Approximation Modeling for the Online Performance Management of Distributed Computing Systems

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SYSTEM MODEL

Three service clusters

Power-save cluster

Enterprise system

Three client classes

All incoming requests

Workload $\lambda(k)$

$m$ performance classes of servers

Response time

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CONTROL PROBLEM

- Maximize profits over all services
  - Workload generated by the various client classes is time varying
- Solve the optimization problem in real time
  - Tackle the “curse of modeling”
    » The system is characterized by complex nonlinear behavior
  - Tackle the “curse of dimensionality”
    » The state space is large to search for each control input
- Use limited lookahead control (LLC) approach
CONTROLLER DESIGN

- Approximate the system behavior
  - Tackle the “curse of modeling”
- Approximate the controller behavior
  - Tackle the “curse of dimensionality”
- Validate two types of approximation models
  - Neural network
  - Regression tree

Train approximation models via simulation-based learning and test the performance against controllers with explicit equations for the system behavior and optimization process.

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EXPERIMENTAL RESULTS

Best results using approximation modeling are within 1% of control with explicit equations.

Control overhead is reduced by 12%-98% when using approximation models.
CONCLUSIONS

- Profit gains in the best case are within 1% of that earned by a controller having perfect knowledge of the system.
- Approximating the system behavior results in a 12-78% reduction in overhead.
- Approximating the control behavior results in a 98% reduction in overhead.

Full results published in a technical report: