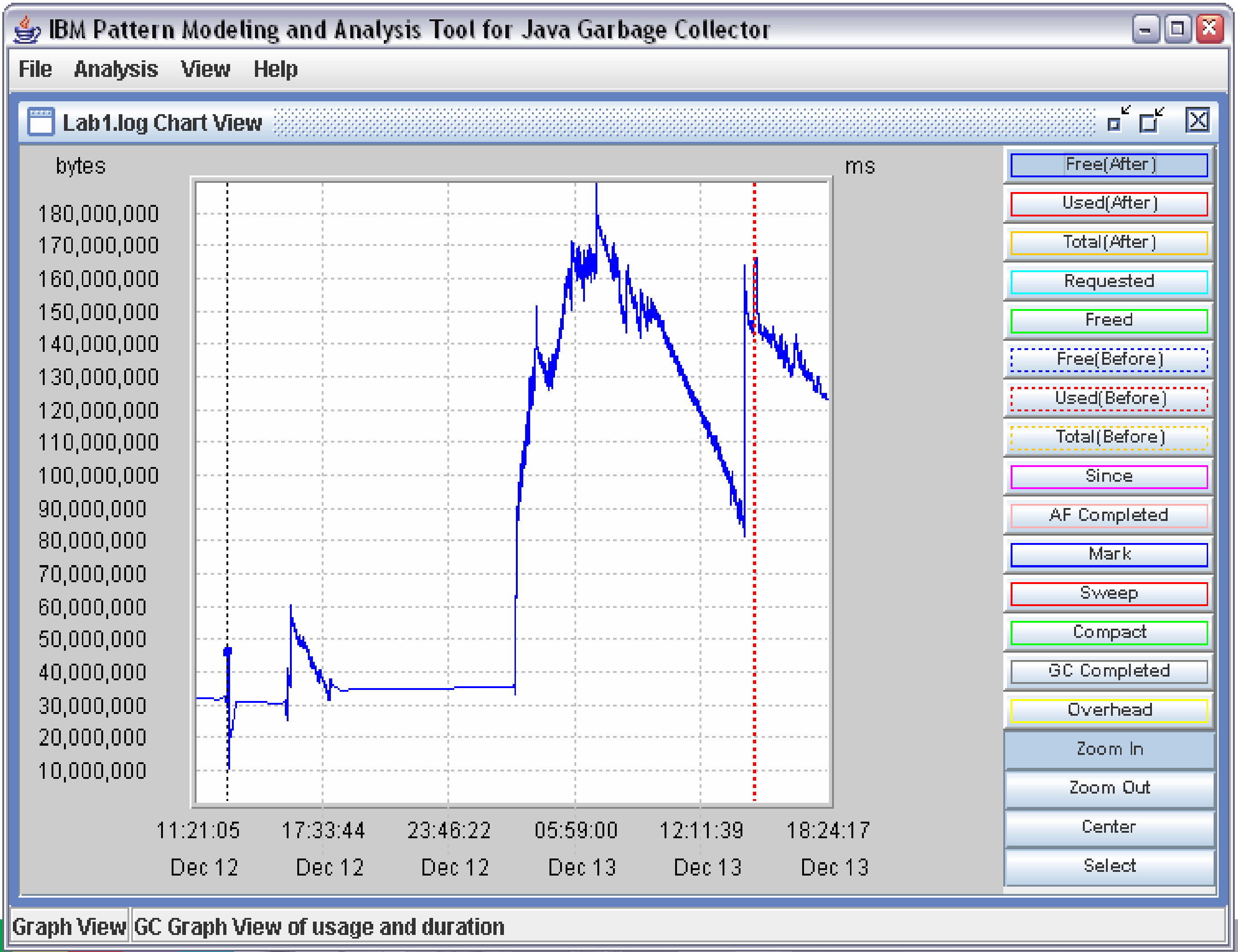
# Graph View



| F | | Needed | Freed | Free(Before) | Total(Before) | AF Completed | Timestamp |
|---|---|---|---|---|---|---|---|
| 182, | | 0,336 | 169,217,1... | 74,576 | 254,576,408 | 825 | Wed Jan 19 00:38:03 20 |
| 182, | | 28 | 169,207,3... | 0 | 253,082,192 | 298 | Tue Nov 23 22:50:53 20 |
| 182, | | 6,400 | 169,098,0... | 39,144 | 253,082,192 | 665 | Tue Nov 23 22:52:02 20 |
| 182, | | 28 | 168,996,0... | 0 | 253,082,192 | 666 | Tue Nov 23 22:47:41 20 |
| 182,296,720 | 266,402,304 | 8,208 | 168,881,2... | 95,576 | 253,082,192 | 502 | Tue Nov 23 22:46:59 20 |
| 182,290,872 | 266,402,304 | 17,296 | 168,903,5... | 67,400 | 253,082,192 | 699 | Tue Nov 23 22:48:35 20 |
| 182,223,264 | 266,402,304 | 16,400 | 168,883,4... | 19,912 | 253,082,192 | 356 | Tue Nov 23 22:49:21 20 |
| 182,178,208 | 266,402,304 | 25,024 | 168,551,2... | 307,096 | 253,082,192 | 551 | Tue Nov 23 22:50:17 20 |
| 182,174,400 | 266,402,304 | 528 | 168,854,4... | 0 | 253,082,192 | 1,003 | Tue Nov 23 22:48:50 20 |
| 182,134,544 | 267,975,168 | 16,400 | 168,926,3... | 23,400 | 254,576,408 | 308 | Mon Jan 3 19:46:28 200 |
| 182,088,424 | 267,975,168 | 6,704 | 168,762,1... | 61,976 | 254,576,408 | 936 | Wed Jan 19 00:38:27 20 |
| 182,073,848 | 266,402,304 | 17,320 | 168,477,5... | 276,400 | 253,082,192 | 891 | Tue Nov 23 22:51:14 20 |
| 181,878,184 | 266,402,304 | 8,208 | 168,557,6... | 648 | 253,082,192 | 665 | Tue Nov 23 22:49:07 20 |
| 181,856,680 | 266,402,304 | 10,336 | 168,516,8... | 19,928 | 253,082,192 | 1,147 | Tue Nov 23 22:51:35 20 |
| 181,704,832 | 266,402,304 | 16,400 | 168,326,1... | 58,800 | 253,082,192 | 691 | Tue Nov 23 22:49:57 20 |
| 181,653,800 | 266,402,304 | 528 | 168,333,8... | 0 | 253,082,192 | 800 | Tue Nov 23 22:47:27 20 |
| 181,653,368 | 255,851,008 | 528 | 168,975,6... | 0 | 243,058,456 | 1,783 | Thu Nov 18 18:07:26 20 |
| 181,639,856 | 255,851,008 | 24,712 | 168,313,5... | 648,648 | 243,058,456 | 900 | Thu Nov 18 18:07:47 20 |
| 181,611,448 | 267,975,168 | 22,600 | 168,097,6 | 328,632 | 254,576,408 | 1,492 | Mon Jan 3 19:47:32 200 |

Graph View | GC Graph View of usage and duration

# Chart View


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
Lab1.log Chart View
bytes
ms
180,000,000
170,000,000
160,000,000
150,000,000
140,000,000
130,000,000
120,000,000
110,000,000
100,000,000
90,000,000
80,000,000
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
11:21:05 Dec 12
17:33:44 Dec 12
23:46:22 Dec 12
05:59:00 Dec 13
12:11:39 Dec 13
18:24:17 Dec 13
Free(After)
Used(After)
Total(After)
Requested
Freed
Free(Before)
Used(Before)
Total(Before)
Since
AF Completed
Mark
Sweep
Compact
GC Completed
Overhead
Zoom In
Zoom Out
Center
Select
Graph View
GC Graph View of usage and duration

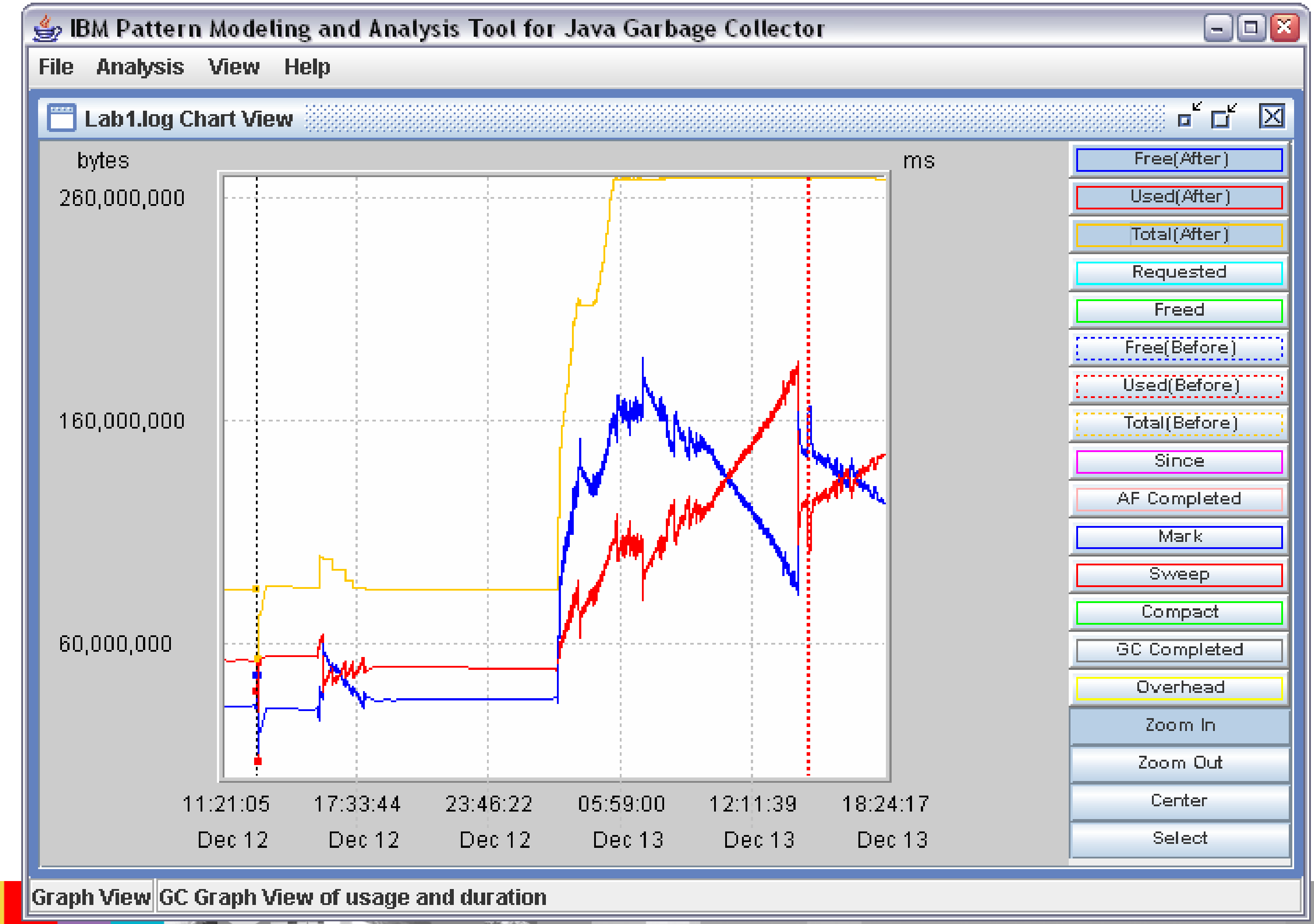
# Chart buttons (1-2)

- **Since** Time(millisecond) elapsed since last allocation failure.
- **Freed** Size(byte) of space that was freed during garbage collection.
- **Requested** Size(byte) of space that was requested during allocation failure.
- **Free** Size(byte) of space that was free after garbage collection.
- **Total** Size(byte) of Java heap after garbage collection.
- **Completed** Time(millisecond) spent during allocation failure.

# Chart buttons (2-2)

- **GC Completed** Time(millisecond) spent during garbage collection.
- **Overhead** Ratio(%) time spent in allocation failure vs. time between AF
- **Zoom In** Zoom in X axis
- **Zoom Out** Zoom out X axis
- **Center** Moves a point to center
- **Select** Brings up GC View of a point

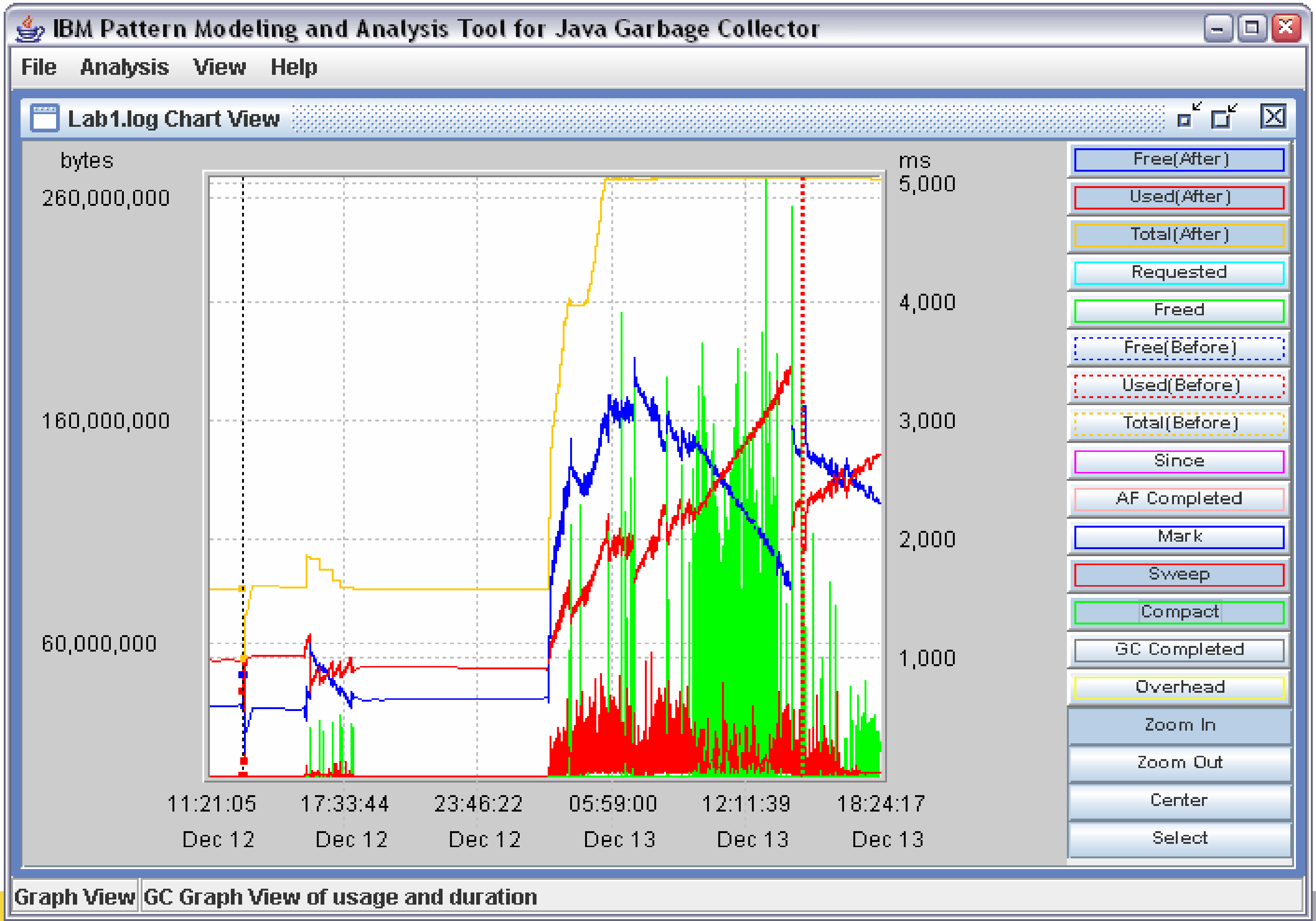
# Graph View



GC Graph View of usage and duration

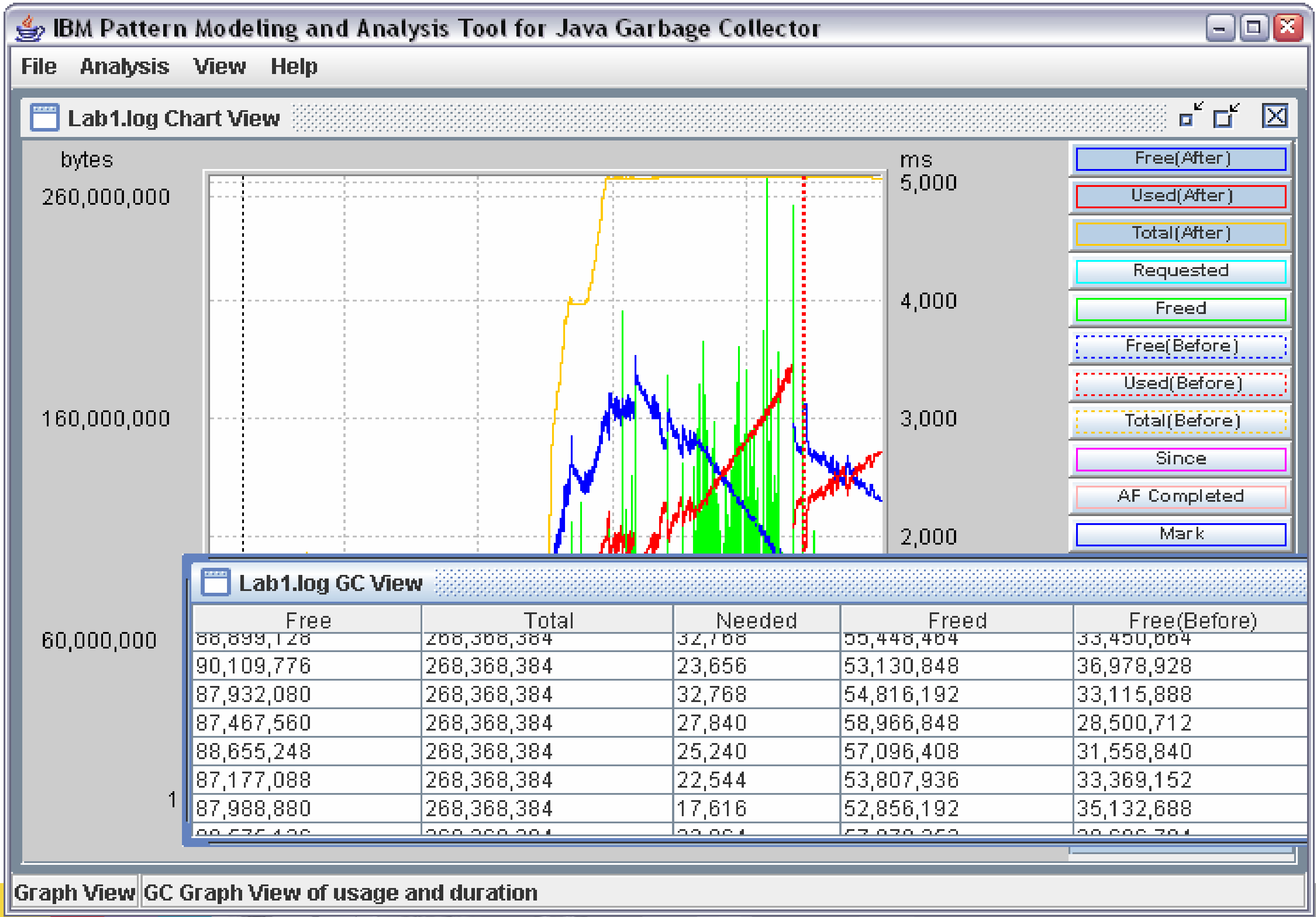
- Free, used, total size are displayed

# Graph View



- Compact and Sweep buttons are enabled.
- You can click on Zoom In/Out and Center to navigate chart in various levels.

