

# Java application performance issues and how to debug them



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Talks about #java, #spring, #developer, #technology, and #webdevelopment

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# Agenda

- JVM performance goals
- Garbage Collection
- Heap dump
- Thread dump
- Metrics
- Further reading
- Useful tools

# JVM Performance Goals

## Responsiveness

Responsiveness is the measure of how quickly the application responds with the requested piece of data

Example – How fast a REST service sends back response

Problem example – Suddenly, application is taking long time to respond

# JVM Performance Goals

## Throughput

Intend to maximize amount of work done by application in specific period of time

Example – Number of requests a REST service can handle in a given period of time

Problem example – A Java application did not respond to many requests and they timed out.

# Garbage Collection

Garbage collection patterns can help point to the causes of JVM performance issues causing reduced responsiveness

Example problem – Your application has many incoming requests waiting or timing out.

Debug approach – See when and how many times full GCs are happening. Too frequent or long GCs can cause such problems.

# Garbage Collection

Garbage collection patterns can indicate problems like

- Code issues – References remain for unrequired objects or resources, thereby making them ineligible for GC.
- Memory leaks
- Insufficient memory allocation – Less heap memory allocated to app than what it needs

# Heap dump

A heap dump is a snapshot of all objects in the JVM heap at that point of time when the heap dump is taken

Example problem – Your application crashed due to OutOfMemory error.

Debug approach – The heap dump at that time will show you which objects were taking up more space than expected causing the memory error.

# Heap dump

- Heap dump files have extension .hprof
- Heap dump can be taken on demand using various tools listed further.
- Below JVM option can be used for JVM to automatically take heap dump if it crashes due to OutOfMemory error

`java -XX:+HeapDumpOnOutOfMemoryError`



# Thread dump

- A thread dump is a snapshot of all threads that are part of a given process
- The state of each thread is presented with a stack trace, which shows the contents of a thread's stack

Example Problem – Applications memory usage is increasing steadily.

Debug approach – It may indicate that threads are waiting on some resources or are deadlocked. Thread dump will help reveal the cause of problem.

# Thread dump

Analyzing thread dumps helps indicate problems like

- Thread deadlock
- Timeouts not set , causing threads to wait on external resources like files or DB connections
- Code issues like buggy for loops

# Metrics

- Recording metrics for various key operations in your application will help you determine bottlenecks.

Example problem – For a particular use case, request takes up lot more time than expected.

Debug approach – Log the times for each step. It may help you find if the extra time being taken is to execute certain function or for a certain DB query execution.

# Metrics

- Libraries like 'dropwizard metrics' can help capture metrics
- Logging is another way to determine code flow and execution times

# Further reading topics

- Setting appropriate timeouts for clients – socket, connect and socket timeouts
- Circuit breakers
- Slow DB queries execution –

Optimize queries, add index, Normalize tables

- Garbage collection – Sawtooth pattern

# Further reading

- <https://dzone.com/articles/interesting-garbage-collection-patterns>
- <https://docs.oracle.com/en/java/javase/18/gctuning/factors-affecting-garbage-collection-performance.html>
- <https://www.baeldung.com/java-heap-dump-capture>
- [https://docs.oracle.com/cd/E13150\\_01/jrockit\\_jvm/jrockit/geninfo/diagnos/using\\_threaddumps.html](https://docs.oracle.com/cd/E13150_01/jrockit_jvm/jrockit/geninfo/diagnos/using_threaddumps.html)

# Useful Tools

- Java Visual VM
- Jmap
- JMX
- <https://github.com/spotify/threaddump-analyzer>

# Over to you

- What performance issues have you encountered and how have you fixed it ?
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