Lightweight Scheduling for Grid Applications

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Outline

- Motivation
- Methodology
- Observed user behaviour
- Prediction Strategy
- Conclusions

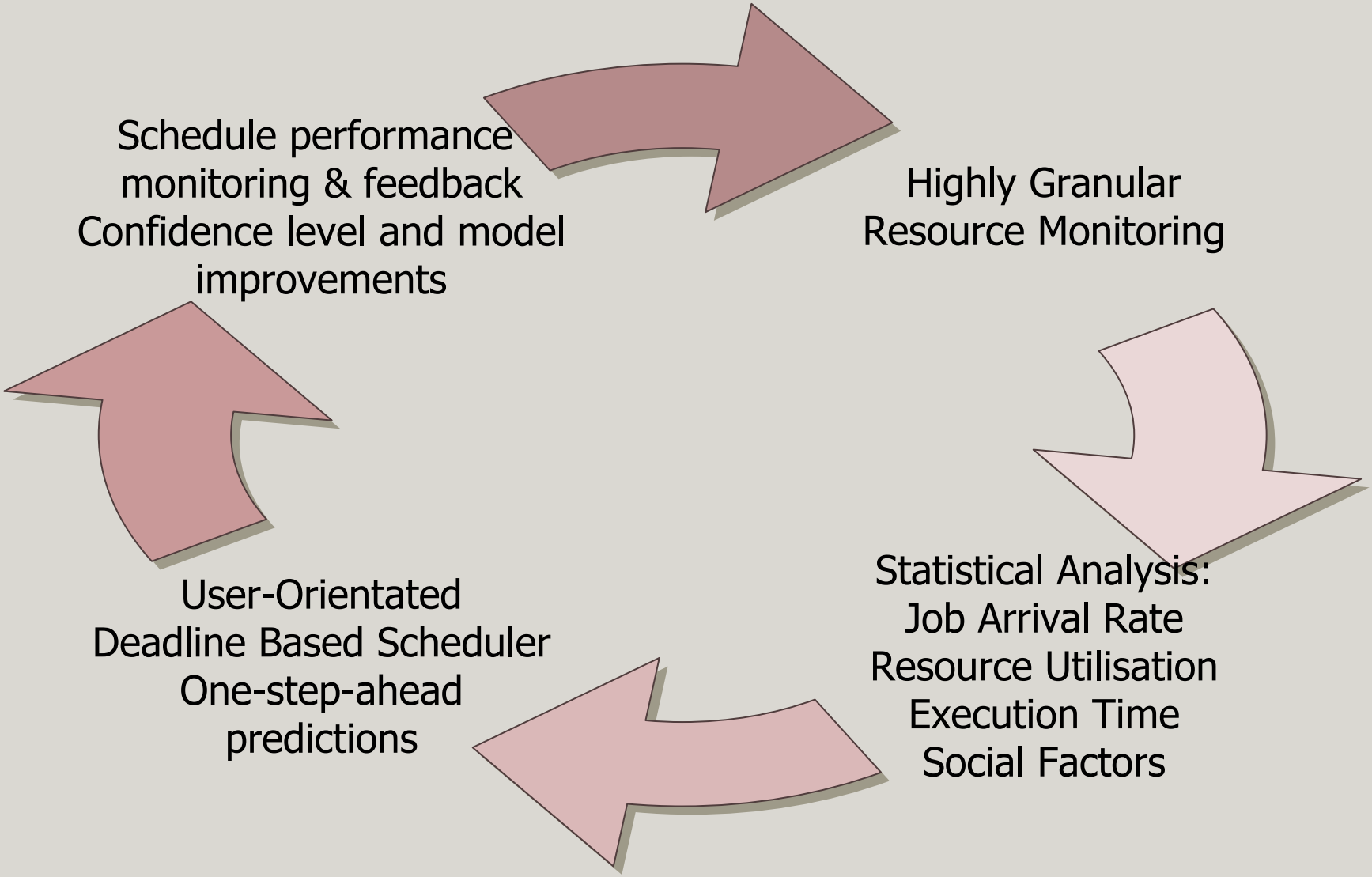
Better Grid Scheduling

- Deadline based
- Transparent to the user
- (mostly) Self-managing
- More effective
  - Out-of-Order execution
  - Priority replaced with confidence level

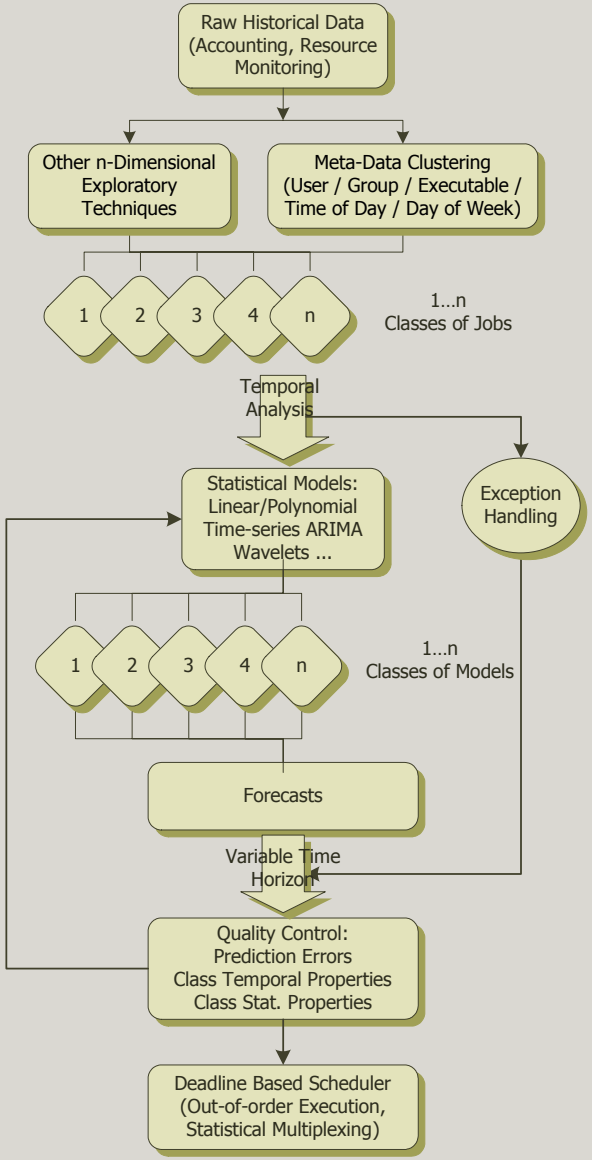
If only…

- We knew…
  - Process' execution time
  - Resource utilisation
  - Likelihood of a similar process arriving
  - Our confidence in these numbers
- We could…
  - Be flexible & robust
  - Treat anomalies in the same way as reg data
  - Adapt to change in circumstance & prediction quality