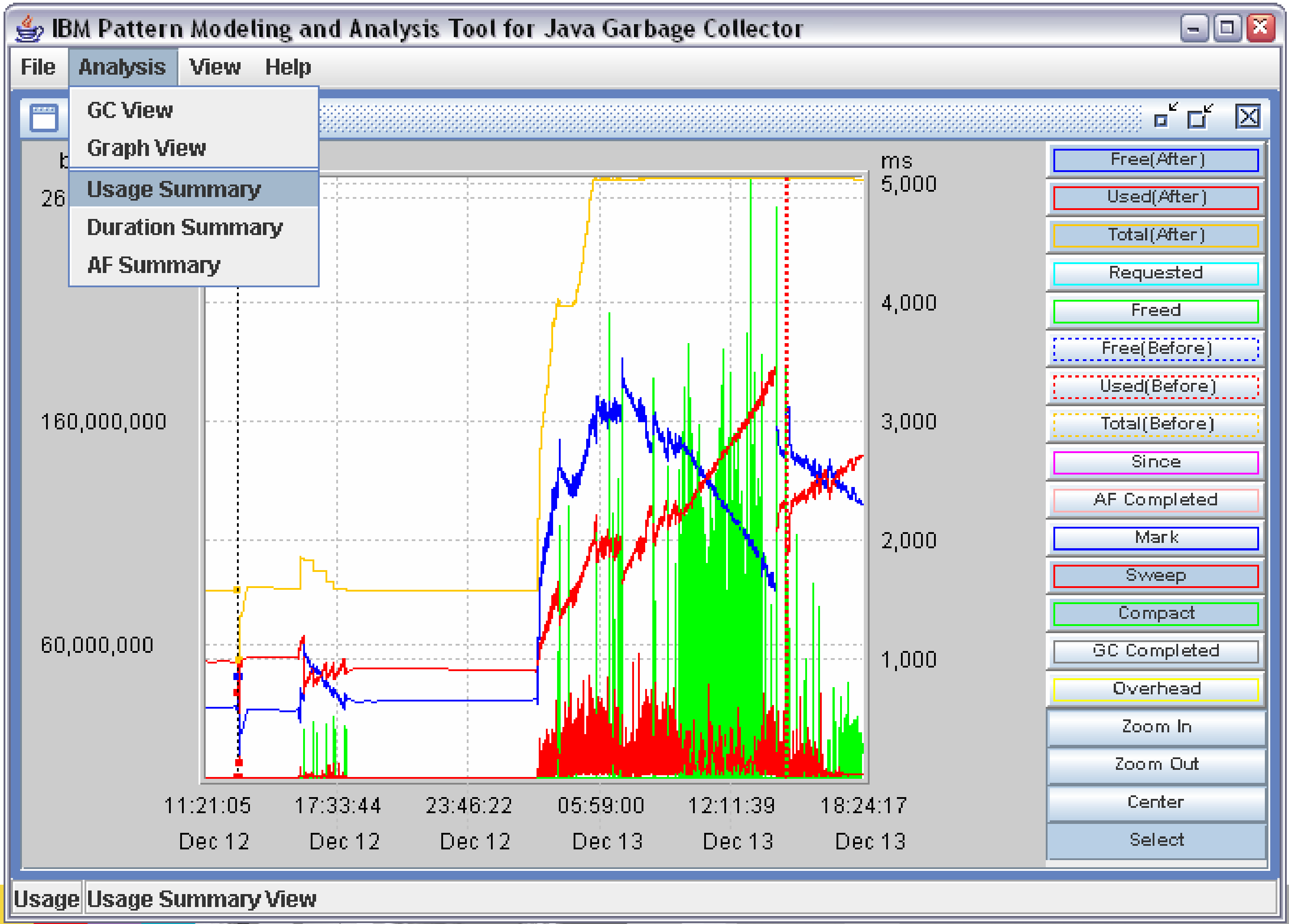
# Graph View



| Free | Total | Needed | Freed | Free(Before) |
|---|---|---|---|---|
| 90,109,776 | 268,368,384 | 23,656 | 53,130,848 | 36,978,928 |
| 87,932,080 | 268,368,384 | 32,768 | 54,816,192 | 33,115,888 |
| 87,467,560 | 268,368,384 | 27,840 | 58,966,848 | 28,500,712 |
| 88,655,248 | 268,368,384 | 25,240 | 57,096,408 | 31,558,840 |
| 87,177,088 | 268,368,384 | 22,544 | 53,807,936 | 33,369,152 |
| 87,988,880 | 268,368,384 | 17,616 | 52,856,192 | 35,132,688 |

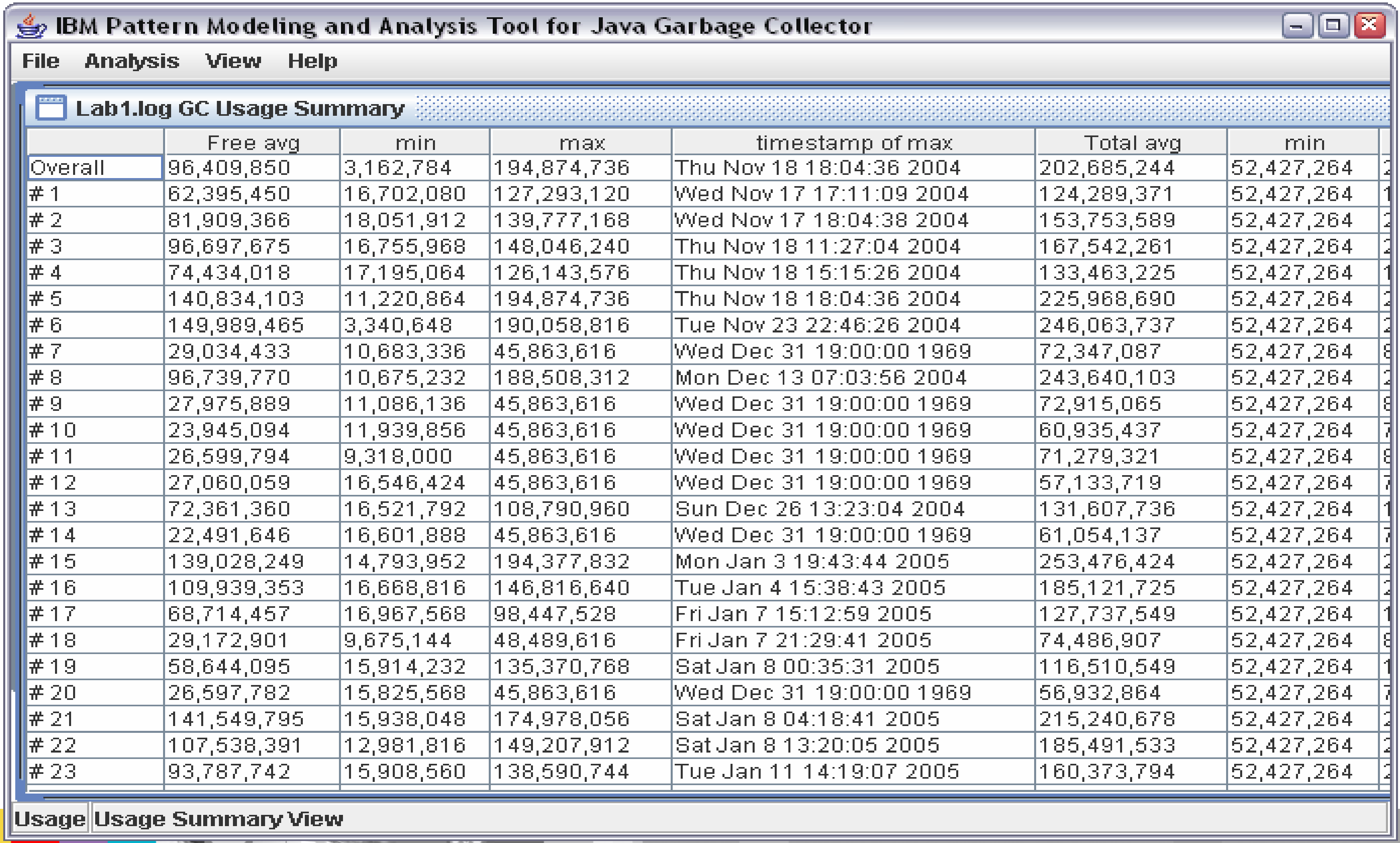
- You can select a point to display its table view

# Usage Summary



- Display usage summary by clicking on Analysis->Usage Summary

# Usage Summary



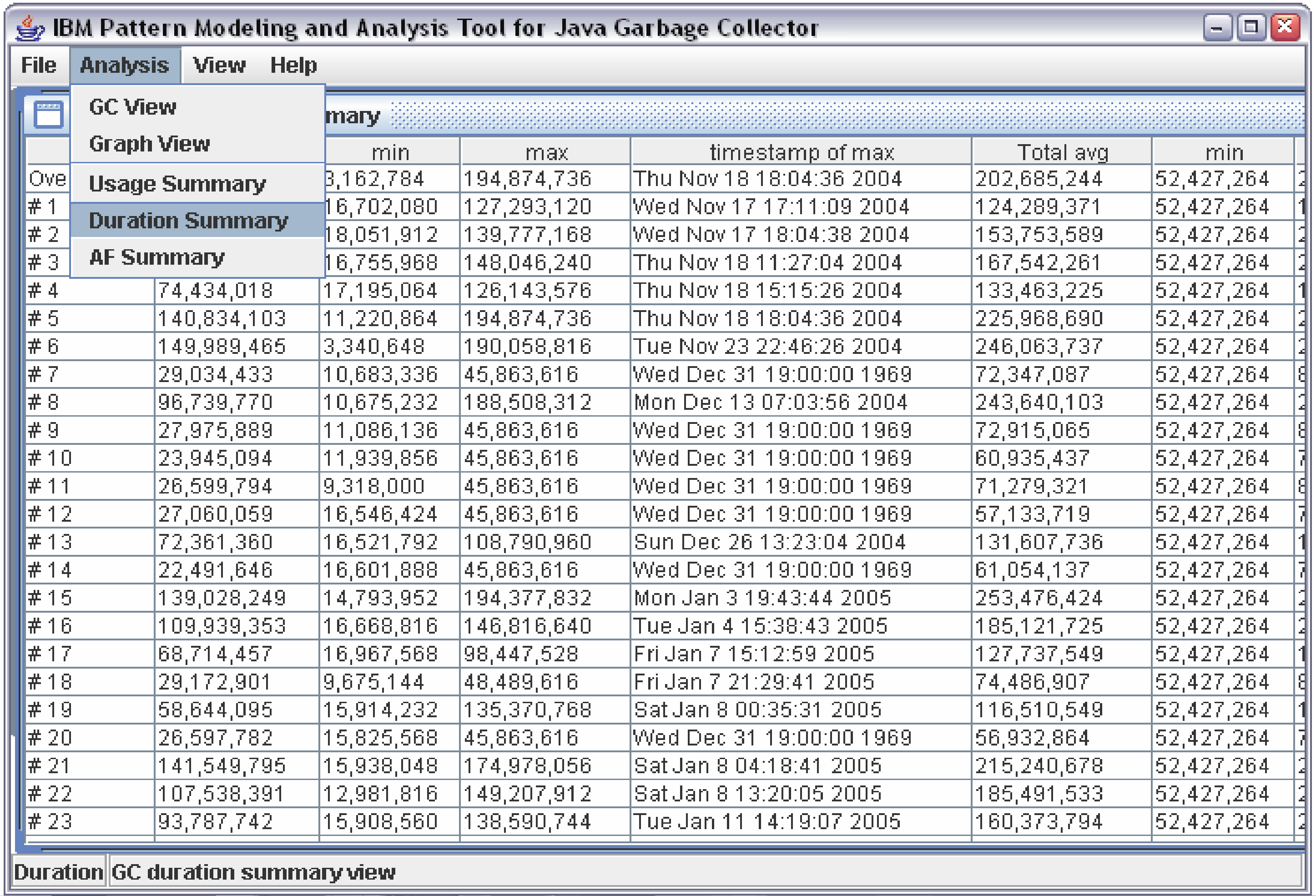
IBM Pattern Modeling and Analysis Tool for Java Garbage Collector

Lab1.log GC Usage Summary

|  | Free avg | min | max | timestamp of max | Total avg | min |
|---|---|---|---|---|---|---|
| Overall | 96,409,850 | 3,162,784 | 194,874,736 | Thu Nov 18 18:04:36 2004 | 202,685,244 | 52,427,264 |
| # 1 | 62,395,450 | 16,702,080 | 127,293,120 | Wed Nov 17 17:11:09 2004 | 124,289,371 | 52,427,264 |
| # 2 | 81,909,366 | 18,051,912 | 139,777,168 | Wed Nov 17 18:04:38 2004 | 153,753,589 | 52,427,264 |
| # 3 | 96,697,675 | 16,755,968 | 148,046,240 | Thu Nov 18 11:27:04 2004 | 167,542,261 | 52,427,264 |
| # 4 | 74,434,018 | 17,195,064 | 126,143,576 | Thu Nov 18 15:15:26 2004 | 133,463,225 | 52,427,264 |
| # 5 | 140,834,103 | 11,220,864 | 194,874,736 | Thu Nov 18 18:04:36 2004 | 225,968,690 | 52,427,264 |
| # 6 | 149,989,465 | 3,340,648 | 190,058,816 | Tue Nov 23 22:46:26 2004 | 246,063,737 | 52,427,264 |
| # 7 | 29,034,433 | 10,683,336 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 72,347,087 | 52,427,264 |
| # 8 | 96,739,770 | 10,675,232 | 188,508,312 | Mon Dec 13 07:03:56 2004 | 243,640,103 | 52,427,264 |
| # 9 | 27,975,889 | 11,086,136 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 72,915,065 | 52,427,264 |
| # 10 | 23,945,094 | 11,939,856 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 60,935,437 | 52,427,264 |
| # 11 | 26,599,794 | 9,318,000 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 71,279,321 | 52,427,264 |
| # 12 | 27,060,059 | 16,546,424 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 57,133,719 | 52,427,264 |
| # 13 | 72,361,360 | 16,521,792 | 108,790,960 | Sun Dec 26 13:23:04 2004 | 131,607,736 | 52,427,264 |
| # 14 | 22,491,646 | 16,601,888 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 61,054,137 | 52,427,264 |
| # 15 | 139,028,249 | 14,793,952 | 194,377,832 | Mon Jan 3 19:43:44 2005 | 253,476,424 | 52,427,264 |
| # 16 | 109,939,353 | 16,668,816 | 146,816,640 | Tue Jan 4 15:38:43 2005 | 185,121,725 | 52,427,264 |
| # 17 | 68,714,457 | 16,967,568 | 98,447,528 | Fri Jan 7 15:12:59 2005 | 127,737,549 | 52,427,264 |
| # 18 | 29,172,901 | 9,675,144 | 48,489,616 | Fri Jan 7 21:29:41 2005 | 74,486,907 | 52,427,264 |
| # 19 | 58,644,095 | 15,914,232 | 135,370,768 | Sat Jan 8 00:35:31 2005 | 116,510,549 | 52,427,264 |
| # 20 | 26,597,782 | 15,825,568 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 56,932,864 | 52,427,264 |
| # 21 | 141,549,795 | 15,938,048 | 174,978,056 | Sat Jan 8 04:18:41 2005 | 215,240,678 | 52,427,264 |
| # 22 | 107,538,391 | 12,981,816 | 149,207,912 | Sat Jan 8 13:20:05 2005 | 185,491,533 | 52,427,264 |
| # 23 | 93,787,742 | 15,908,560 | 138,590,744 | Tue Jan 11 14:19:07 2005 | 160,373,794 | 52,427,264 |

Usage Summary View

# Duration Summary

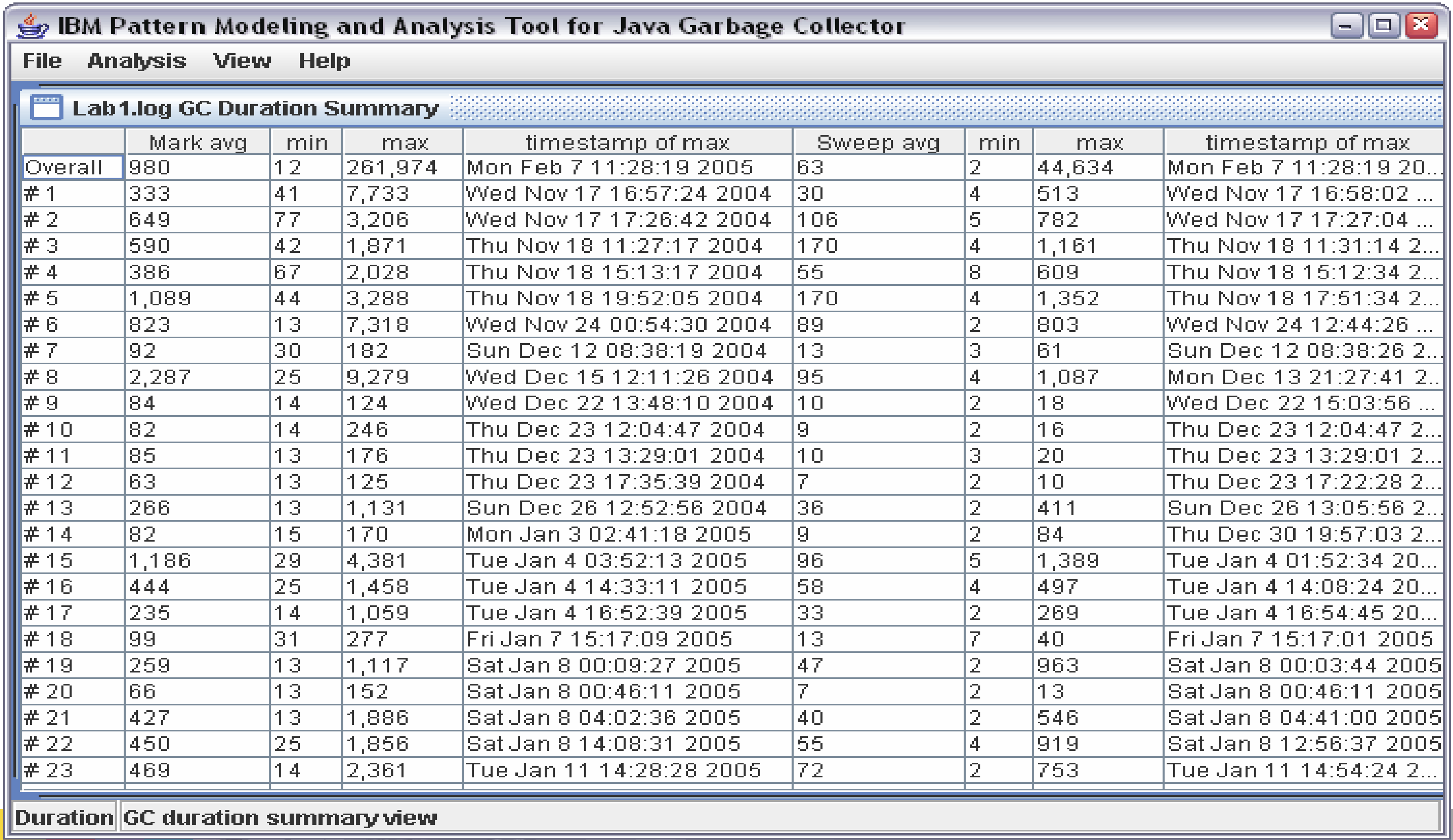


| | | min | max | timestamp of max | Total avg | min |
|---|---|---|---|---|---|---|
| Ove | | 3,162,784 | 194,874,736 | Thu Nov 18 18:04:36 2004 | 202,685,244 | 52,427,264 |
| # 1 | | 16,702,080 | 127,293,120 | Wed Nov 17 17:11:09 2004 | 124,289,371 | 52,427,264 |
| # 2 | | 18,051,912 | 139,777,168 | Wed Nov 17 18:04:38 2004 | 153,753,589 | 52,427,264 |
| # 3 | | 16,755,968 | 148,046,240 | Thu Nov 18 11:27:04 2004 | 167,542,261 | 52,427,264 |
| # 4 | 74,434,018 | 17,195,064 | 126,143,576 | Thu Nov 18 15:15:26 2004 | 133,463,225 | 52,427,264 |
| # 5 | 140,834,103 | 11,220,864 | 194,874,736 | Thu Nov 18 18:04:36 2004 | 225,968,690 | 52,427,264 |
| # 6 | 149,989,465 | 3,340,648 | 190,058,816 | Tue Nov 23 22:46:26 2004 | 246,063,737 | 52,427,264 |
| # 7 | 29,034,433 | 10,683,336 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 72,347,087 | 52,427,264 |
| # 8 | 96,739,770 | 10,675,232 | 188,508,312 | Mon Dec 13 07:03:56 2004 | 243,640,103 | 52,427,264 |
| # 9 | 27,975,889 | 11,086,136 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 72,915,065 | 52,427,264 |
| # 10 | 23,945,094 | 11,939,856 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 60,935,437 | 52,427,264 |
| # 11 | 26,599,794 | 9,318,000 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 71,279,321 | 52,427,264 |
| # 12 | 27,060,059 | 16,546,424 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 57,133,719 | 52,427,264 |
| # 13 | 72,361,360 | 16,521,792 | 108,790,960 | Sun Dec 26 13:23:04 2004 | 131,607,736 | 52,427,264 |
| # 14 | 22,491,646 | 16,601,888 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 61,054,137 | 52,427,264 |
| # 15 | 139,028,249 | 14,793,952 | 194,377,832 | Mon Jan 3 19:43:44 2005 | 253,476,424 | 52,427,264 |
| # 16 | 109,939,353 | 16,668,816 | 146,816,640 | Tue Jan 4 15:38:43 2005 | 185,121,725 | 52,427,264 |
| # 17 | 68,714,457 | 16,967,568 | 98,447,528 | Fri Jan 7 15:12:59 2005 | 127,737,549 | 52,427,264 |
| # 18 | 29,172,901 | 9,675,144 | 48,489,616 | Fri Jan 7 21:29:41 2005 | 74,486,907 | 52,427,264 |
| # 19 | 58,644,095 | 15,914,232 | 135,370,768 | Sat Jan 8 00:35:31 2005 | 116,510,549 | 52,427,264 |
| # 20 | 26,597,782 | 15,825,568 | 45,863,616 | Wed Dec 31 19:00:00 1969 | 56,932,864 | 52,427,264 |
| # 21 | 141,549,795 | 15,938,048 | 174,978,056 | Sat Jan 8 04:18:41 2005 | 215,240,678 | 52,427,264 |
| # 22 | 107,538,391 | 12,981,816 | 149,207,912 | Sat Jan 8 13:20:05 2005 | 185,491,533 | 52,427,264 |
| # 23 | 93,787,742 | 15,908,560 | 138,590,744 | Tue Jan 11 14:19:07 2005 | 160,373,794 | 52,427,264 |

Duration GC duration summary view

- Duration Summary by clicking on Analysis-.Duration Summary

# Duration Summary

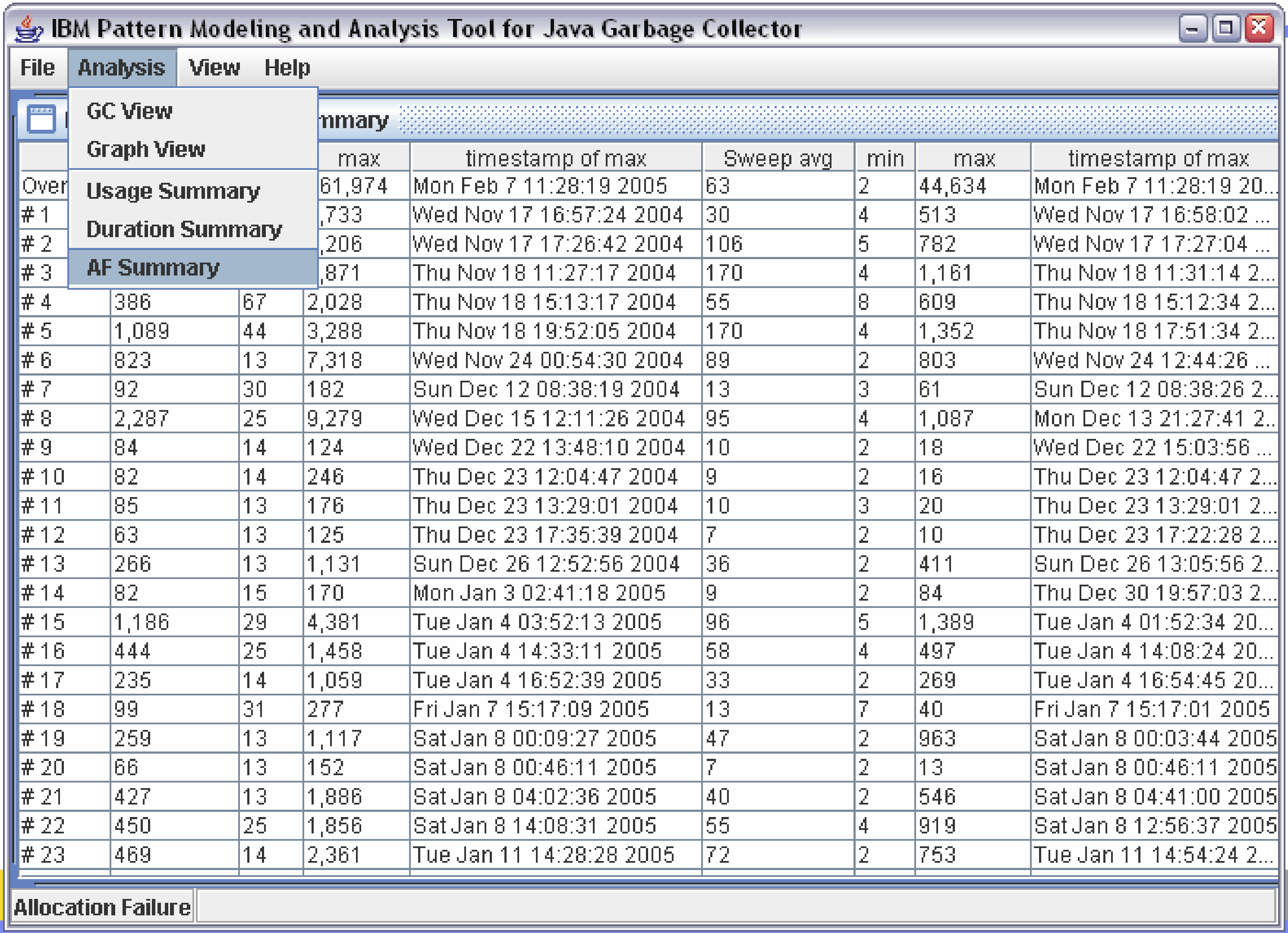

IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help

Lab1.log GC Duration Summary

|  | Mark avg | min | max | timestamp of max | Sweep avg | min | max | timestamp of max |
|---|---|---|---|---|---|---|---|---|
| Overall | 980 | 12 | 261,974 | Mon Feb 7 11:28:19 2005 | 63 | 2 | 44,634 | Mon Feb 7 11:28:19 20... |
| # 1 | 333 | 41 | 7,733 | Wed Nov 17 16:57:24 2004 | 30 | 4 | 513 | Wed Nov 17 16:58:02 ... |
| # 2 | 649 | 77 | 3,206 | Wed Nov 17 17:26:42 2004 | 106 | 5 | 782 | Wed Nov 17 17:27:04 ... |
| # 3 | 590 | 42 | 1,871 | Thu Nov 18 11:27:17 2004 | 170 | 4 | 1,161 | Thu Nov 18 11:31:14 2... |
| # 4 | 386 | 67 | 2,028 | Thu Nov 18 15:13:17 2004 | 55 | 8 | 609 | Thu Nov 18 15:12:34 2... |
| # 5 | 1,089 | 44 | 3,288 | Thu Nov 18 19:52:05 2004 | 170 | 4 | 1,352 | Thu Nov 18 17:51:34 2... |
| # 6 | 823 | 13 | 7,318 | Wed Nov 24 00:54:30 2004 | 89 | 2 | 803 | Wed Nov 24 12:44:26 ... |
| # 7 | 92 | 30 | 182 | Sun Dec 12 08:38:19 2004 | 13 | 3 | 61 | Sun Dec 12 08:38:26 2... |
| # 8 | 2,287 | 25 | 9,279 | Wed Dec 15 12:11:26 2004 | 95 | 4 | 1,087 | Mon Dec 13 21:27:41 2... |
| # 9 | 84 | 14 | 124 | Wed Dec 22 13:48:10 2004 | 10 | 2 | 18 | Wed Dec 22 15:03:56 ... |
| # 10 | 82 | 14 | 246 | Thu Dec 23 12:04:47 2004 | 9 | 2 | 16 | Thu Dec 23 12:04:47 2... |
| # 11 | 85 | 13 | 176 | Thu Dec 23 13:29:01 2004 | 10 | 3 | 20 | Thu Dec 23 13:29:01 2... |
| # 12 | 63 | 13 | 125 | Thu Dec 23 17:35:39 2004 | 7 | 2 | 10 | Thu Dec 23 17:22:28 2... |
| # 13 | 266 | 13 | 1,131 | Sun Dec 26 12:52:56 2004 | 36 | 2 | 411 | Sun Dec 26 13:05:56 2... |
| # 14 | 82 | 15 | 170 | Mon Jan 3 02:41:18 2005 | 9 | 2 | 84 | Thu Dec 30 19:57:03 2... |
| # 15 | 1,186 | 29 | 4,381 | Tue Jan 4 03:52:13 2005 | 96 | 5 | 1,389 | Tue Jan 4 01:52:34 20... |
| # 16 | 444 | 25 | 1,458 | Tue Jan 4 14:33:11 2005 | 58 | 4 | 497 | Tue Jan 4 14:08:24 20... |
| # 17 | 235 | 14 | 1,059 | Tue Jan 4 16:52:39 2005 | 33 | 2 | 269 | Tue Jan 4 16:54:45 20... |
| # 18 | 99 | 31 | 277 | Fri Jan 7 15:17:09 2005 | 13 | 7 | 40 | Fri Jan 7 15:17:01 2005 |
| # 19 | 259 | 13 | 1,117 | Sat Jan 8 00:09:27 2005 | 47 | 2 | 963 | Sat Jan 8 00:03:44 2005 |
| # 20 | 66 | 13 | 152 | Sat Jan 8 00:46:11 2005 | 7 | 2 | 13 | Sat Jan 8 00:46:11 2005 |
| # 21 | 427 | 13 | 1,886 | Sat Jan 8 04:02:36 2005 | 40 | 2 | 546 | Sat Jan 8 04:41:00 2005 |
| # 22 | 450 | 25 | 1,856 | Sat Jan 8 14:08:31 2005 | 55 | 4 | 919 | Sat Jan 8 12:56:37 2005 |
| # 23 | 469 | 14 | 2,361 | Tue Jan 11 14:28:28 2005 | 72 | 2 | 753 | Tue Jan 11 14:54:24 2... |

Duration GC duration summary view

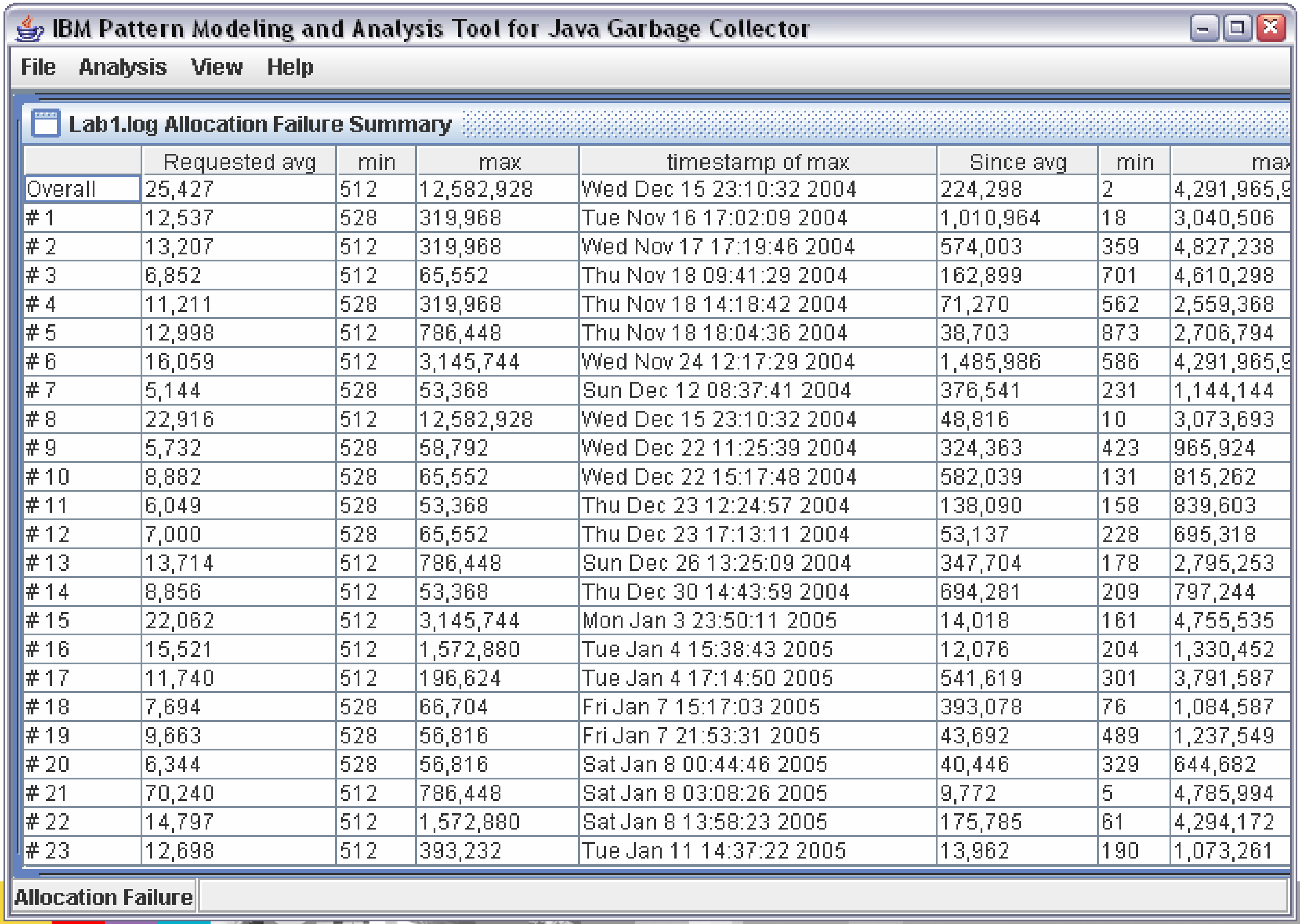
# AF Summary



| | | | max | timestamp of max | Sweep avg | min | max | timestamp of max |
|---|---|---|---|---|---|---|---|---|
| Over | | | 61,974 | Mon Feb 7 11:28:19 2005 | 63 | 2 | 44,634 | Mon Feb 7 11:28:19 20... |
| # 1 | | | ,733 | Wed Nov 17 16:57:24 2004 | 30 | 4 | 513 | Wed Nov 17 16:58:02 ... |
| # 2 | | | ,206 | Wed Nov 17 17:26:42 2004 | 106 | 5 | 782 | Wed Nov 17 17:27:04 ... |
| # 3 | | | ,871 | Thu Nov 18 11:27:17 2004 | 170 | 4 | 1,161 | Thu Nov 18 11:31:14 2... |
| # 4 | 386 | 67 | 2,028 | Thu Nov 18 15:13:17 2004 | 55 | 8 | 609 | Thu Nov 18 15:12:34 2... |
| # 5 | 1,089 | 44 | 3,288 | Thu Nov 18 19:52:05 2004 | 170 | 4 | 1,352 | Thu Nov 18 17:51:34 2... |
| # 6 | 823 | 13 | 7,318 | Wed Nov 24 00:54:30 2004 | 89 | 2 | 803 | Wed Nov 24 12:44:26 ... |
| # 7 | 92 | 30 | 182 | Sun Dec 12 08:38:19 2004 | 13 | 3 | 61 | Sun Dec 12 08:38:26 2... |
| # 8 | 2,287 | 25 | 9,279 | Wed Dec 15 12:11:26 2004 | 95 | 4 | 1,087 | Mon Dec 13 21:27:41 2... |
| # 9 | 84 | 14 | 124 | Wed Dec 22 13:48:10 2004 | 10 | 2 | 18 | Wed Dec 22 15:03:56 ... |
| # 10 | 82 | 14 | 246 | Thu Dec 23 12:04:47 2004 | 9 | 2 | 16 | Thu Dec 23 12:04:47 2... |
| # 11 | 85 | 13 | 176 | Thu Dec 23 13:29:01 2004 | 10 | 3 | 20 | Thu Dec 23 13:29:01 2... |
| # 12 | 63 | 13 | 125 | Thu Dec 23 17:35:39 2004 | 7 | 2 | 10 | Thu Dec 23 17:22:28 2... |
| # 13 | 266 | 13 | 1,131 | Sun Dec 26 12:52:56 2004 | 36 | 2 | 411 | Sun Dec 26 13:05:56 2... |
| # 14 | 82 | 15 | 170 | Mon Jan 3 02:41:18 2005 | 9 | 2 | 84 | Thu Dec 30 19:57:03 2... |
| # 15 | 1,186 | 29 | 4,381 | Tue Jan 4 03:52:13 2005 | 96 | 5 | 1,389 | Tue Jan 4 01:52:34 20... |
| # 16 | 444 | 25 | 1,458 | Tue Jan 4 14:33:11 2005 | 58 | 4 | 497 | Tue Jan 4 14:08:24 20... |
| # 17 | 235 | 14 | 1,059 | Tue Jan 4 16:52:39 2005 | 33 | 2 | 269 | Tue Jan 4 16:54:45 20... |
| # 18 | 99 | 31 | 277 | Fri Jan 7 15:17:09 2005 | 13 | 7 | 40 | Fri Jan 7 15:17:01 2005 |
| # 19 | 259 | 13 | 1,117 | Sat Jan 8 00:09:27 2005 | 47 | 2 | 963 | Sat Jan 8 00:03:44 2005 |
| # 20 | 66 | 13 | 152 | Sat Jan 8 00:46:11 2005 | 7 | 2 | 13 | Sat Jan 8 00:46:11 2005 |
| # 21 | 427 | 13 | 1,886 | Sat Jan 8 04:02:36 2005 | 40 | 2 | 546 | Sat Jan 8 04:41:00 2005 |
| # 22 | 450 | 25 | 1,856 | Sat Jan 8 14:08:31 2005 | 55 | 4 | 919 | Sat Jan 8 12:56:37 2005 |
| # 23 | 469 | 14 | 2,361 | Tue Jan 11 14:28:28 2005 | 72 | 2 | 753 | Tue Jan 11 14:54:24 2... |

