TRACING A JAVA PROGRAM ON JAVA VIRTUAL MACHINE

Karthika Nanthakumar, Tristan M. Basa, Gerhard Dueck
University of New Brunswick
Faculty of Computer Science
knanthak@unb.ca, tristan.basa@gmail.com, gdueck@unb.ca

INTRODUCTION

• **Automatic Memory Management (AMM)**: The Java Virtual Machine (JVM) feature responsible for the following memory-handling tasks: object memory allocation, identification, and deallocation. [2]

Tracefiles: Due to the deterministic nature of a simulator it needs an input file that it can run multiple times in order to present results. This list of commands is called a tracefile.

•**Simulator:** A simulation program imitates the operation of JVM on a very abstract level. Therefore this simulator will only be able to create objects and move them virtually in a simulated heap. This allows the fast prototyping of new GC techniques.

•**Goal:** Generate a realistic memory trace of a Java program by instrumenting the JVM.

•**Problem**: If the tracefile is created artificially, then this may not reflect the behavior of a Java program.

•**Idea:** Perform trace dumps whenever object allocation, reassignment, and deallocation occurs in the JVM.

BACKGROUND

The configuration of the artificial tracefile is given below:

Parameter	Description	Value
rootsetSize	Size of rootset per thread	7
threadsNumber	Number of threads	5
ratioAllocationSetpointer	Number of allocation operations	70
ratioNullpointerAssignment	Probability of setting a reference to NULL instead an object	20
maximumPointers	maximum reference slots	10
minimumPayload	minimum size for an object	1
maximumPayload	maximum size for an object	64

Three events in the JVM are relevant in creating the tracefile:

1. **Capturing Object Allocation:** In JVM, object allocation is performed under two functions. Both function calls must be caught in order to dump needed information for the tracefile.
2. **Capturing Change in Object Reference**: JVM has read and write barriers that intercept the execution of an application. Change in object reference are tracked in these barriers.
3. **Rootset Dump**: In order to perform a root set dump, two steps are needed: stop-the-world and root set source scanning. Stop-the-world (only the root scanning thread will be running) can only be performed when the VM is at a safe point. This is achieved by signalling the event *AsyncEvent* in the JVM. This is needed since thread stack frames keep changing while the threads are running.

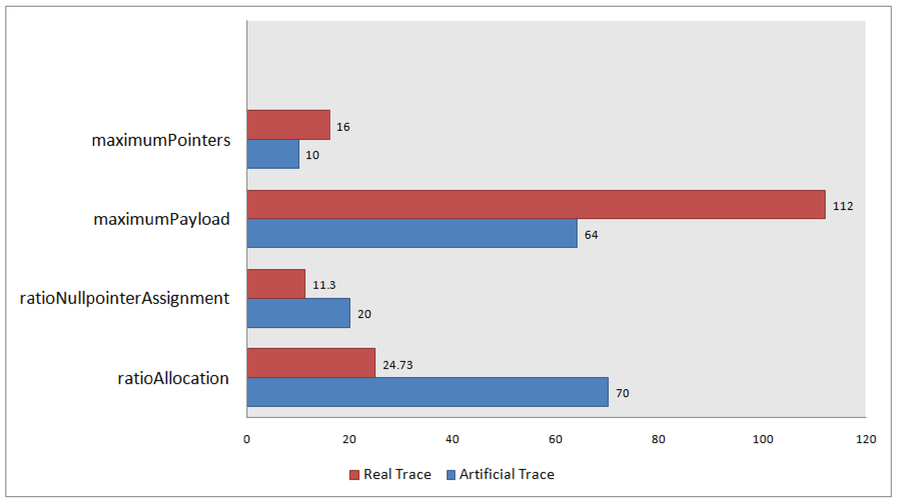
TRACEFILE FORMAT

The tracefile has the following instructions:

1. **a Ti Oj Ss Nn**
   -- Allocate an object with the following characteristics:
   - i is the thread number;
   - j is the object id;
   - s is the payload of the object;
   - n is the number of pointers in the object.
2. **+ Ti Oj**
   -- Add object j as a root to thread i
3. **- Ti Oj**
   -- Remove object j from the root set of thread i
4. **r Ti Pm #i Oj**
   -- Set the ith pointer of object m to point to object j:

EVALUATION

The figure below shows the statistics between the parameter values of an artificial tracefile (Artificial Trace) and our trace output (Real Trace).



FUTURE WORK

- Implement a dynamic rootset. Currently, a maximum size for the rootset is chosen. In the JVM however, the size of the rootset varies dramatically. Having a dynamic rootset size will make the system more efficient in terms of memory usage.
- Consider information relevant only to the target Java application. Many memory management operations being performed are internal to JVM. Ignoring these operations would result in fewer dumps, and thus a more compact tracefile.