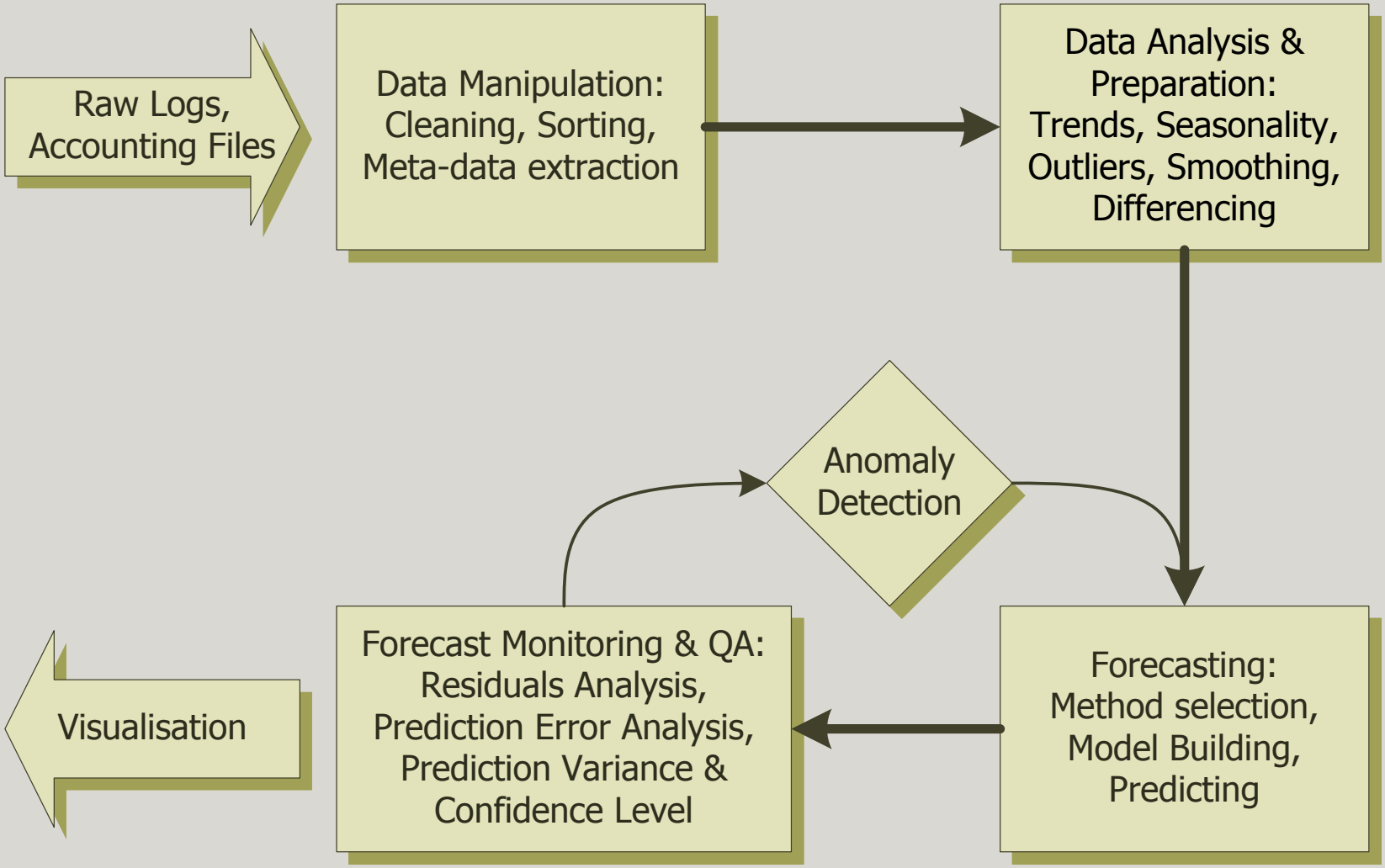
Methodology



Methodology



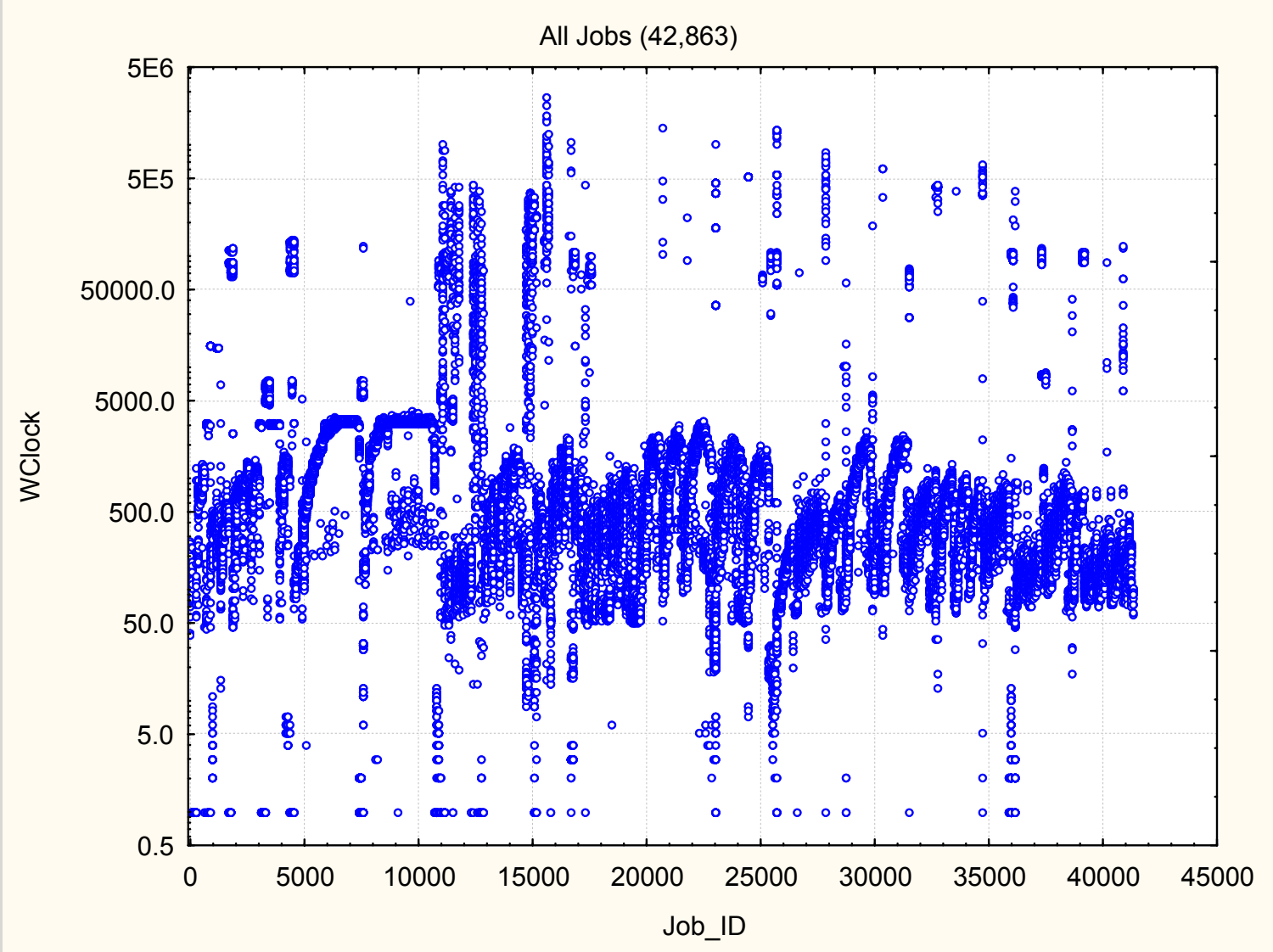
MATLAB Framework



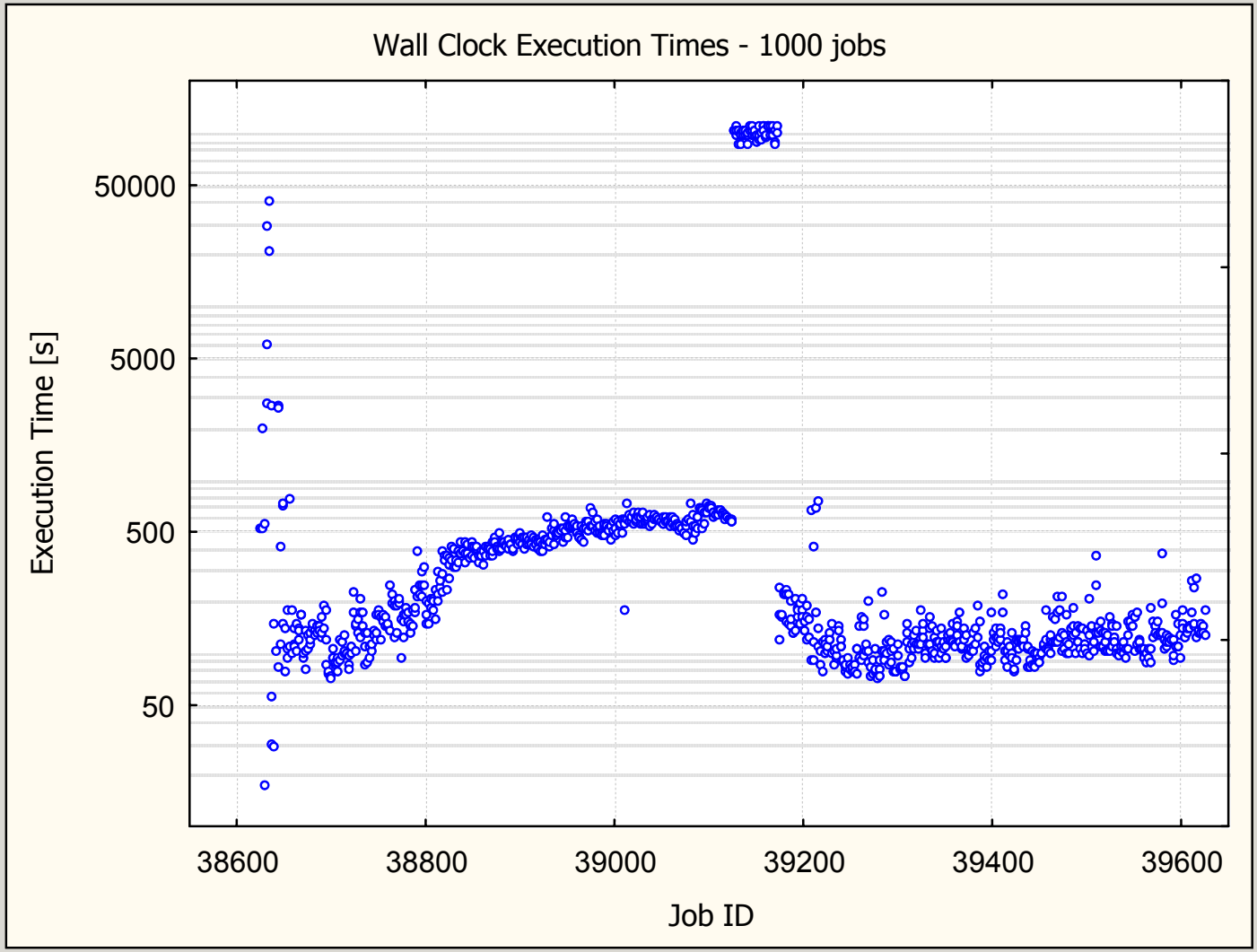
Preliminary Data Analysis

- Data Source:
  - 200 CPU Sun Grid Engine cluster @ UCL
- User community:
  - 20 UK e-Science projects
  - 5-10 different projects concurrently running
- Scope:
  - 50,000 jobs (>5,500 CPU days)
  - Jul 2004 – Dec 2004