- AF Summary by clicking on Analysis->AF Summary

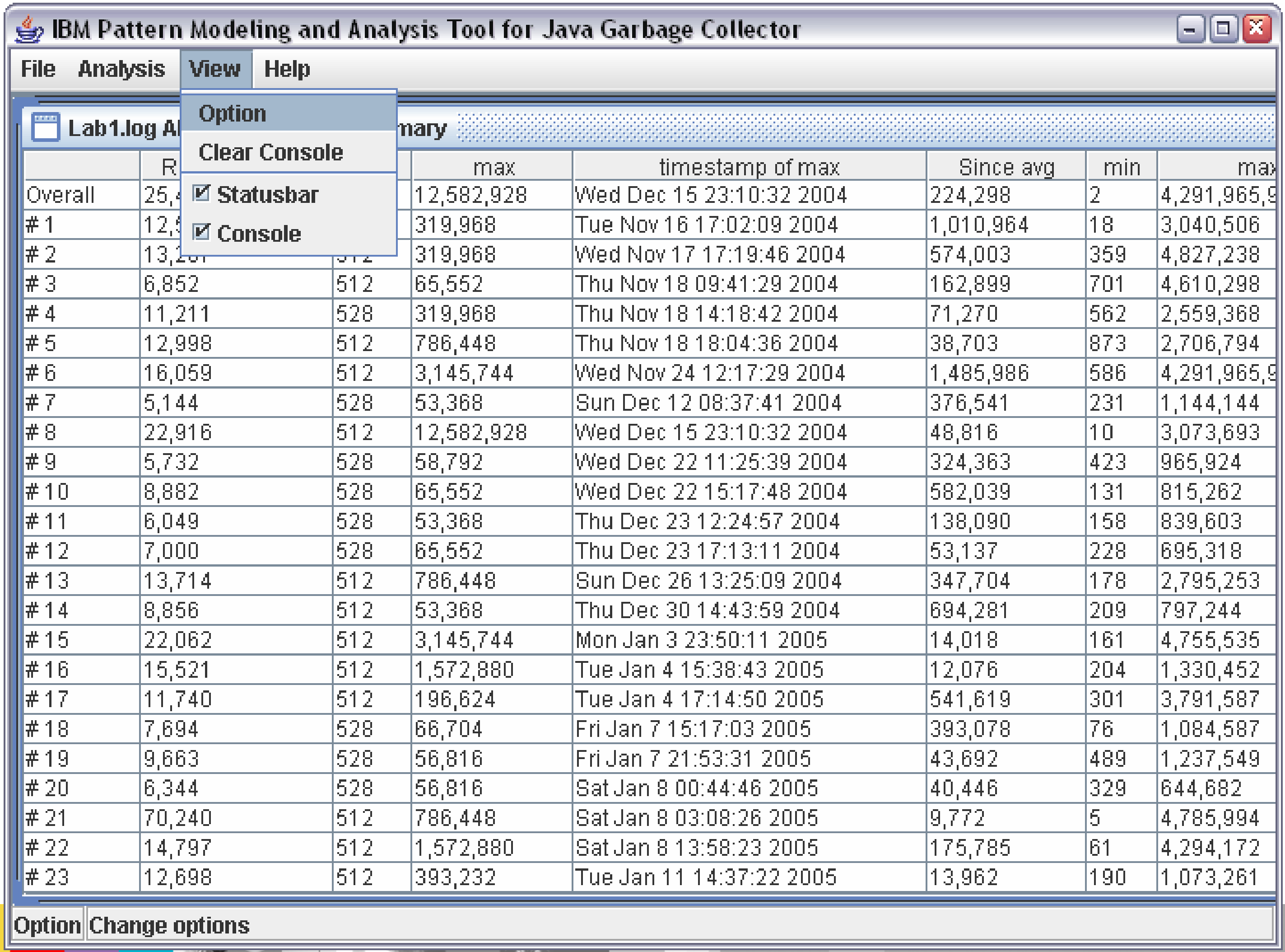
# AF Summary


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
Lab1.log Allocation Failure Summary
Allocation Failure

|  | Requested avg | min | max | timestamp of max | Since avg | min | max |
|---|---|---|---|---|---|---|---|
| Overall | 25,427 | 512 | 12,582,928 | Wed Dec 15 23:10:32 2004 | 224,298 | 2 | 4,291,965,9 |
| # 1 | 12,537 | 528 | 319,968 | Tue Nov 16 17:02:09 2004 | 1,010,964 | 18 | 3,040,506 |
| # 2 | 13,207 | 512 | 319,968 | Wed Nov 17 17:19:46 2004 | 574,003 | 359 | 4,827,238 |
| # 3 | 6,852 | 512 | 65,552 | Thu Nov 18 09:41:29 2004 | 162,899 | 701 | 4,610,298 |
| # 4 | 11,211 | 528 | 319,968 | Thu Nov 18 14:18:42 2004 | 71,270 | 562 | 2,559,368 |
| # 5 | 12,998 | 512 | 786,448 | Thu Nov 18 18:04:36 2004 | 38,703 | 873 | 2,706,794 |
| # 6 | 16,059 | 512 | 3,145,744 | Wed Nov 24 12:17:29 2004 | 1,485,986 | 586 | 4,291,965,9 |
| # 7 | 5,144 | 528 | 53,368 | Sun Dec 12 08:37:41 2004 | 376,541 | 231 | 1,144,144 |
| # 8 | 22,916 | 512 | 12,582,928 | Wed Dec 15 23:10:32 2004 | 48,816 | 10 | 3,073,693 |
| # 9 | 5,732 | 528 | 58,792 | Wed Dec 22 11:25:39 2004 | 324,363 | 423 | 965,924 |
| # 10 | 8,882 | 528 | 65,552 | Wed Dec 22 15:17:48 2004 | 582,039 | 131 | 815,262 |
| # 11 | 6,049 | 528 | 53,368 | Thu Dec 23 12:24:57 2004 | 138,090 | 158 | 839,603 |
| # 12 | 7,000 | 528 | 65,552 | Thu Dec 23 17:13:11 2004 | 53,137 | 228 | 695,318 |
| # 13 | 13,714 | 512 | 786,448 | Sun Dec 26 13:25:09 2004 | 347,704 | 178 | 2,795,253 |
| # 14 | 8,856 | 512 | 53,368 | Thu Dec 30 14:43:59 2004 | 694,281 | 209 | 797,244 |
| # 15 | 22,062 | 512 | 3,145,744 | Mon Jan 3 23:50:11 2005 | 14,018 | 161 | 4,755,535 |
| # 16 | 15,521 | 512 | 1,572,880 | Tue Jan 4 15:38:43 2005 | 12,076 | 204 | 1,330,452 |
| # 17 | 11,740 | 512 | 196,624 | Tue Jan 4 17:14:50 2005 | 541,619 | 301 | 3,791,587 |
| # 18 | 7,694 | 528 | 66,704 | Fri Jan 7 15:17:03 2005 | 393,078 | 76 | 1,084,587 |
| # 19 | 9,663 | 528 | 56,816 | Fri Jan 7 21:53:31 2005 | 43,692 | 489 | 1,237,549 |
| # 20 | 6,344 | 528 | 56,816 | Sat Jan 8 00:44:46 2005 | 40,446 | 329 | 644,682 |
| # 21 | 70,240 | 512 | 786,448 | Sat Jan 8 03:08:26 2005 | 9,772 | 5 | 4,785,994 |
| # 22 | 14,797 | 512 | 1,572,880 | Sat Jan 8 13:58:23 2005 | 175,785 | 61 | 4,294,172 |
| # 23 | 12,698 | 512 | 393,232 | Tue Jan 11 14:37:22 2005 | 13,962 | 190 | 1,073,261 |

- Display usage summary by clicking on Analysis->Usage Summary

# Option



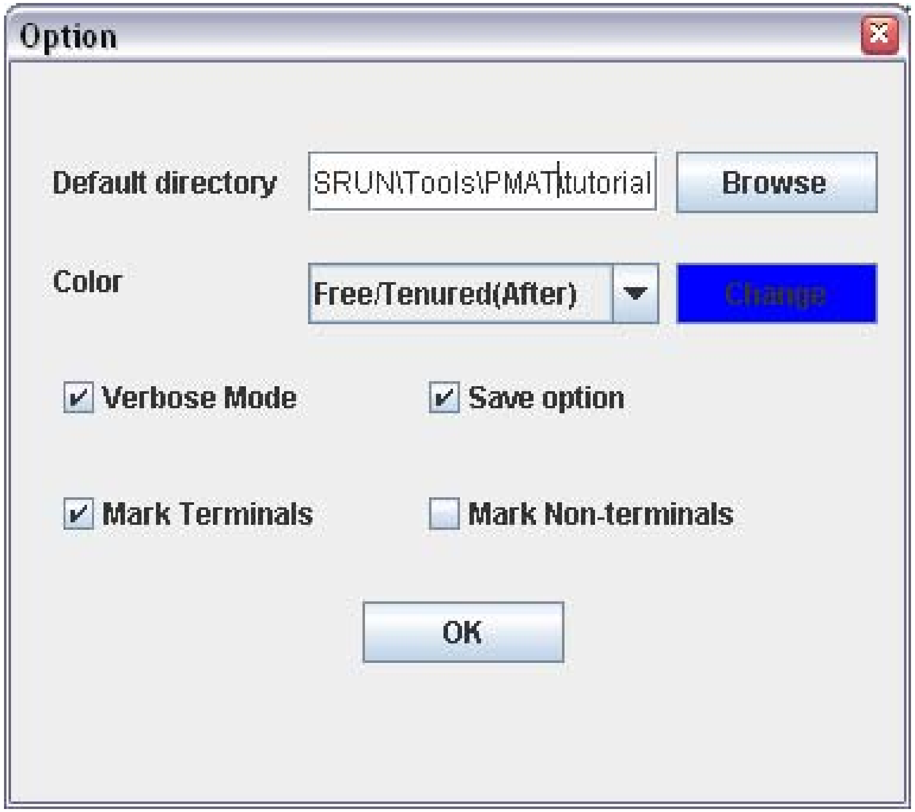
| | R | | max | timestamp of max | Since avg | min | ma |
|---|---|---|---|---|---|---|---|
| Overall | 25, | | 12,582,928 | Wed Dec 15 23:10:32 2004 | 224,298 | 2 | 4,291,965, |
| # 1 | 12, | | 319,968 | Tue Nov 16 17:02:09 2004 | 1,010,964 | 18 | 3,040,506 |
| # 2 | 13, | 512 | 319,968 | Wed Nov 17 17:19:46 2004 | 574,003 | 359 | 4,827,238 |
| # 3 | 6,852 | 512 | 65,552 | Thu Nov 18 09:41:29 2004 | 162,899 | 701 | 4,610,298 |
| # 4 | 11,211 | 528 | 319,968 | Thu Nov 18 14:18:42 2004 | 71,270 | 562 | 2,559,368 |
| # 5 | 12,998 | 512 | 786,448 | Thu Nov 18 18:04:36 2004 | 38,703 | 873 | 2,706,794 |
| # 6 | 16,059 | 512 | 3,145,744 | Wed Nov 24 12:17:29 2004 | 1,485,986 | 586 | 4,291,965, |
| # 7 | 5,144 | 528 | 53,368 | Sun Dec 12 08:37:41 2004 | 376,541 | 231 | 1,144,144 |
| # 8 | 22,916 | 512 | 12,582,928 | Wed Dec 15 23:10:32 2004 | 48,816 | 10 | 3,073,693 |
| # 9 | 5,732 | 528 | 58,792 | Wed Dec 22 11:25:39 2004 | 324,363 | 423 | 965,924 |
| # 10 | 8,882 | 528 | 65,552 | Wed Dec 22 15:17:48 2004 | 582,039 | 131 | 815,262 |
| # 11 | 6,049 | 528 | 53,368 | Thu Dec 23 12:24:57 2004 | 138,090 | 158 | 839,603 |
| # 12 | 7,000 | 528 | 65,552 | Thu Dec 23 17:13:11 2004 | 53,137 | 228 | 695,318 |
| # 13 | 13,714 | 512 | 786,448 | Sun Dec 26 13:25:09 2004 | 347,704 | 178 | 2,795,253 |
| # 14 | 8,856 | 512 | 53,368 | Thu Dec 30 14:43:59 2004 | 694,281 | 209 | 797,244 |
| # 15 | 22,062 | 512 | 3,145,744 | Mon Jan 3 23:50:11 2005 | 14,018 | 161 | 4,755,535 |
| # 16 | 15,521 | 512 | 1,572,880 | Tue Jan 4 15:38:43 2005 | 12,076 | 204 | 1,330,452 |
| # 17 | 11,740 | 512 | 196,624 | Tue Jan 4 17:14:50 2005 | 541,619 | 301 | 3,791,587 |
| # 18 | 7,694 | 528 | 66,704 | Fri Jan 7 15:17:03 2005 | 393,078 | 76 | 1,084,587 |
| # 19 | 9,663 | 528 | 56,816 | Fri Jan 7 21:53:31 2005 | 43,692 | 489 | 1,237,549 |
| # 20 | 6,344 | 528 | 56,816 | Sat Jan 8 00:44:46 2005 | 40,446 | 329 | 644,682 |
| # 21 | 70,240 | 512 | 786,448 | Sat Jan 8 03:08:26 2005 | 9,772 | 5 | 4,785,994 |
| # 22 | 14,797 | 512 | 1,572,880 | Sat Jan 8 13:58:23 2005 | 175,785 | 61 | 4,294,172 |
| # 23 | 12,698 | 512 | 393,232 | Tue Jan 11 14:37:22 2005 | 13,962 | 190 | 1,073,261 |

Option | Change options

- Display option by clicking on View->Option

# Option

- You can change default directory as well as the following settings:
- Verbose Mode: display messages in console
- Save option: Saves options to configuration file during exit
- Mark Terminals: Mark points of start/end
- Mark non-terminals: Mark points except for start and end



Option

Default directory: SRUN\Tools\PMAT\tutorial

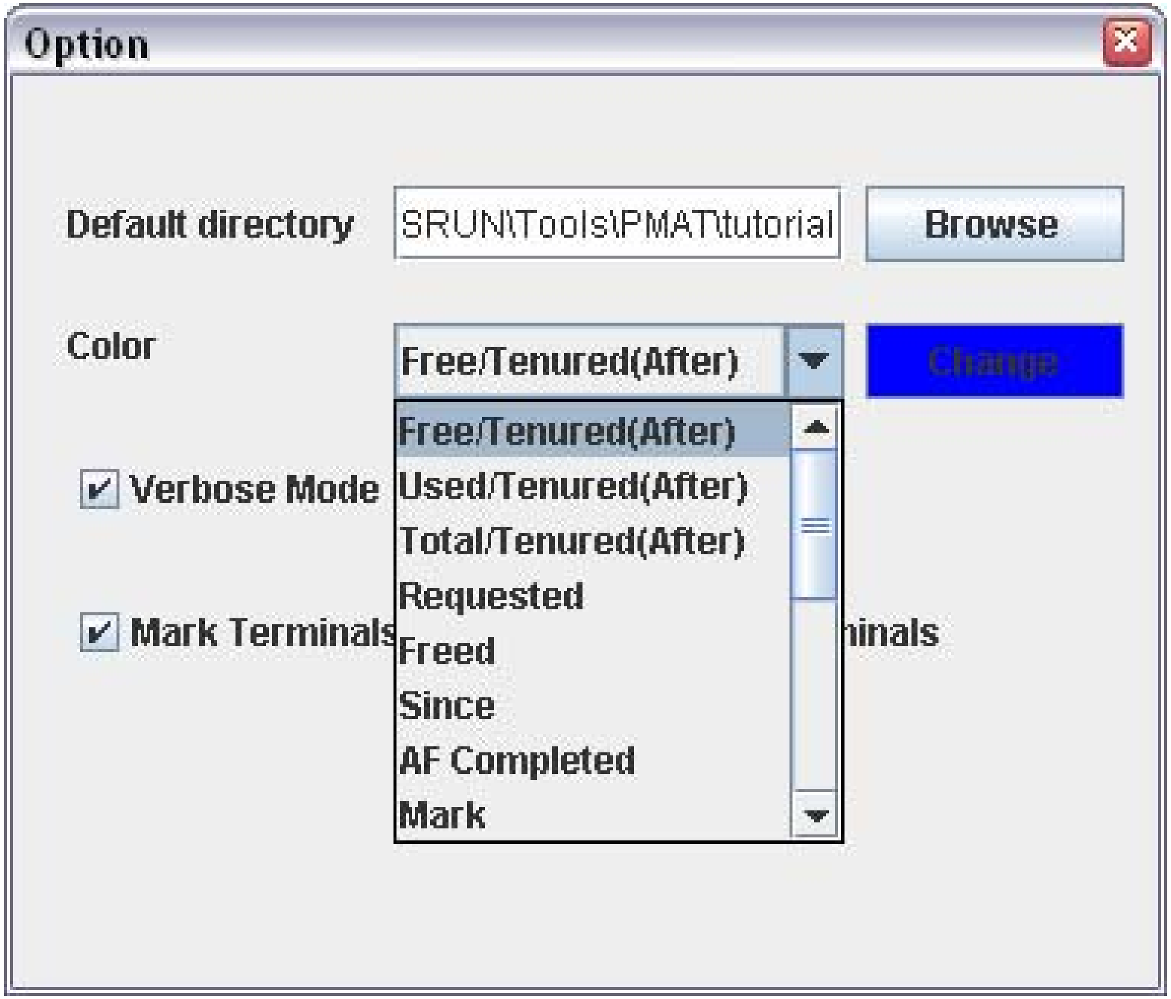
Color: Free/Tenured(After)

