Utilizing Green Energy Prediction to Adapt to Energy Supply Variability when Scheduling Mixed Batch and Service Jobs in Data Centers

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Motivation
• Data centers consume a lot of power
  • Millions of MWh, reflected as billions of dollars in the electricity bills
  • Tons of carbon emissions to the atmosphere
• Idea: Use renewable energy to reduce carbon emissions
• Problem: Renewable energy supply is highly variable which decreases the energy usage efficiency.

Renewable energy prediction
• Instantaneous renewable energy usage may result in power shortages
• Use short term prediction algorithms (30min window) to decide when renewable energy to run additional processing requests in order to achieve higher energy efficiency while meeting performance constraints

System Architecture
• Use green energy to schedule more batch jobs – MapReduce jobs are good as 92% finish within 30min
• Terminate MR task when green energy supply drops
• Guarantee service jobs meet their performance constraints, and limit performance hit to batch job completion times

Results
• Prediction has 15% lower job completion time on average compared to instantaneous case
• Prediction has 2x overall higher GE efficiency vs. instantaneous
  • GE Efficiency: % of the GE that is used for useful work
• Prediction leads to ~2x more jobs completed with green energy vs. instantaneous case
  • GE Job Percentage: ratio of jobs completed with GE over all completed jobs
• On average, 5x fewer batch tasks need to be terminated with prediction.
  • %Incomplete Jobs: ratio of terminated jobs over all jobs completed with GE

Comparison of solar prediction algorithms. Data gathered from solar installation at UCSD

Comparison of wind prediction algorithms. Data gathered from a wind farm in Lake Benton, available by NREL

Combination of a weighted nearest-neighbor (NN) tables and wind power curve models
• 21.2% error vs. state-of-the-art predictor 48.2% error
