Auto-tuning HotSpot JVM using OpenTuner

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Milinda Fernando (CSE, Univ. of Moratuwa)
Tharindu Rusira (CSE, Univ. of Moratuwa)
Chalitha Perera (CSE, Univ. of Moratuwa)
Chamara Philips (CSE, Univ. of Moratuwa)

Prof. Sanath Jayasena (CSE, Univ. of Moratuwa)
Prof. Saman Amarasinghe (CSAIL, MIT)
Motivation

- Java Virtual machine is a complex piece of Software
- Responsible for providing execution environment for Java programs
- What if the JVM can execute Java applications better (faster?)
JVM and Complexity

- HotSpot JVM
- More than 600 tunable flags and parameters
- How to handle a configuration space of this scale?
OpenTuner[1]


[1] provides results for a number of successful case studies

- GCC/G++ auto-tuner inspired a solution for JVM auto-tuning
- Multiple search techniques
- Evolutionary algorithms allow to reach optima aggressively in non-trivial configuration landscapes
- works best with massive search spaces and manages computational complexity really well
Configuration Manipulator

Used to define the configuration space

```python
def manipulator(self):
    m = manipulator.ConfigurationManipulator()
    for flag_set in self.bool_flags:
        for flag in flag_set:
            m.add_parameter(manipulator.EnumParameter(flag, ['on', 'off']))
    for flag_set in self.param_flags:
        for flag in flag_set:
            value = flag_set[flag]
            if value['min'] >= value['max']:
                m.add_parameter(manipulator.IntegerParameter(value['flag name'], value['max'], value['min']))
            else:
                m.add_parameter(manipulator.IntegerParameter(value['flag name'], value['min'], value['max']))
    return m
```
Run function

Measures the quality (fitness) of a given configuration.

Eg.
- For SPECjvm2008, operations per minute (ops/m)
- For DaCapo, execution time in ms
JVM Flag Hierarchy

if (TieredCompilation) == TRUE

TieredCompilation + C1  C2  Common

CMS  G1

Throughput Collector

ParallelOld  Parallel

Serial
JVM Tuner

- OpenTuner
  - JVMTunerAbstract
    - JavaProgramTuner
    - SpecJVMTuner
    - DacapoTuner
    - TomcatTunerAbstract
      - TomcatTunerJmeter
      - TomcatTunerAB
    - HadoopPseudoTuner
Performance Improvement of SPECjvm2008 Startup Benchmarks
Performance Improvement of Dacapo Benchmarks
What happens to the JVM when auto-tuned?

- Observations on heap usage, compilation and class loading before and after tuning
- Compilation rate has a major impact on performance

DaCapo pmd benchmark CR (38.73%)

DaCapo h2 benchmark CR (5.76%)
Thank You