☑ Verbose Mode ☑ Save option

☑ Mark Terminals ☐ Mark Non-terminals

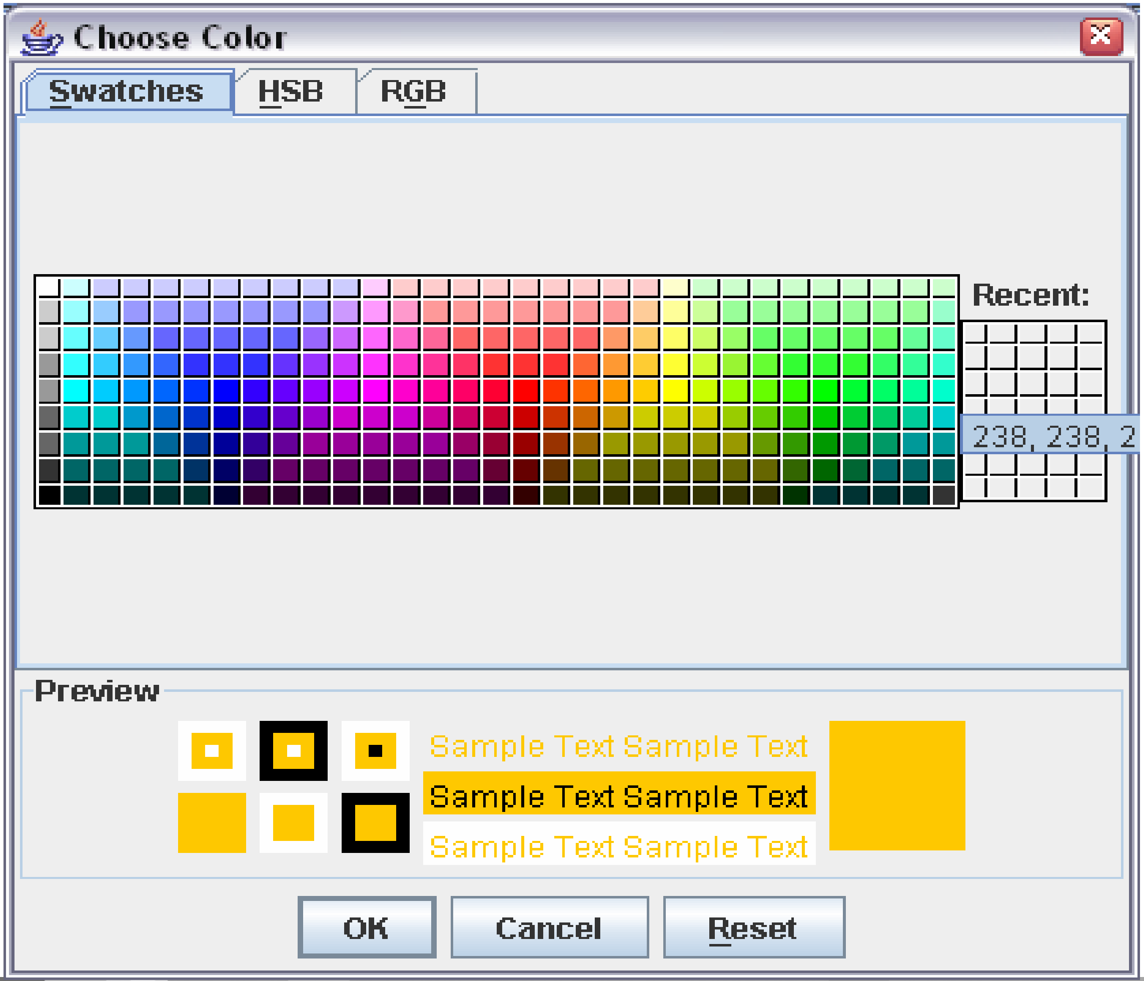
# Option

- You can also change color of chart

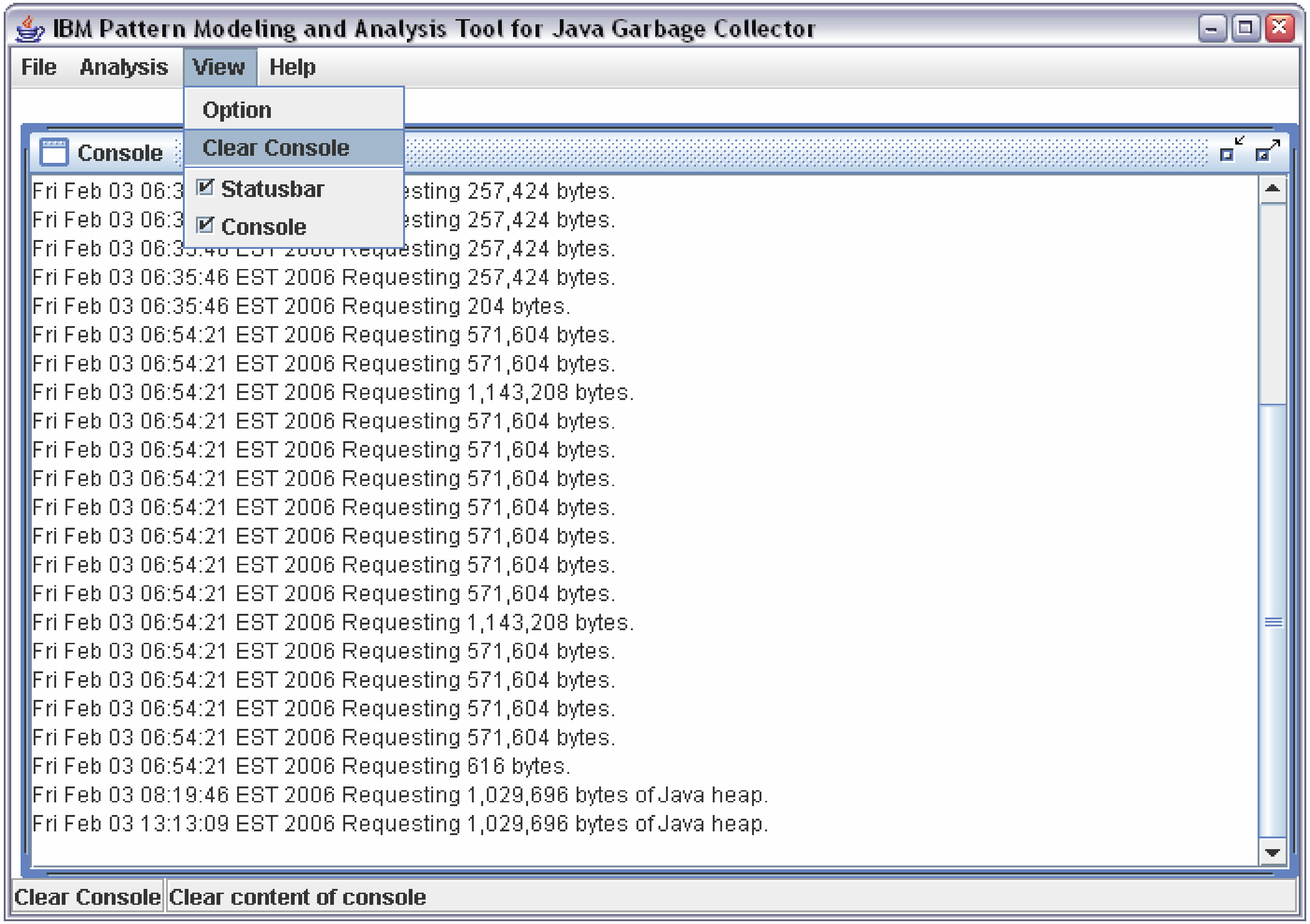


# Option

- You can also change color of chart



# Clear Console

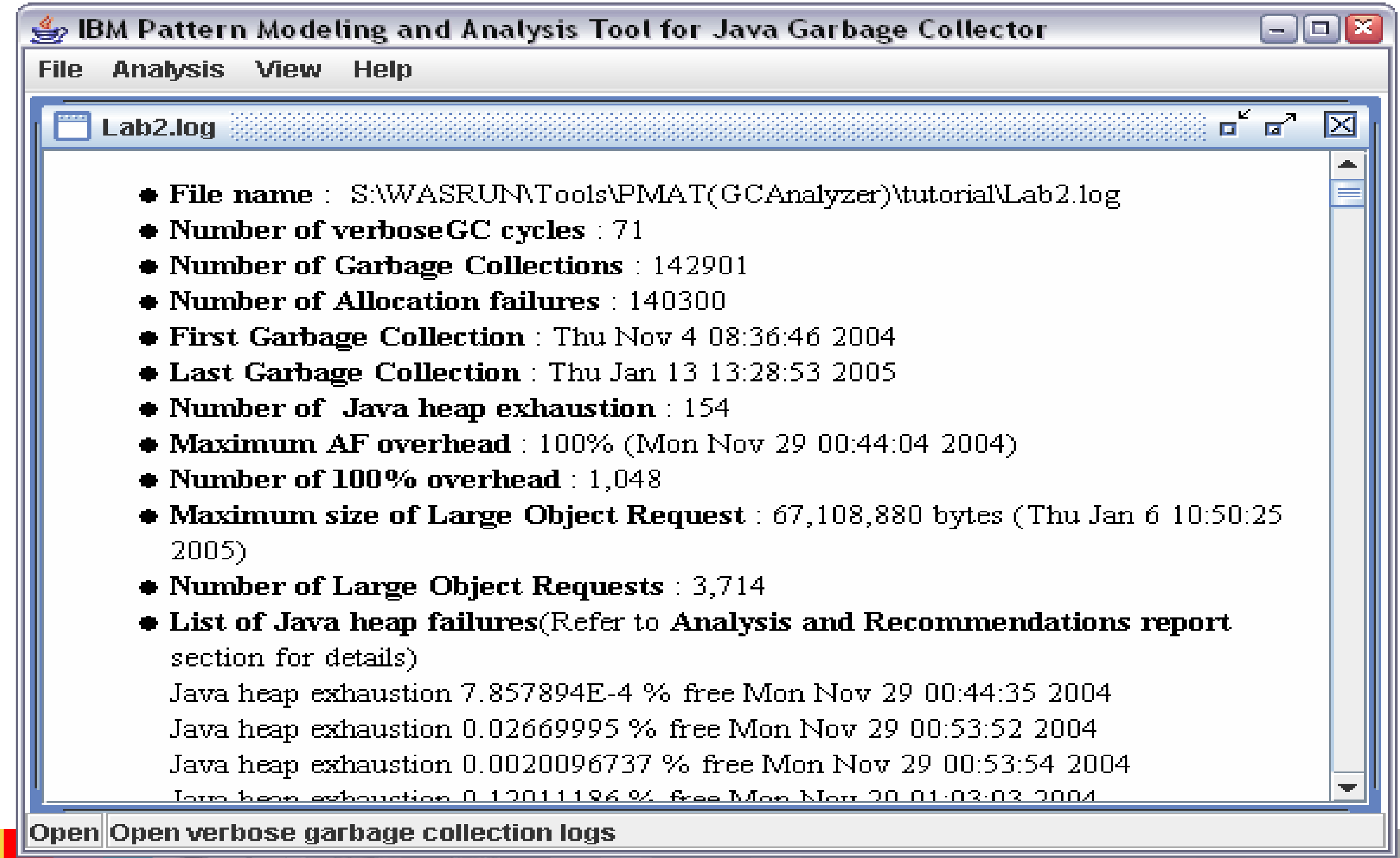


```
Fri Feb 03 06:3                    esting 257,424 bytes.
Fri Feb 03 06:3                    esting 257,424 bytes.
Fri Feb 03 06:3                    esting 257,424 bytes.
Fri Feb 03 06:35:46 EST 2006 Requesting 257,424 bytes.
Fri Feb 03 06:35:46 EST 2006 Requesting 204 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 1,143,208 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 1,143,208 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 571,604 bytes.
Fri Feb 03 06:54:21 EST 2006 Requesting 616 bytes.
Fri Feb 03 08:19:46 EST 2006 Requesting 1,029,696 bytes of Java heap.
Fri Feb 03 13:13:09 EST 2006 Requesting 1,029,696 bytes of Java heap.
```

Clear Console | Clear content of console

- You can clear logs in console by clicking on View->Clear Console

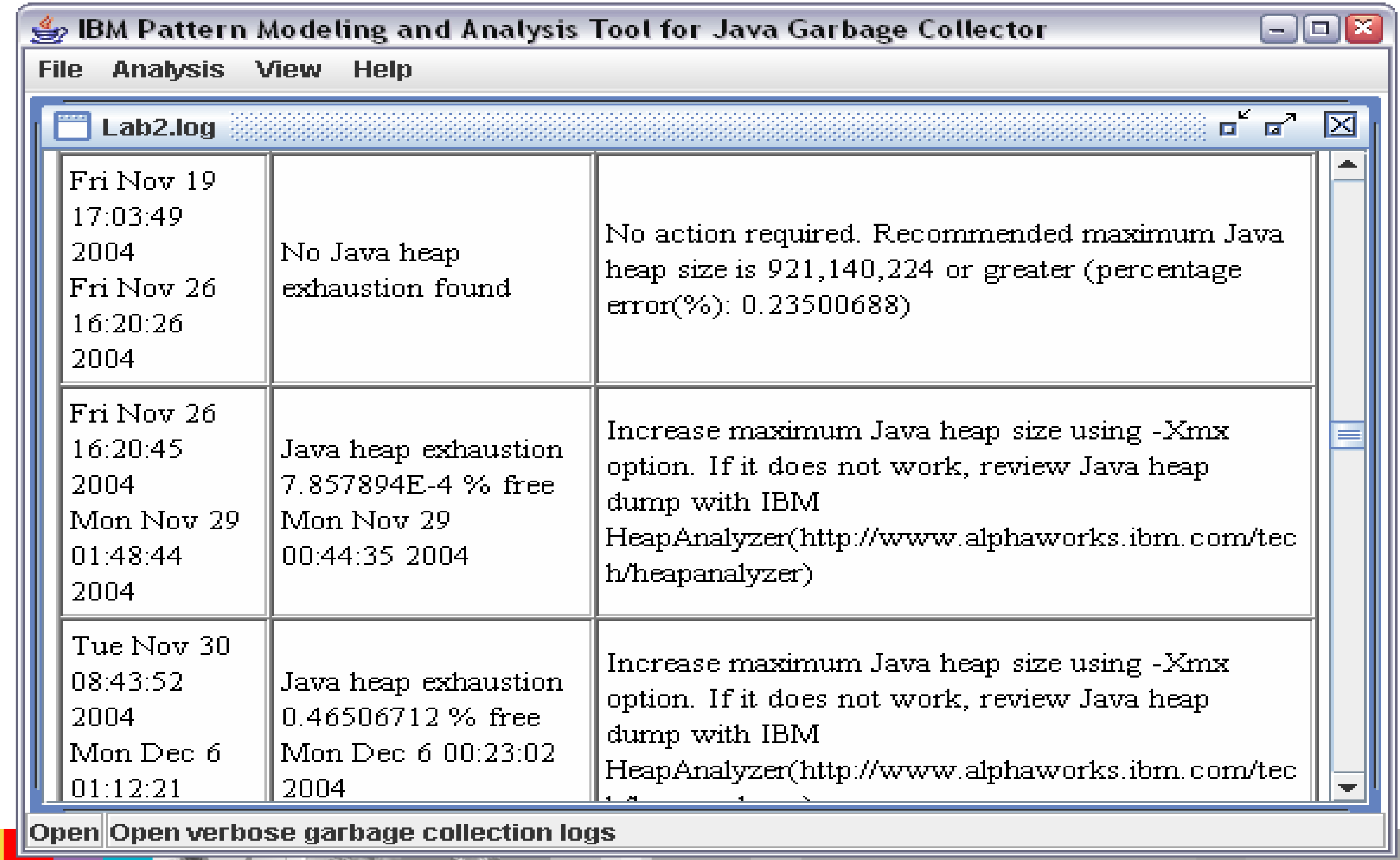
# Case Study I (1/8)


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
Lab2.log
Open
Open verbose garbage collection logs

- **File name** : S:\WASRUN\Tools\PMAT(GCAnalyzer)\tutorial\Lab2.log
- **Number of verboseGC cycles** : 71
- **Number of Garbage Collections** : 142901
- **Number of Allocation failures** : 140300
- **First Garbage Collection** : Thu Nov 4 08:36:46 2004
- **Last Garbage Collection** : Thu Jan 13 13:28:53 2005
- **Number of Java heap exhaustion** : 154
- **Maximum AF overhead** : 100% (Mon Nov 29 00:44:04 2004)
- **Number of 100% overhead** : 1,048
- **Maximum size of Large Object Request** : 67,108,880 bytes (Thu Jan 6 10:50:25 2005)
- **Number of Large Object Requests** : 3,714
- **List of Java heap failures**(Refer to **Analysis and Recommendations report** section for details)

  Java heap exhaustion 7.857894E-4 % free Mon Nov 29 00:44:35 2004
  Java heap exhaustion 0.02669995 % free Mon Nov 29 00:53:52 2004
  Java heap exhaustion 0.0020096737 % free Mon Nov 29 00:53:54 2004
  Java heap exhaustion 0.12011186 % free Mon Nov 29 01:03:03 2004

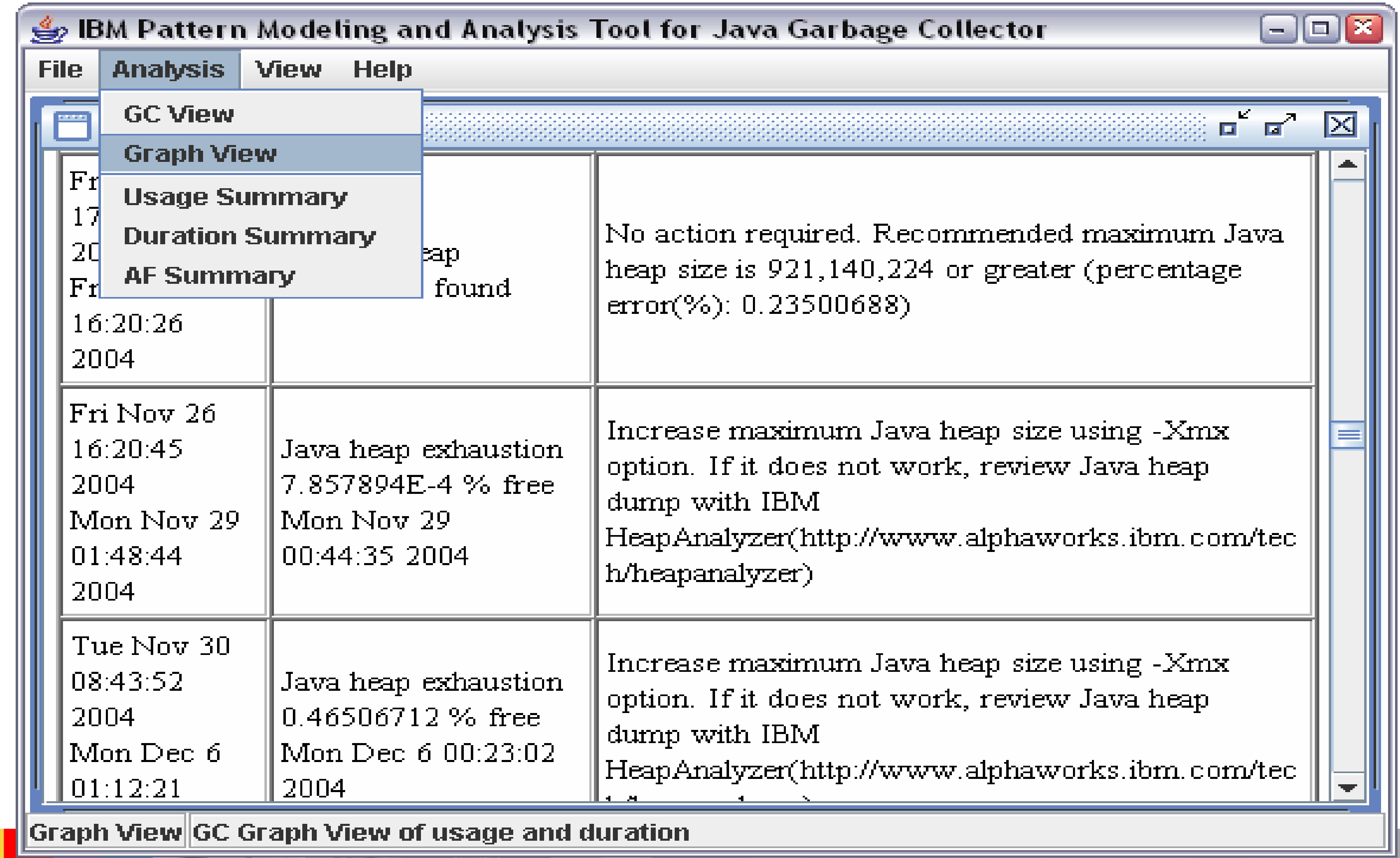
# Case Study I (2/8)


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
Lab2.log
Open

| | | |
|---|---|---|
| Fri Nov 19 17:03:49 2004<br>Fri Nov 26 16:20:26 2004 | No Java heap exhaustion found | No action required. Recommended maximum Java heap size is 921,140,224 or greater (percentage error(%): 0.23500688) |
| Fri Nov 26 16:20:45 2004<br>Mon Nov 29 01:48:44 2004 | Java heap exhaustion 7.857894E-4 % free Mon Nov 29 00:44:35 2004 | Increase maximum Java heap size using -Xmx option. If it does not work, review Java heap dump with IBM HeapAnalyzer(http://www.alphaworks.ibm.com/tech/heapanalyzer) |
| Tue Nov 30 08:43:52 2004<br>Mon Dec 6 01:12:21 | Java heap exhaustion 0.46506712 % free Mon Dec 6 00:23:02 2004 | Increase maximum Java heap size using -Xmx option. If it does not work, review Java heap dump with IBM HeapAnalyzer(http://www.alphaworks.ibm.com/tec |

