Selection of Virtual Machines
Based on Classification of MapReduce Jobs

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Cloud Computing

- Large number of physical machines (PM)
- Strongly networked together
- Resources sold on an hourly basis as virtual machines (VM)
- Eucalyptus
- Amazon EC2
Motivation

• Find the minimal virtual machine that will run a Map Reduce job as fast as possible
Map Reduce

• Programming Paradigm for distributed computing
• Two phases
  • Map Phase
  • Reduce Phase
• Apache Hadoop
  • Open source implementation used
Map Reduce

• Map
  • Many small Map tasks
  • Each task takes a small chunk of data
  • Turn the data into Key value pair (i.e <the,1>)
  • Number of Map tasks varies based on input data size
  • When all Map task are finished data is Pasted to the Reduce Phase

• Reduce
  • Very few set number of Reduce tasks
  • Combine all the input key value pairs from the maps
  • Also takes care of shuffling data from Map Locations to Reduce Locations
Map Reduce

- Reduce
  - All Mapping must finish before Reducing can start
  - Shuffling can start before Mapping ends
Issues when Used Together

- Some jobs run better on different configurations of virtual machines
- Different configurations of virtual machines have different costs
- Some jobs may need more CPU’s while others may need I/O
TCloud Test Bed

• Hardware
  • 12 Dell Power Edge R614 Servers
  • 96 conventional CPU Cores
  • 4-Way redundant 10 GB Ethernet
  • 2-Way redundant InfiniBand

• Software
  • Eucalyptus 3.3 (Amazon EC2 compatible)
Net Cloud (Physical Cluster)

• Hardware
  • 32 Dell PowerEdge R210 servers
  • Each server has
    • 4 GB of RAM Memory
    • 500 GB HDD

• Software
  • Hadoop version 1.2.1
  • CentOS 6.6
Net Cloud (continued)

• Networking
  • Tree like structure
    • 4 machines to 1 group switch
    • 4 group switches to 1 rack switch
    • 2 rack switches connected to 1 Top Switch
Our Approach

• Attempt to classify tasks into two types
  • CPU Based Jobs
    • Jobs spent more time doing CPU work then I/O
    • Jobs need more CPUS’s and less I/O
    • Smaller more numerous machines
  • I/O Based Tasks
    • Jobs spent more time doing I/O work then CPU
    • Jobs need more I/O and less CPU
    • Less Larger Machines
Mapping to machines

- If a job is classified as
  - CPU Bound Job
    - Many virtual machines
    - Little memory per virtual machine
  - I/O Bound Job
    - Fewer virtual machines
    - Each virtual machine has larger amounts of memory
Why?

• If a job is I/O bound
  • Would like to keep job running in memory rather than hit HDD
  • I/O more important than number of cores

• If a job is CPU bound
  • More important to have many cores running the maps
  • Less likely to hit HDD while running
How to classify

• Metrics
  • Shuffle_bytes
  • CPU_time

• (Shuffle_bytes/CPU_time)
  • Take the average of the map tasks
  • If value is over 1, then job is I/O Bound
  • Else CPU Bound
Results from Physical Machine runs

![Graph showing Shuffle Bytes per CPU (ms)](image)

<table>
<thead>
<tr>
<th>Task</th>
<th>Mean Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Count</td>
<td>133.4174082</td>
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<tr>
<td>Pi</td>
<td>0.109941888</td>
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<tr>
<td>Pentomino</td>
<td>0.019261066</td>
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<tr>
<td>TeraGen</td>
<td>9328.415925</td>
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<tr>
<td>TeraSort</td>
<td>0</td>
</tr>
<tr>
<td>Grep</td>
<td>0.036108882</td>
</tr>
<tr>
<td>MRBench</td>
<td>0.008636364</td>
</tr>
<tr>
<td>DFCIOTest Read</td>
<td>0.042364532</td>
</tr>
<tr>
<td>DFCIOTest Write</td>
<td>0.038053097</td>
</tr>
</tbody>
</table>

Log10 Scale
# Results on the Virtual Clusters

<table>
<thead>
<tr>
<th>Job</th>
<th>Large Time (S)</th>
<th>Small Time (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Count</td>
<td>257.2338</td>
<td>235.2299</td>
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<tr>
<td>PI</td>
<td>473.3364</td>
<td>419.88242</td>
</tr>
<tr>
<td>Pentomino</td>
<td>408.1599 &amp;</td>
<td>355.0055</td>
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<tr>
<td>TeraSort</td>
<td>603.9358</td>
<td>183.1389</td>
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<tr>
<td>TeraGen</td>
<td>89.2324</td>
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<tr>
<td>Grep</td>
<td>217.8305</td>
<td>188.0857</td>
</tr>
<tr>
<td>MRBench</td>
<td>21.0116</td>
<td>18.6668</td>
</tr>
<tr>
<td>DFSCIOTest read</td>
<td>24.5882</td>
<td>19.5072</td>
</tr>
<tr>
<td>DFSCIOTest write</td>
<td>25.2971</td>
<td>20.2712</td>
</tr>
</tbody>
</table>
Conclusion

• Selection is quick and simple
• Most jobs are mapped to the correct virtual machine type
Questions?

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