Trivial Approach – All In

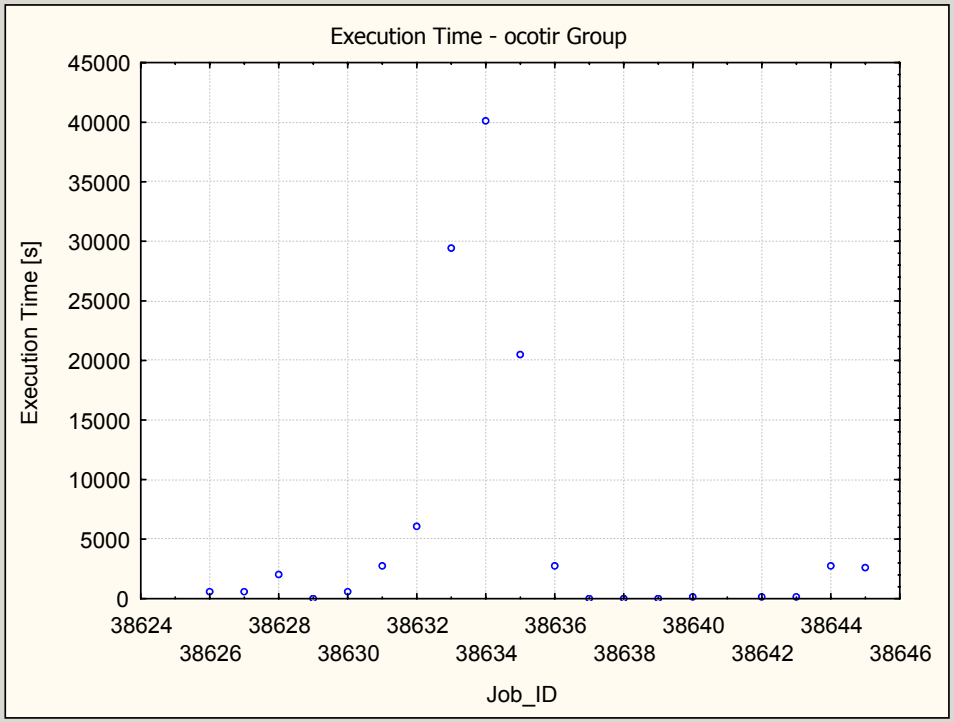


Temporal Job Selection

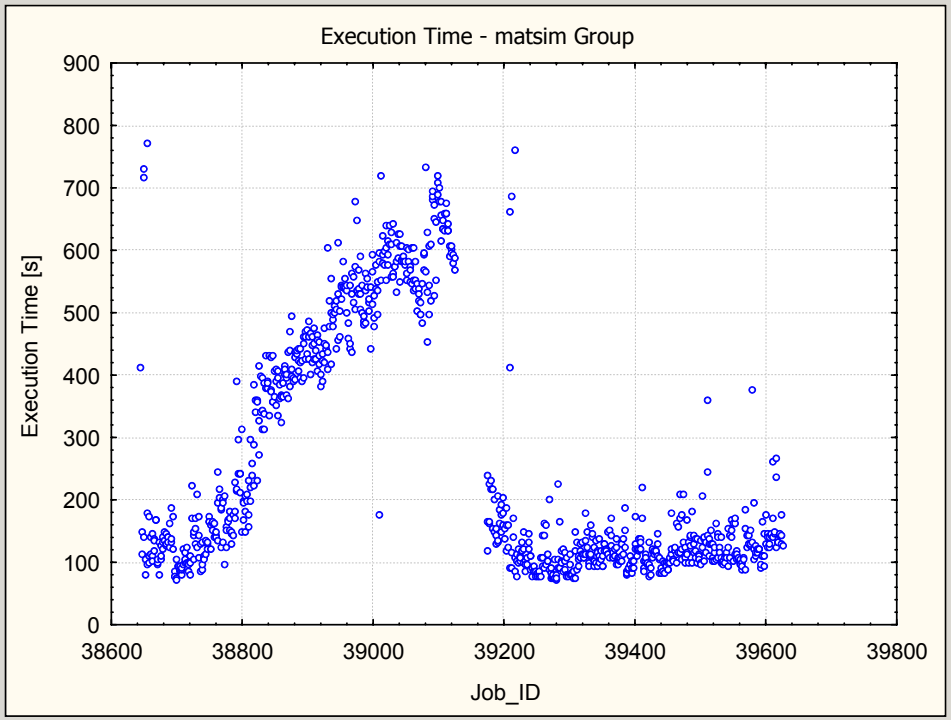