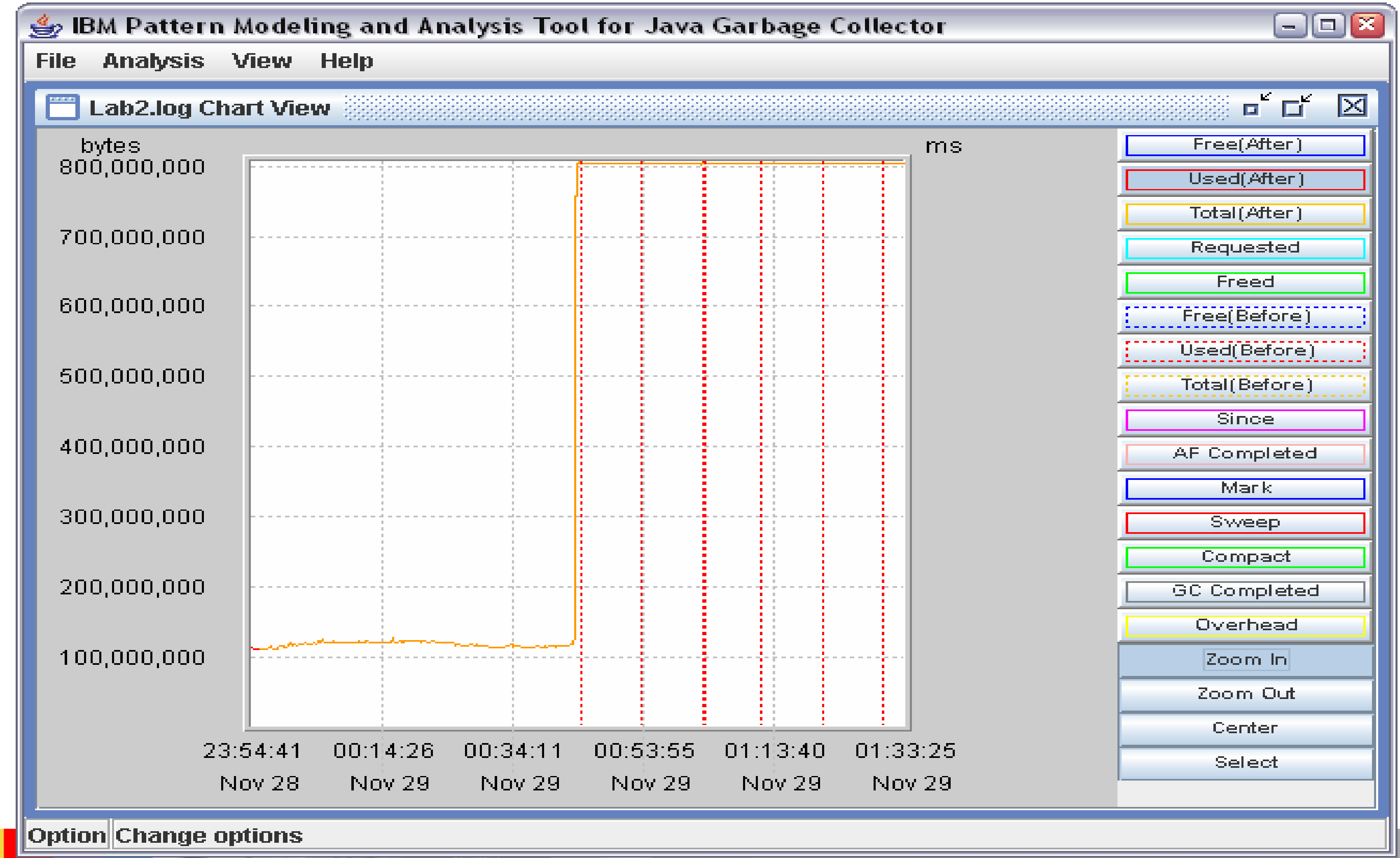
Open verbose garbage collection logs

# Case Study I (3/8)

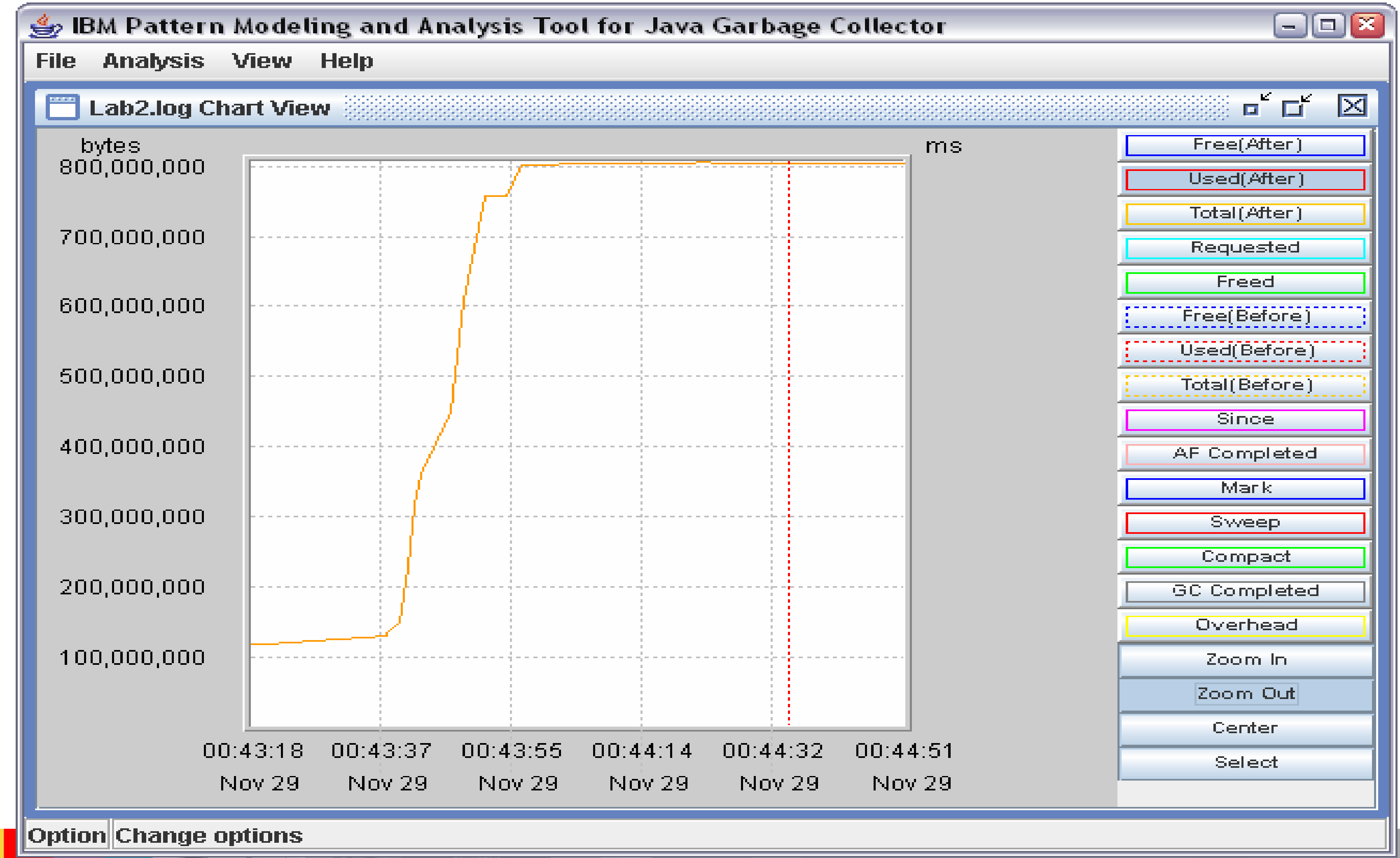

IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
GC View
Graph View
Usage Summary
Duration Summary
AF Summary
Graph View
GC Graph View of usage and duration

| | | |
|---|---|---|
| Fr<br>17<br>20<br>Fr<br>16:20:26<br>2004 | eap<br>found | No action required. Recommended maximum Java heap size is 921,140,224 or greater (percentage error(%): 0.23500688) |
| Fri Nov 26 16:20:45 2004<br>Mon Nov 29 01:48:44 2004 | Java heap exhaustion 7.857894E-4 % free<br>Mon Nov 29 00:44:35 2004 | Increase maximum Java heap size using -Xmx option. If it does not work, review Java heap dump with IBM HeapAnalyzer(http://www.alphaworks.ibm.com/tech/heapanalyzer) |
| Tue Nov 30 08:43:52 2004<br>Mon Dec 6 01:12:21 | Java heap exhaustion 0.46506712 % free<br>Mon Dec 6 00:23:02 2004 | Increase maximum Java heap size using -Xmx option. If it does not work, review Java heap dump with IBM HeapAnalyzer(http://www.alphaworks.ibm.com/tec |

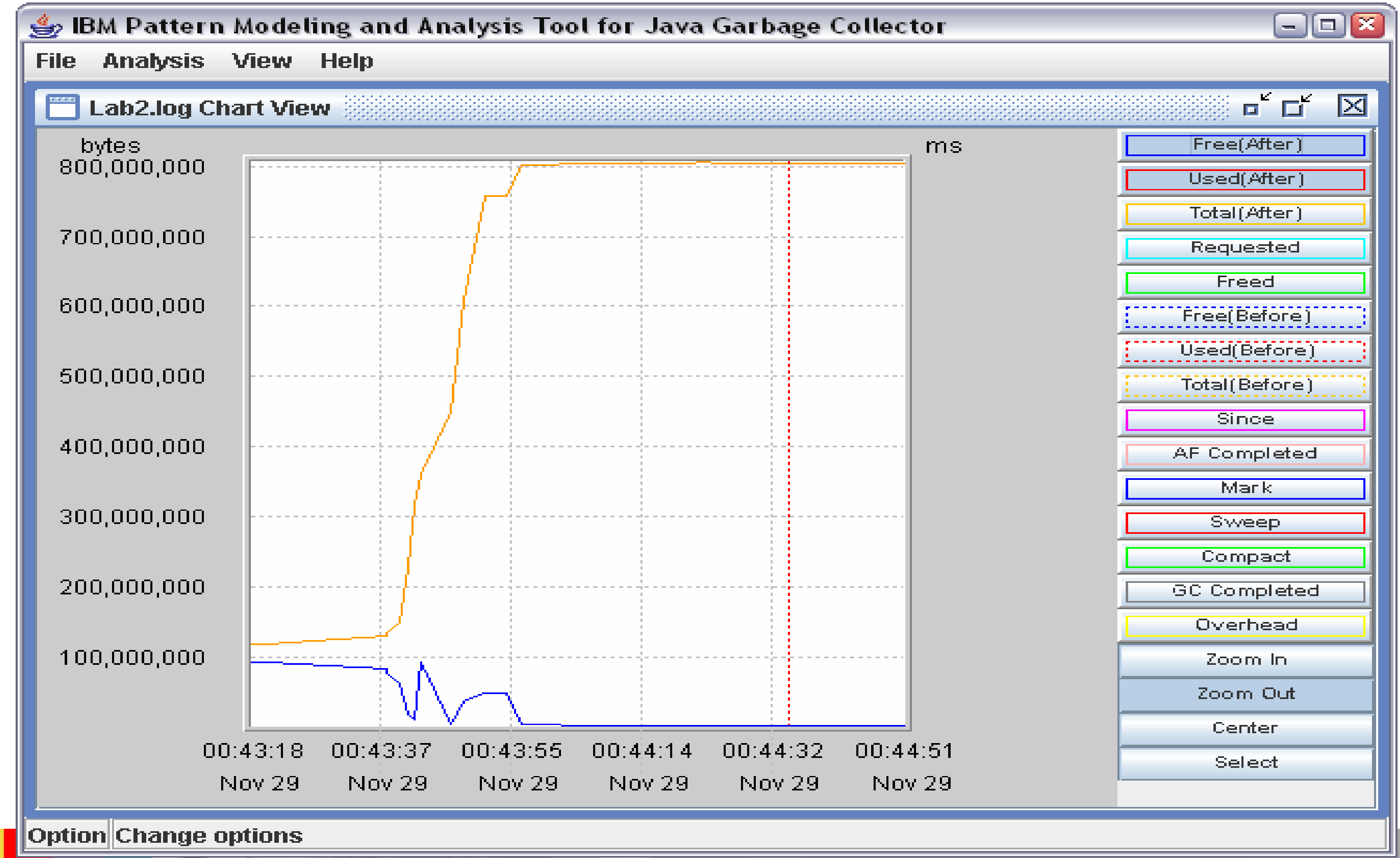
# Case Study I (4/8)



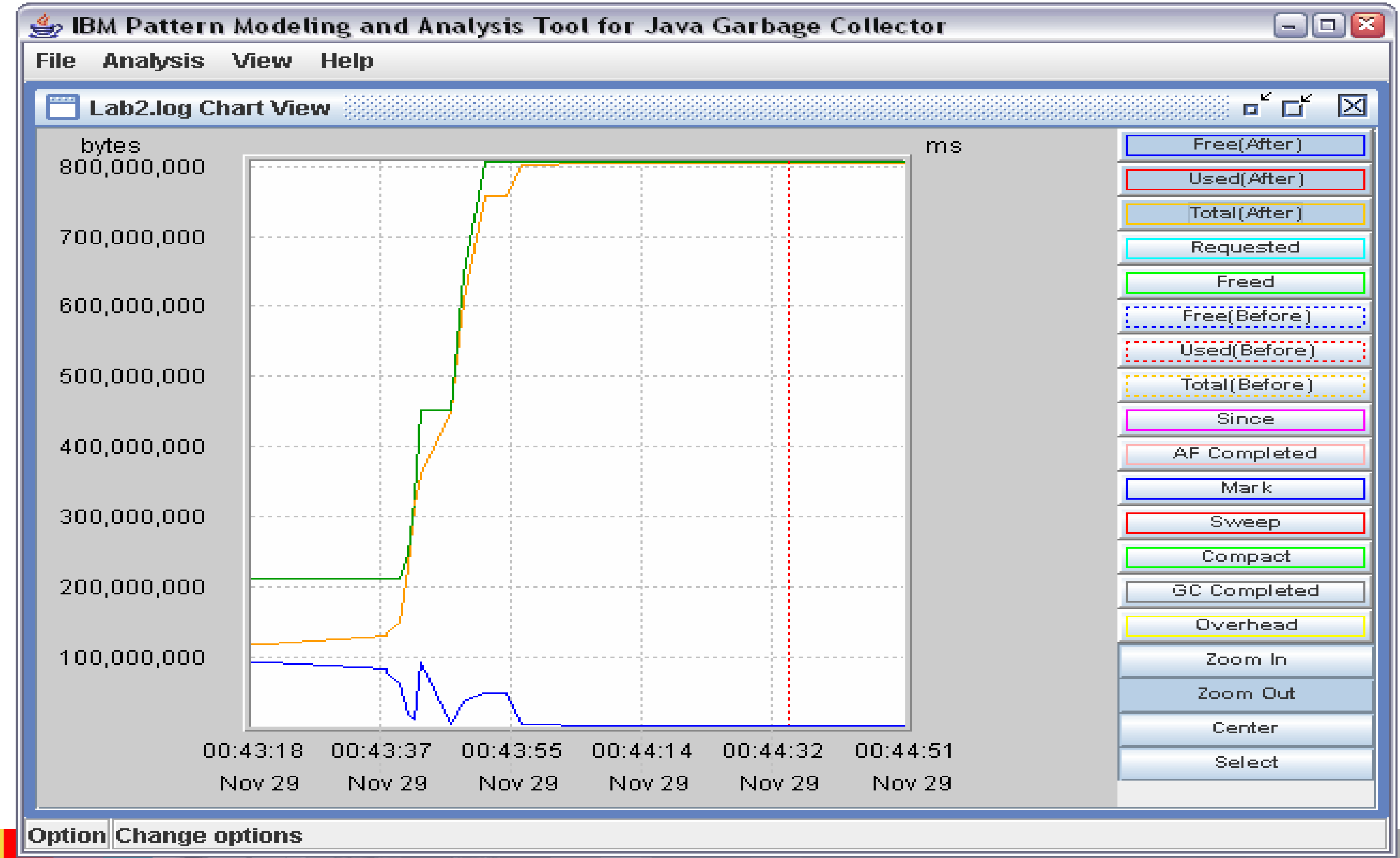
# Case Study I (5/8)



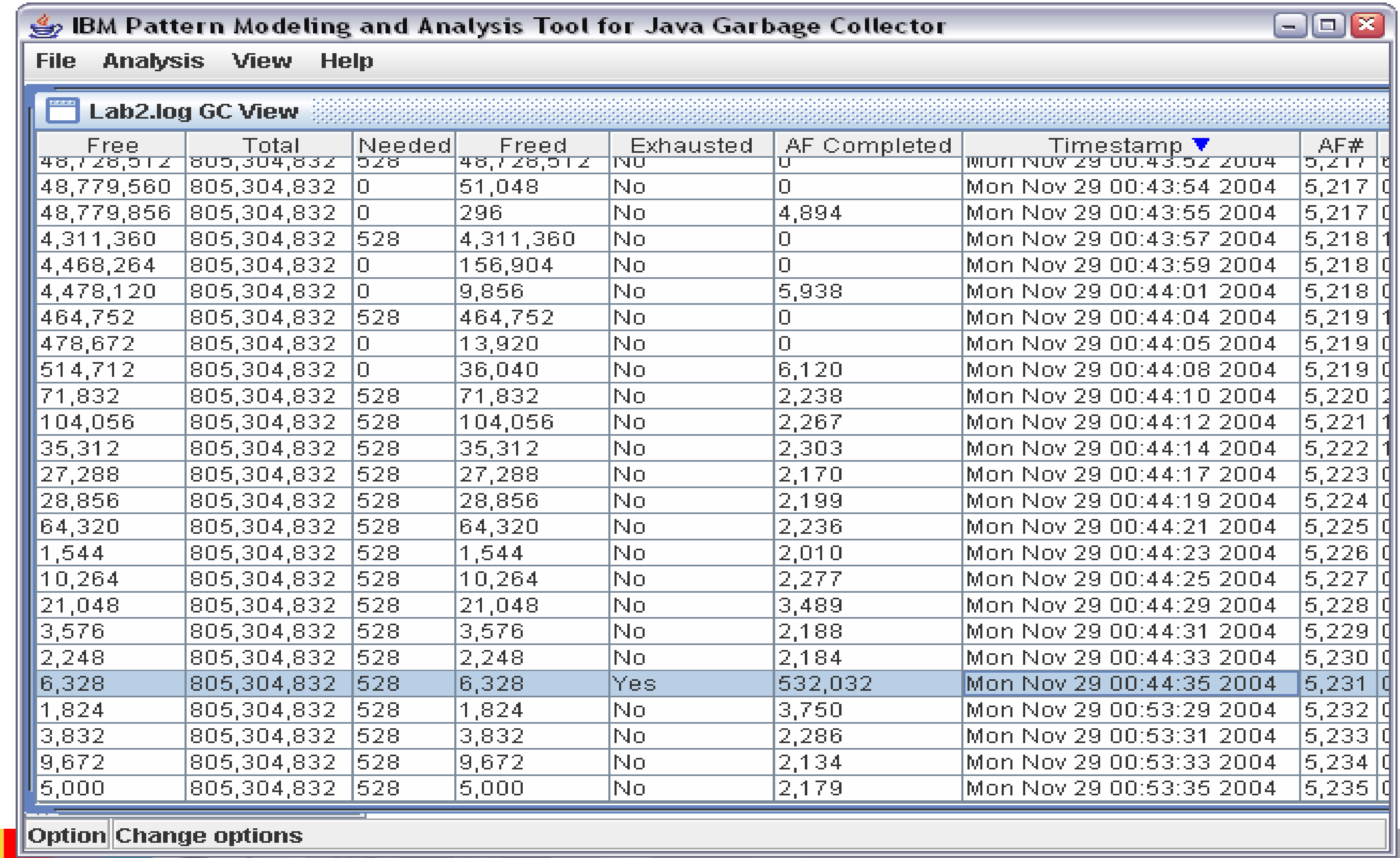
# Case Study I (6/8)



