Performance Measurement of Dynamically Compiled Java Executions

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Motivation for profiling tool

- Java is increasingly being used for large, long-running, complex applications
  - Meta-computing
  - High performance numeric applications
  - Parallel computing

- Dynamic Compiler Java virtual machines will become ubiquitous
  - Native code execution + run-time optimizations
  - Potential to outperform statically compiled code
Profiling DC Java is hard

- Java application changes form at run-time
  - discover mappings to correlate data
  - find size & location of native AP to measure it
- Run-time interactions between VM and AP
  - describe VM interactions with AP native code

Interpret
Java AP byte-codes
Java dynComp VM
Platform (OS/Arch)

Directly execute
Java AP native code
Performance issues of dynamically compiled Java

- When dynamically compiling doesn’t win:
  - small method functions with simple CFG’s
  - methods whose time not dominated by interpreting byte-code (I/O or synchronization)
  - methods whose native code form still has a lot of interaction with Java VM (object creates)

- Simple study:
  - run application kernels on ExactVM & compare all-interpreted to dynamically compiled execution
We need a profiling tool

- Dynamic compilation is not the only answer
- Need more information to tune application
  - performance measures with native code form
    and byte-code form of a method
    - did run-time compilation help?
  - VM interactions with native code form of a method
    - what are these interactions?
    - how much do they affect the application’s execution?
Paradyn-J

- Extension of Paradyn Parallel Performance Tools for measuring Java executions
  - profiles simulation of dynamically compiled Java
  - dynamically inserts native and byte-code instrumentation in VM & AP at run-time
    + instrument unmodified Java .class files and VM

- Provides performance data that:
  - associated with AP’s multiple execution forms
  - describes VM-AP interactions (see EuroPar’98)
  - describes run-time compilation costs
Performance tuning study

Neural network application

(15,800 lines of source code, 23 class files)
A method that doesn't benefit from run-time compilation
Why not?

VM still handles all memory management
How can we tune the Java AP?

- Remove some object creates
  - 10% improvement in method’s execution time

  Original: 3.96 20.8 Total time 24.76 secs
  Tuned: 3.53 18.7 Total time 22.23 secs

- ExactVM’s execution of the tuned AP
  - 10% improvement in total execution time
    (21.09 seconds vs. 18.97 seconds)
How can we tune the Java VM?

- Tune the VM routines responsible for handling object creates in the Java application
- Tune the dynamic compiler’s run-time compiling heuristics
  - characteristics of method that make it a bad candidate?
  - incorporating profile data into the heuristic
Conclusions

- Paradyn-J provides data to easily determine how to tune application
  - measure AP byte-code and native code
  - measure VM interactions w/ AP native code
  - measure AP transformations
  - instrument unmodified binaries and .class files
- AP developers can see inside VM
- VM developers can characterize VM’s performance in terms of AP code it runs