An Analysis of Availability Distributions in Condor

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Distributed Computing: How long can we run?

• Modern distributed systems are heterogeneous
  – Large scale SMP
  – Clusters
  – Cycle-harvesting systems

• Resource availability duration is important
  – We are given ‘max walltime’ in supercomputers
  – Resource availability times determined by competing users in cycle-harvesting systems!

• Question: can we predict how much time we are given to compute?
Condor: distributed computing through cycle-harvesting

• Idea: use desktop and cluster resources when they are idle
  — Achieve high-throughput computing

• Processes are scheduled on idle resources until...
  — Process completes
  — Resource is reclaimed

• Submitted ten sensor processes to UW Madison pool
  — Sensor records time between ‘began execution’ and ‘resource was revoked’
  — In total gathered process lifetime intervals from 900 hosts over 26 months
Availability Modeling

• Wish to generate accurate descriptive models
  – Simulation
  – Prediction

• Typically assume exponential distribution
  – Shown in literature to be inaccurate for lifetime modeling

• We choose some other distributions from similar family
  – Weibull, Pareto, Log-normal, Hyper Exponential

• Perform MLE fitting technique on gathered process lifetime intervals
  – Tools for automatic model fitting
The shape of condor resource availability

![Graph showing the distribution of process lifetime intervals for different distributions: Empirical, Log-normal, and Weibull. The x-axis represents process lifetime intervals in seconds, ranging from 0.001 to 10,000,000. The y-axis represents the cumulative distribution function (CDF), ranging from 0 to 1. The graph compares the empirical distribution with theoretical distributions like Log-normal and Weibull.](attachment:condor_resource_availability.png)
Cluster availability vs. Desktop availability

- 'Clustering' results in better fit
- For non-cluster data, neither model fits very well
  - **Weibull** better for large quantiles
  - **Log-normal** better for small quantiles
Prediction Results

<table>
<thead>
<tr>
<th>Data Set</th>
<th>Parametric MLE Method</th>
<th>Bootstrapping</th>
<th>Binomial Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSIL</td>
<td>93.3%</td>
<td>96.7%</td>
<td>96.6%</td>
</tr>
<tr>
<td>Condor</td>
<td>99.5%</td>
<td>97.1%</td>
<td>95.0%</td>
</tr>
<tr>
<td>Long</td>
<td>91.7%</td>
<td>96.0%</td>
<td>97.3%</td>
</tr>
</tbody>
</table>

• Quantile prediction experiment
  - Compare parametric (stat. Model based) method to non-parametric methods

• Non-parametric more accurate, Binomial Method (novel) most accurate with smallest data set size
Conclusions

- **Log-normal** or **Weibull** distributions are useful for modeling **Condor process lifetimes**

- Clustering of data into ‘cluster’ and ‘desktop’ sets improves model accuracy
  - Desktop data not very well modeled using parametric techniques
  - Non-parametric better for prediction

- We can **accurately predict** process lifetime quantiles
  - Optimal checkpoint interval selection
  - Redundancy hints
  - Condor scheduler hints

- Thank You! Questions?