# Case Study I (7/8)

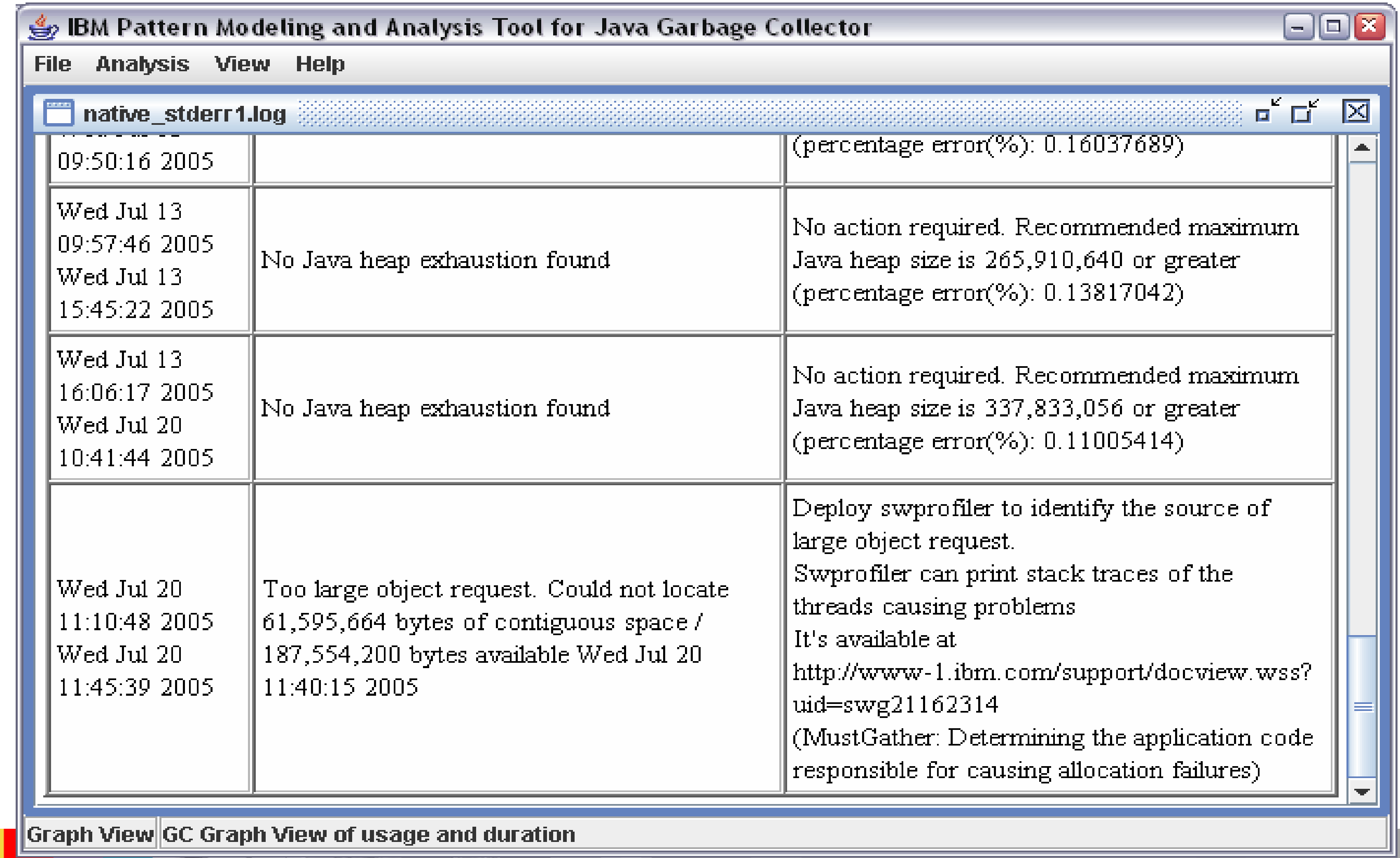


# Case Study I (8/8)


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
Lab2.log GC View
Option
Change options

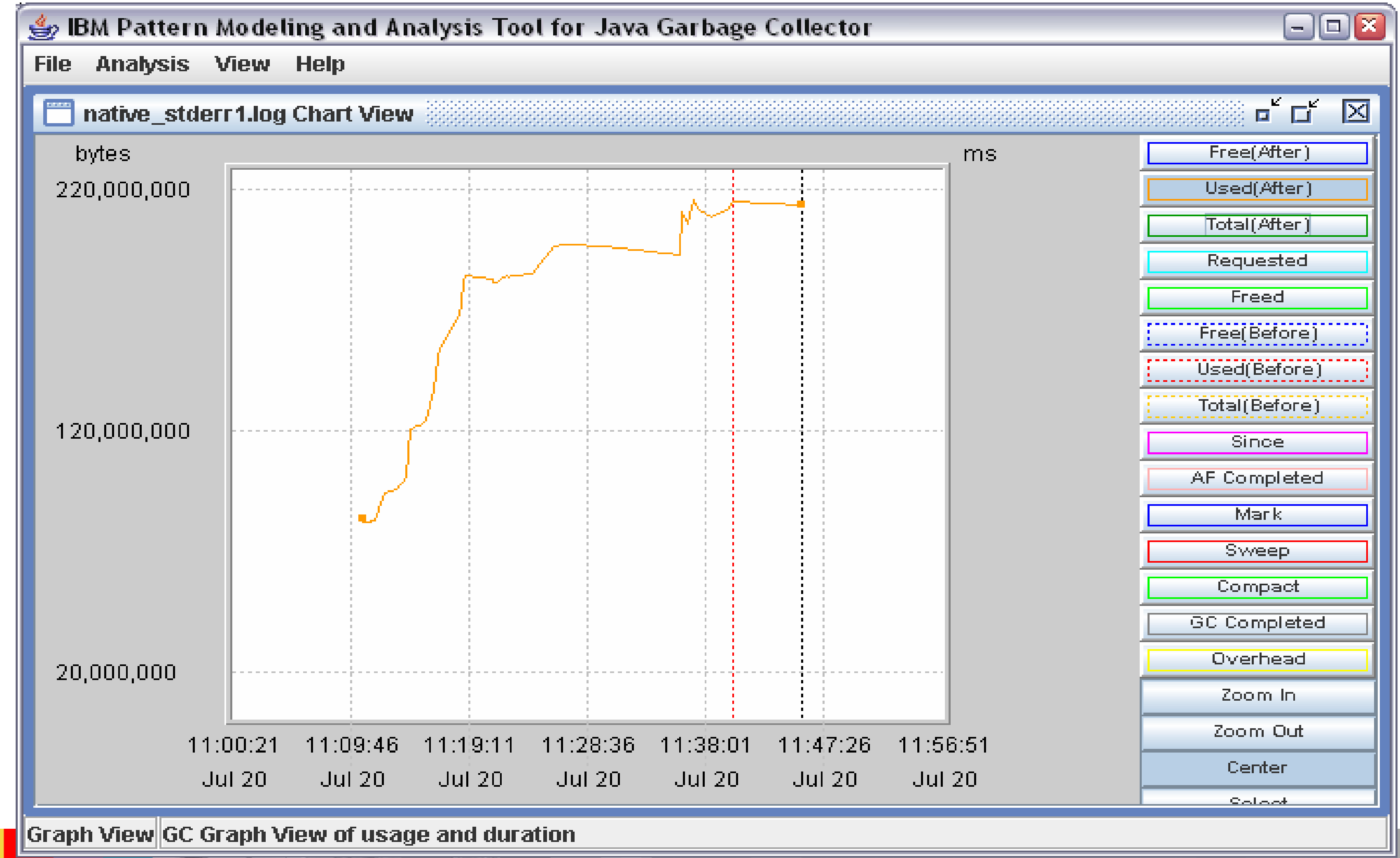
| Free | Total | Needed | Freed | Exhausted | AF Completed | Timestamp ▼ | AF# |
|---|---|---|---|---|---|---|---|
| 48,728,512 | 805,304,832 | 528 | 48,728,512 | No | 0 | Mon Nov 29 00:43:52 2004 | 5,217 |
| 48,779,560 | 805,304,832 | 0 | 51,048 | No | 0 | Mon Nov 29 00:43:54 2004 | 5,217 |
| 48,779,856 | 805,304,832 | 0 | 296 | No | 4,894 | Mon Nov 29 00:43:55 2004 | 5,217 |
| 4,311,360 | 805,304,832 | 528 | 4,311,360 | No | 0 | Mon Nov 29 00:43:57 2004 | 5,218 |
| 4,468,264 | 805,304,832 | 0 | 156,904 | No | 0 | Mon Nov 29 00:43:59 2004 | 5,218 |
| 4,478,120 | 805,304,832 | 0 | 9,856 | No | 5,938 | Mon Nov 29 00:44:01 2004 | 5,218 |
| 464,752 | 805,304,832 | 528 | 464,752 | No | 0 | Mon Nov 29 00:44:04 2004 | 5,219 |
| 478,672 | 805,304,832 | 0 | 13,920 | No | 0 | Mon Nov 29 00:44:05 2004 | 5,219 |
| 514,712 | 805,304,832 | 0 | 36,040 | No | 6,120 | Mon Nov 29 00:44:08 2004 | 5,219 |
| 71,832 | 805,304,832 | 528 | 71,832 | No | 2,238 | Mon Nov 29 00:44:10 2004 | 5,220 |
| 104,056 | 805,304,832 | 528 | 104,056 | No | 2,267 | Mon Nov 29 00:44:12 2004 | 5,221 |
| 35,312 | 805,304,832 | 528 | 35,312 | No | 2,303 | Mon Nov 29 00:44:14 2004 | 5,222 |
| 27,288 | 805,304,832 | 528 | 27,288 | No | 2,170 | Mon Nov 29 00:44:17 2004 | 5,223 |
| 28,856 | 805,304,832 | 528 | 28,856 | No | 2,199 | Mon Nov 29 00:44:19 2004 | 5,224 |
| 64,320 | 805,304,832 | 528 | 64,320 | No | 2,236 | Mon Nov 29 00:44:21 2004 | 5,225 |
| 1,544 | 805,304,832 | 528 | 1,544 | No | 2,010 | Mon Nov 29 00:44:23 2004 | 5,226 |
| 10,264 | 805,304,832 | 528 | 10,264 | No | 2,277 | Mon Nov 29 00:44:25 2004 | 5,227 |
| 21,048 | 805,304,832 | 528 | 21,048 | No | 3,489 | Mon Nov 29 00:44:29 2004 | 5,228 |
| 3,576 | 805,304,832 | 528 | 3,576 | No | 2,188 | Mon Nov 29 00:44:31 2004 | 5,229 |
| 2,248 | 805,304,832 | 528 | 2,248 | No | 2,184 | Mon Nov 29 00:44:33 2004 | 5,230 |
| 6,328 | 805,304,832 | 528 | 6,328 | Yes | 532,032 | Mon Nov 29 00:44:35 2004 | 5,231 |
| 1,824 | 805,304,832 | 528 | 1,824 | No | 3,750 | Mon Nov 29 00:53:29 2004 | 5,232 |
| 3,832 | 805,304,832 | 528 | 3,832 | No | 2,286 | Mon Nov 29 00:53:31 2004 | 5,233 |
| 9,672 | 805,304,832 | 528 | 9,672 | No | 2,134 | Mon Nov 29 00:53:33 2004 | 5,234 |
| 5,000 | 805,304,832 | 528 | 5,000 | No | 2,179 | Mon Nov 29 00:53:35 2004 | 5,235 |

# Case Study II (1/5)


IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
native_stderr1.log
Graph View
GC Graph View of usage and duration

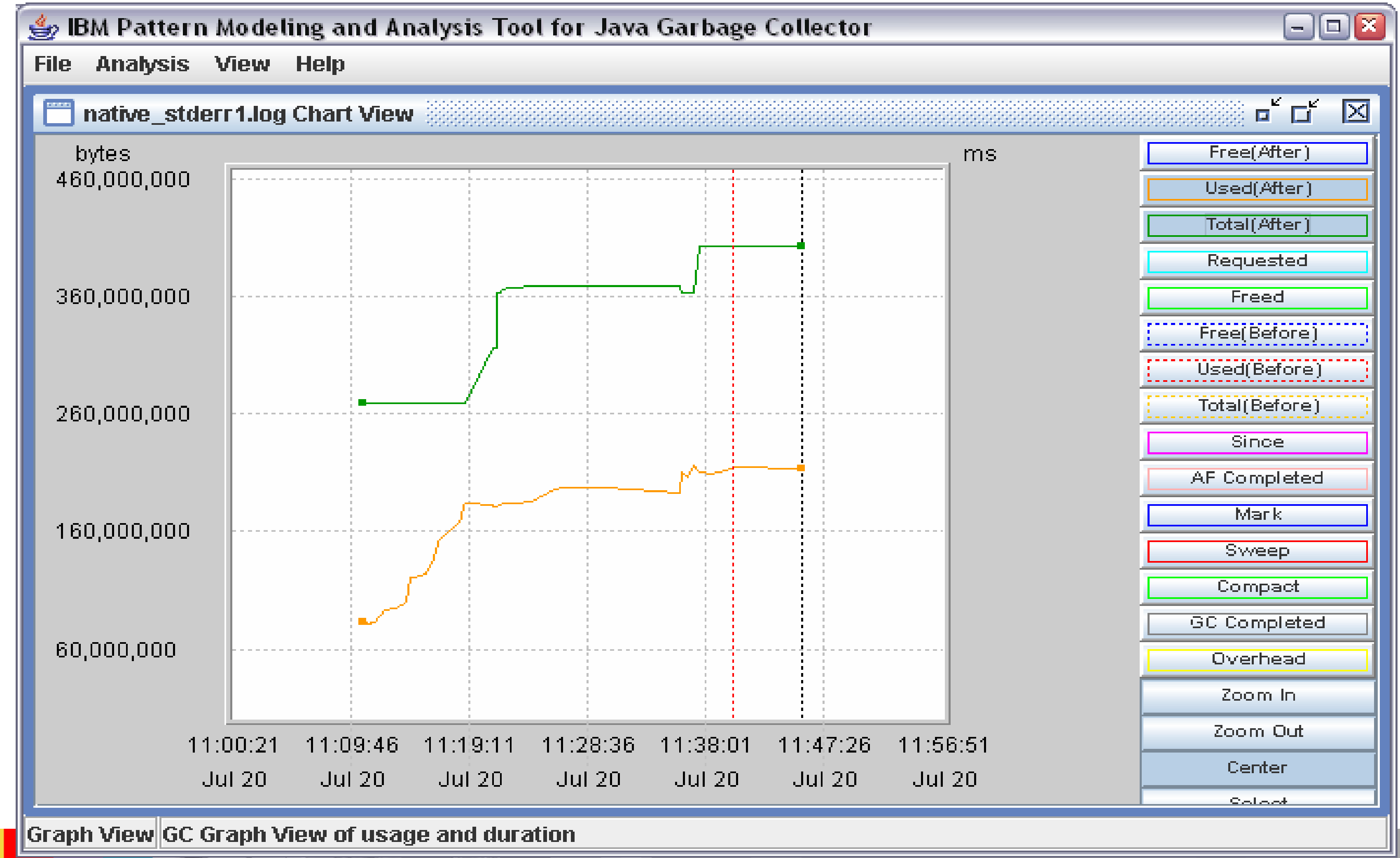
| | | |
|---|---|---|
| 09:50:16 2005 | | (percentage error(%): 0.16037689) |
| Wed Jul 13<br>09:57:46 2005<br>Wed Jul 13<br>15:45:22 2005 | No Java heap exhaustion found | No action required. Recommended maximum Java heap size is 265,910,640 or greater (percentage error(%): 0.13817042) |
| Wed Jul 13<br>16:06:17 2005<br>Wed Jul 20<br>10:41:44 2005 | No Java heap exhaustion found | No action required. Recommended maximum Java heap size is 337,833,056 or greater (percentage error(%): 0.11005414) |
| Wed Jul 20<br>11:10:48 2005<br>Wed Jul 20<br>11:45:39 2005 | Too large object request. Could not locate 61,595,664 bytes of contiguous space / 187,554,200 bytes available Wed Jul 20 11:40:15 2005 | Deploy swprofiler to identify the source of large object request.<br>Swprofiler can print stack traces of the threads causing problems<br>It's available at http://www-1.ibm.com/support/docview.wss?uid=swg21162314<br>(MustGather: Determining the application code responsible for causing allocation failures) |