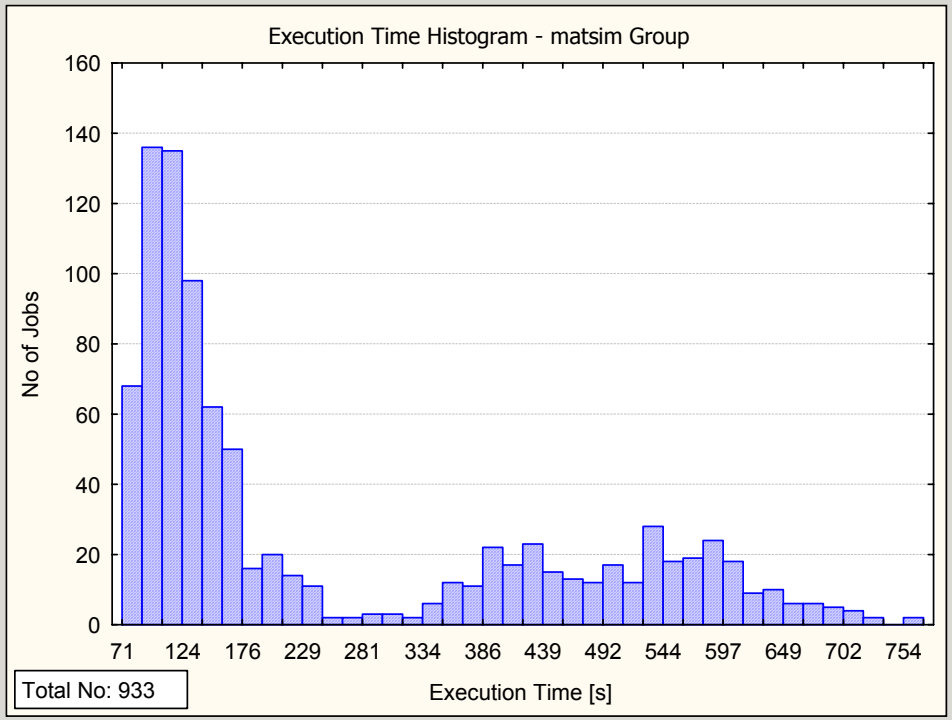
1000 Jobs, 15 hours of total execution time, used in all following analyses

