See Spot Run: Using Spot Instances for MapReduce Workflows

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Overview

- Data Analytic Cloud
- Instance Options
- MapReduce
- Spot Instances
- Evaluation
Data Analytic Cloud

Accelerators

Data

Public Cloud

DFS
Cloud Options

- Different VM Sizes
- Pricing Options
  - On-demand
  - Leased
  - Spot Instances
## VM Resources

<table>
<thead>
<tr>
<th>Instance Type</th>
<th>EC2 Compute Units</th>
<th>Memory (GB)</th>
<th>Storage (GB)</th>
<th>On-Demand Price (per hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>m1.small</td>
<td>1</td>
<td>1.7</td>
<td>160</td>
<td>$0.095</td>
</tr>
<tr>
<td>c1.medium</td>
<td>5</td>
<td>1.7</td>
<td>350</td>
<td>$0.19</td>
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<tr>
<td>m1.large</td>
<td>4</td>
<td>7.5</td>
<td>850</td>
<td>$0.380</td>
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<tr>
<td>m2.xlarge</td>
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<td>17.1</td>
<td>420</td>
<td>$0.570</td>
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<tr>
<td>m1.xlarge</td>
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<td>15</td>
<td>1690</td>
<td>$0.760</td>
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<tr>
<td>c1.xlarge</td>
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<td>7</td>
<td>1690</td>
<td>$0.760</td>
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<tr>
<td>m2.2xlarge</td>
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<td>$1.340</td>
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<tr>
<td>m2.4xlarge</td>
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<td>1690</td>
<td>$2.68</td>
</tr>
</tbody>
</table>

## Pricing Options

<table>
<thead>
<tr>
<th>Instance Type</th>
<th>On-Demand Price (per hr)</th>
<th>Reserved-1 Year Price (per hr)</th>
<th>Reserved-3 Year Price (per hr)</th>
<th>Spot Instance Average Price (per hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>m1.small</td>
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<td>$0.448</td>
<td>$0.347</td>
<td>$0.320</td>
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<tr>
<td>c1.xlarge</td>
<td>$0.760</td>
<td>$0.448</td>
<td>$0.347</td>
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<td>$1.56</td>
<td>$1.21</td>
<td>$1.12</td>
</tr>
</tbody>
</table>

Building Blocks

Spot Instances

Leased Machines

EC2 Cloud

HDFS
MapReduce

Input File from DFS

\[ \text{M}_0 \rightarrow \text{M}_1 \rightarrow \text{M}_2 \rightarrow \text{M}_3 \]

\[ \text{R}_0 \rightarrow \text{R}_1 \rightarrow \text{R}_2 \]

Output File from DFS
MapReduce with Accelerators

- Input File from DFS
- Mappers
- Reducers
- Output File from DFS

Leased Machines

Spot Instances

- $M_A$
- $R_A$
How Spot Instances Work

• Make a max bid on a spot instance
• Spot instance is available if
  ◦ Max bid > market price
• Not available if
  ◦ Max bid ≤ market price
• Always pay market price
• Pay for full hour if terminated by user
• Free partial hour if terminated by Amazon
MapReduce with Spot Instances

- MR paradigm
  - Embarrassingly parallel jobs
  - Fault tolerant
  - Transient workers
  - Workers pull data

- Spot Instances
  - Provide transient and (relatively) inexpensive resources
Speedup Cost

![Graph showing speedup cost relationship]
Downside of Spot Instances

- Termination has a cost
- VM uptime probability is a function of the user’s maximum bid price
- Work will have to be redone
  - Operational nodes must pick up the slack
  - This includes map output which has been already consumed by a reducer
VM Lifetime

Modeling m1.small instance using data from cloudexchange.net
MapReduce with Faults

Fault injected at half-way point of original job

WordCount

Sort
Handling Faults Efficiently

- Have Hadoop track which map output has been consumed by a reducer to avoid re-execution
- Store intermediate data (map output) in HDFS*
- Lower fault detection time
  - Default: 10 minutes

*Steven Y. Ko et al. from HotOS09’
Summary

- Spot instances provide inexpensive resources for transient workloads
- MapReduce jobs speedup with more resources
- Spot instance termination hurts a job’s time to completion
Questions?