# Case Study II (2/5)



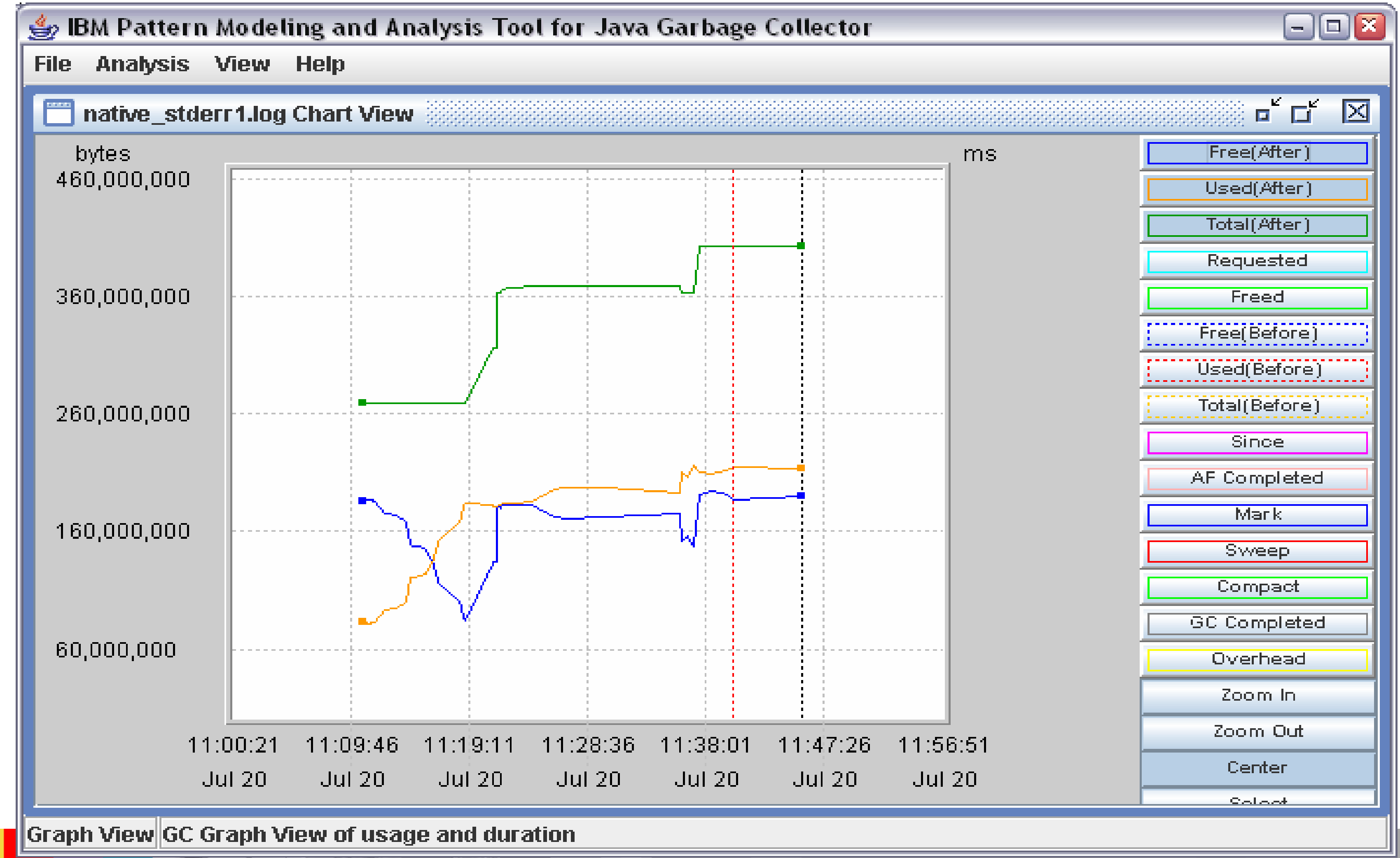
GC Graph View of usage and duration

# Case Study II (3/5)

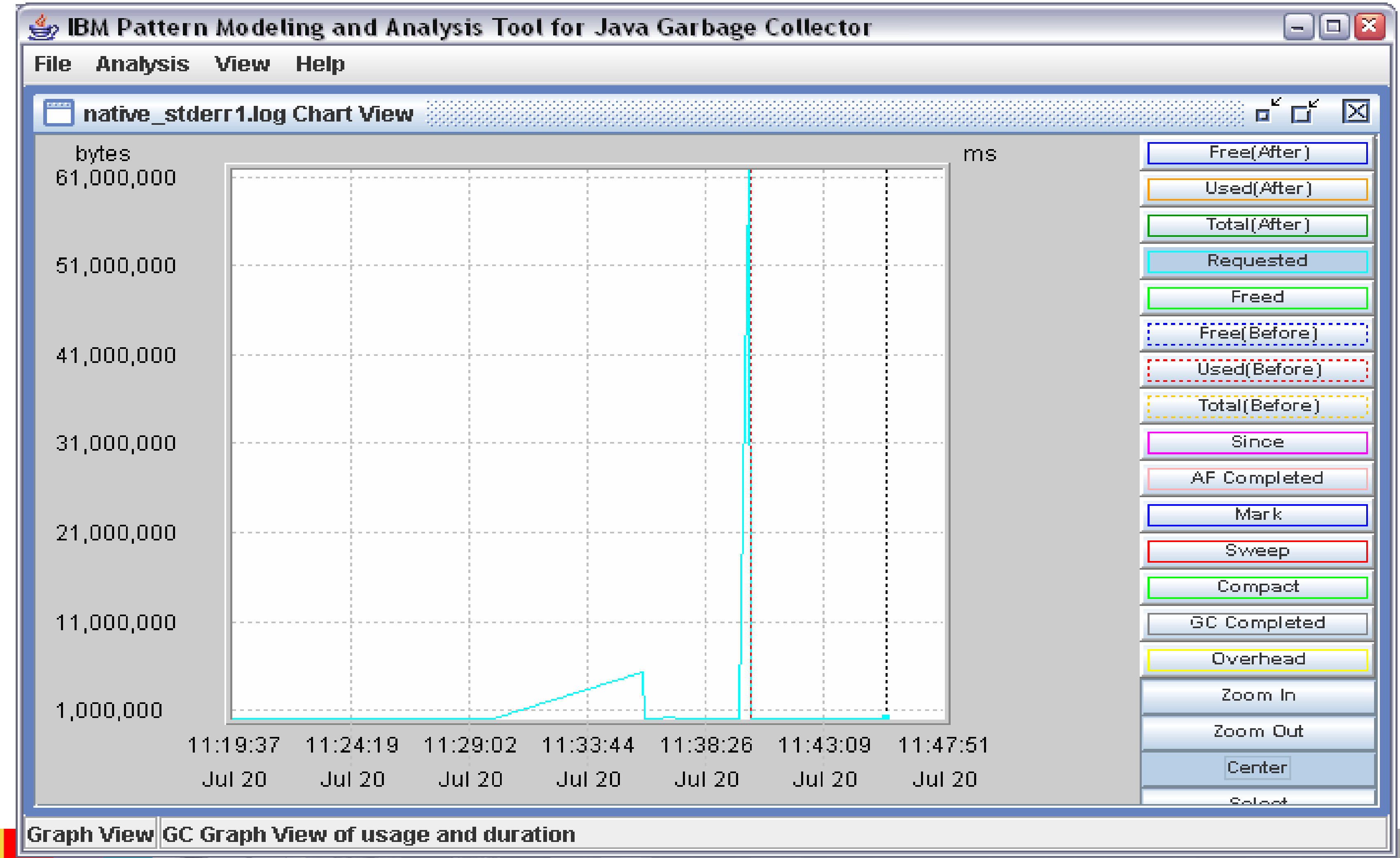


GC Graph View of usage and duration

# Case Study II (4/5)

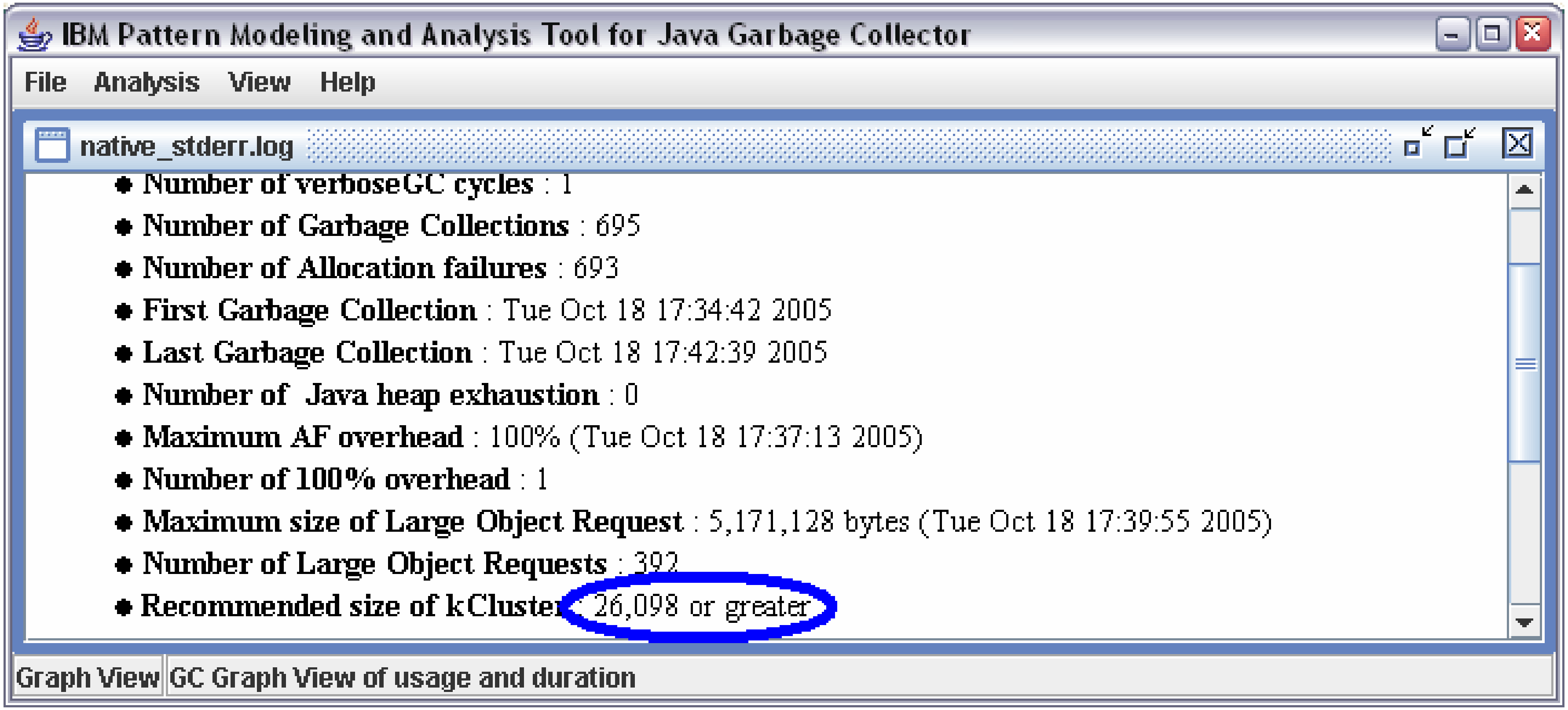


# Case Study II (5/5)



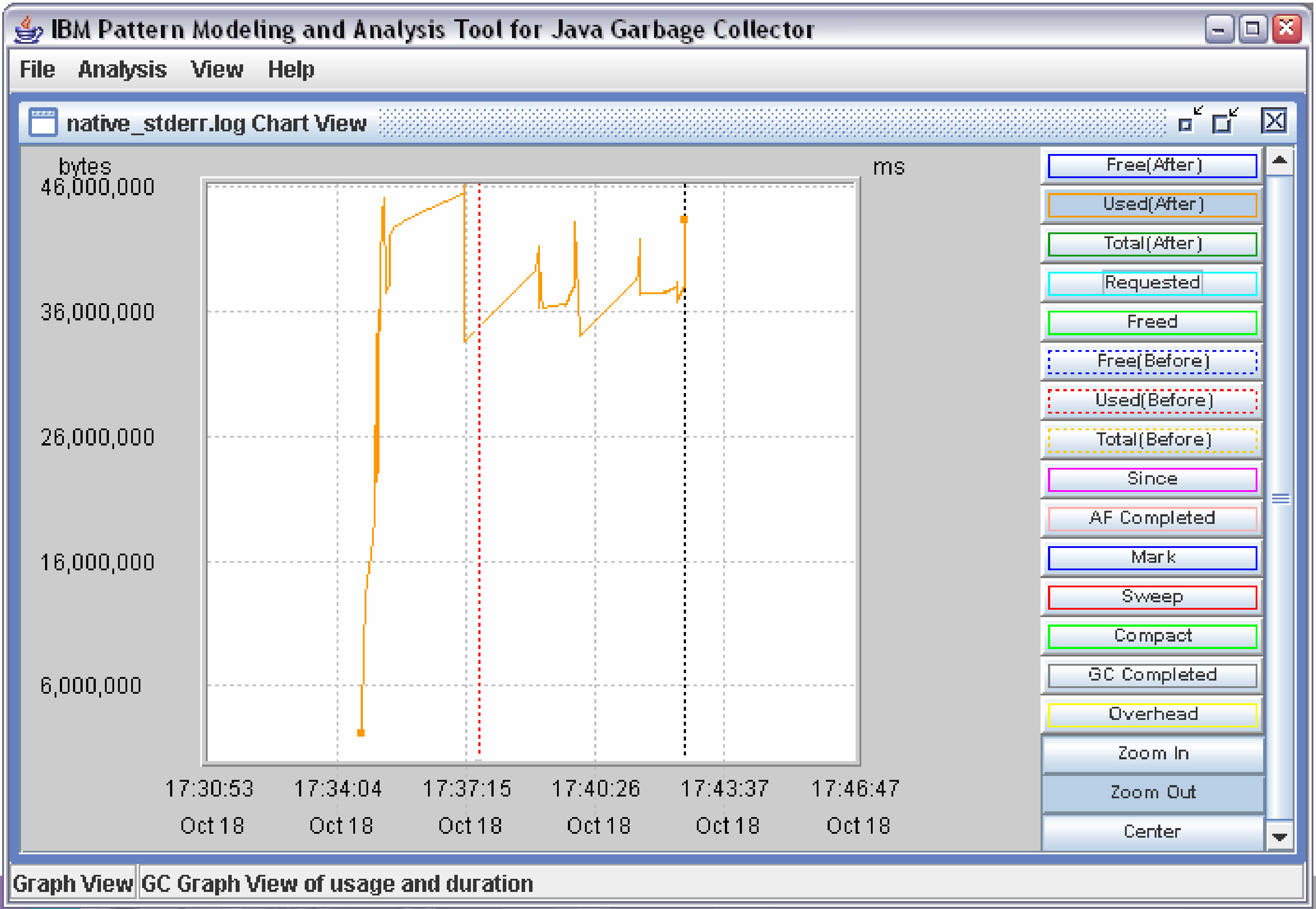
GC Graph View of usage and duration

# Case Study III (1/5)

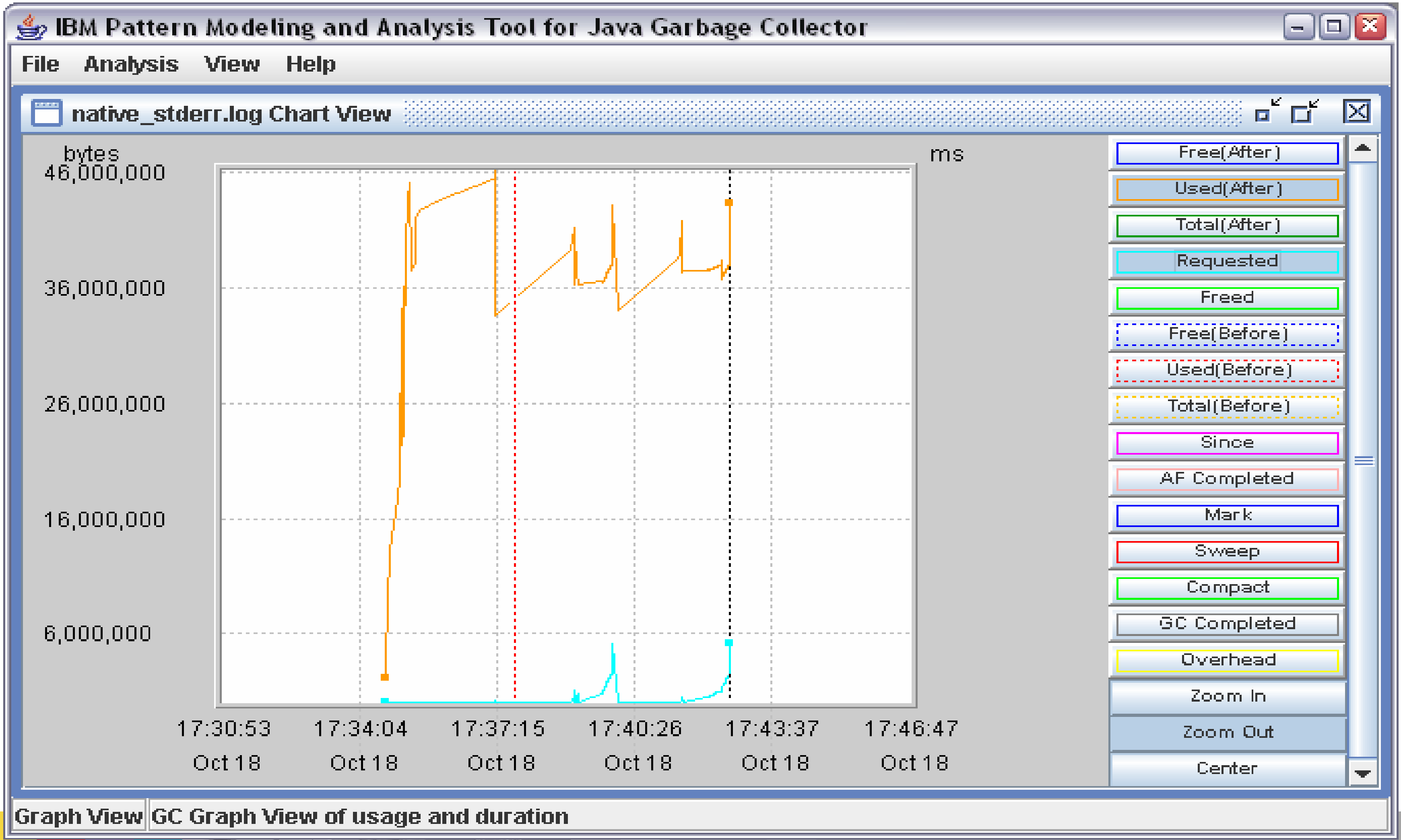

IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
File
Analysis
View
Help
native_stderr.log

- **Number of verboseGC cycles** : 1
- **Number of Garbage Collections** : 695
- **Number of Allocation failures** : 693
- **First Garbage Collection** : Tue Oct 18 17:34:42 2005
- **Last Garbage Collection** : Tue Oct 18 17:42:39 2005
- **Number of Java heap exhaustion** : 0
- **Maximum AF overhead** : 100% (Tue Oct 18 17:37:13 2005)
- **Number of 100% overhead** : 1
- **Maximum size of Large Object Request** : 5,171,128 bytes (Tue Oct 18 17:39:55 2005)
- **Number of Large Object Requests** : 392
- **Recommended size of kCluster** : 26,098 or greater

# Case Study III (2/5)



# Case Study III (3/5)



IBM Pattern Modeling and Analysis Tool for Java Garbage Collector

native_stderr.log Chart View

GC Graph View of usage and duration

# Case Study III (4/5)

- What is kCluster?

  Objects that are on the Java heap are usually mobile; that is, the garbage collector (GC) can move them around if it decides to resequence the heap. Some objects, however, cannot be moved either permanently or temporarily and might cause problems. One of them is a class block.

  The GC allocates a kCluster as the first object at the bottom of the heap.
  A kCluster is an area of storage that is used exclusively for class blocks.
  It is large enough to hold 1280 entries.
  Each class block is 256 bytes long.

# Case Study III (5/5)

- How can I find out the number of classes?

  GC trace data obtained by setting
  -Xtgc2 ( SDK 1.3.1 SR7 or higher)
  or
  -Dibm.dg.trc.print=st_verify ( SDK 1.4.2 )
  provides a guide for the optimum size of the *kCluster*.

- How can I set kCluster ?

  -Xk*nnnn*

  where *nnnn* specifies the maximum number of classes the kCluster contains. -Xk instructs the JVM to allocate space for *nnnn* class blocks in kCluster.

# Generic JVM settings on admin. console

- On WebSphere Application Server V5

  **Servers > Application Servers >** *server_name* **> Process Definition > Java Virtual Machine**> **Generic JVM Arguments**

- On WebSphere Application Server V6

  **Servers > Application Servers >** *server_name* **> Java and Process Management > Process definition > Java Virtual Machine** > **Generic JVM Arguments**

- On WebSphere Application Server V4

  1.Select the Application Server and go to the **JVM Settings** tab.
  2.Click on the **Advanced JVM Settings** button.
  3.Enter the values in the **Generic JVM Arguments** section.
  4.Click **OK**.
  5.Click **Apply**.
  6.Stop and re-start the Application Server.

# Useful links

- IBM SDK Diagnostics Guides http://www-106.ibm.com/developerworks/java/jdk/diagnosis/
- IBM Pattern Modeling and Analysis Tool for IBM Java Garbage Collector http://www.alphaworks.ibm.com/tech/pmat
- IBM HeapAnalyzer http://www.alphaworks.ibm.com/tech/heapanalyzer
- Webcast replay: Using IBM HeapAnalyzer to diagnose Java heap issues http://www.ibm.com/support/docview.wss?uid=swg27006624

# Additional WebSphere Product Resources

- Discover the latest trends in WebSphere Technology and implementation, participate in technically-focused briefings, webcasts and podcasts at: www.ibm.com/developerworks/websphere/community/
- Learn about other upcoming webcasts, conferences and events: www.ibm.com/software/websphere/events_1.html
- Join the Global WebSphere User Group Community: www.websphere.org
- Access key product show-me demos and tutorials by visiting IBM Education Assistant: ibm.com/software/info/education/assistant
- Learn about the Electronic Service Request (ESR) tool for submitting problems electronically: www.ibm.com/software/support/viewlet/probsub/ESR_Overview_viewlet_swf.html
- Sign up to receive weekly technical support emails: www.ibm.com/software/support/einfo.html

# Questions?