Intra-Group Analysis – *ocotir*

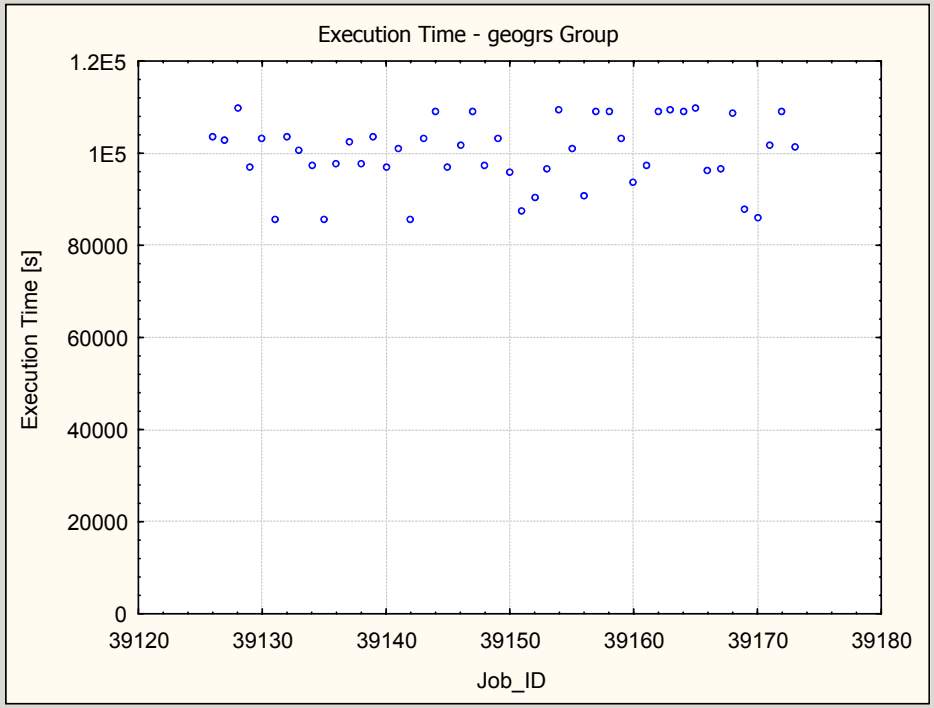


Intra-Group Analysis – *matsim*

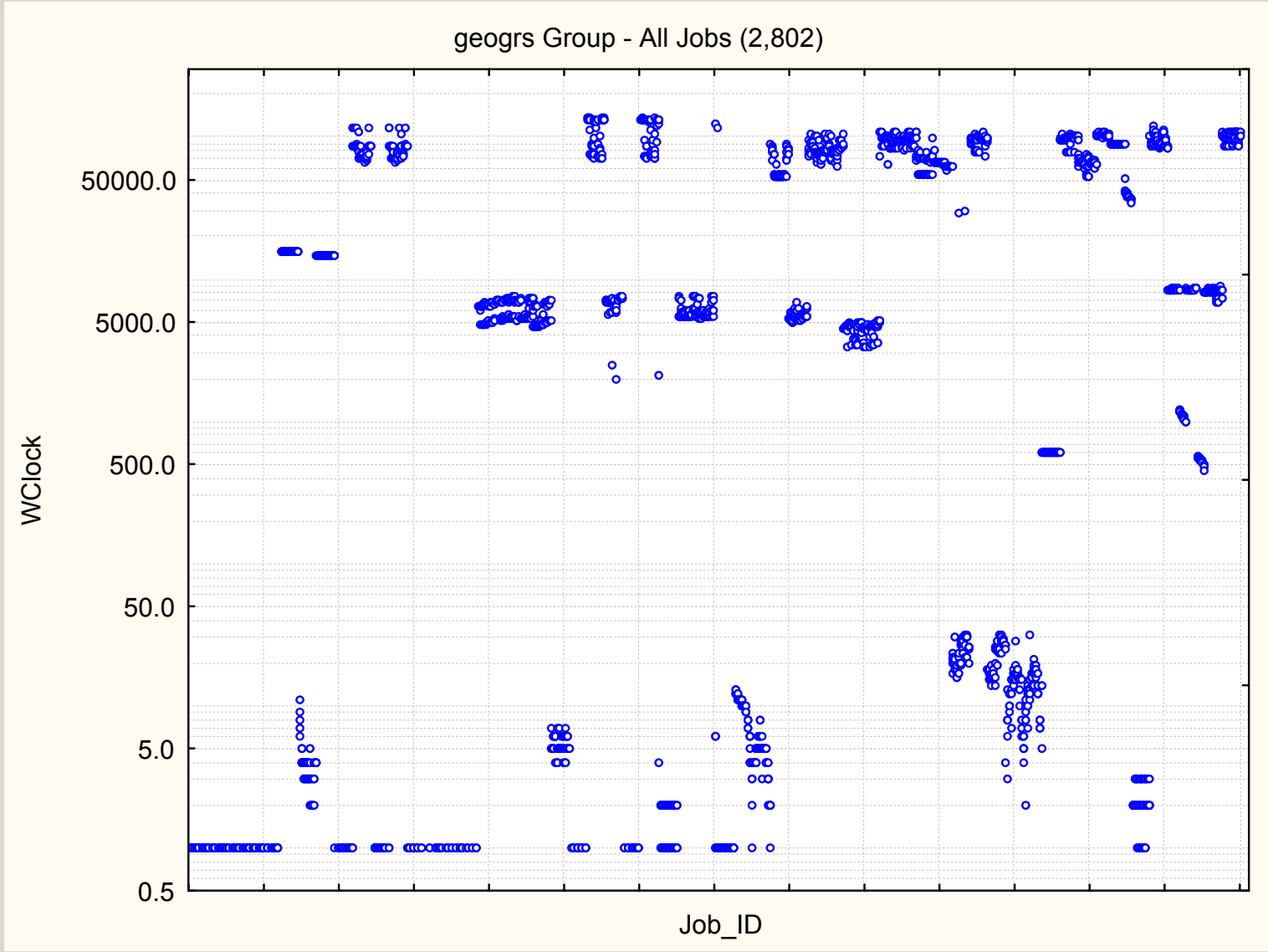




Intra-Group Analysis – *geogrs*



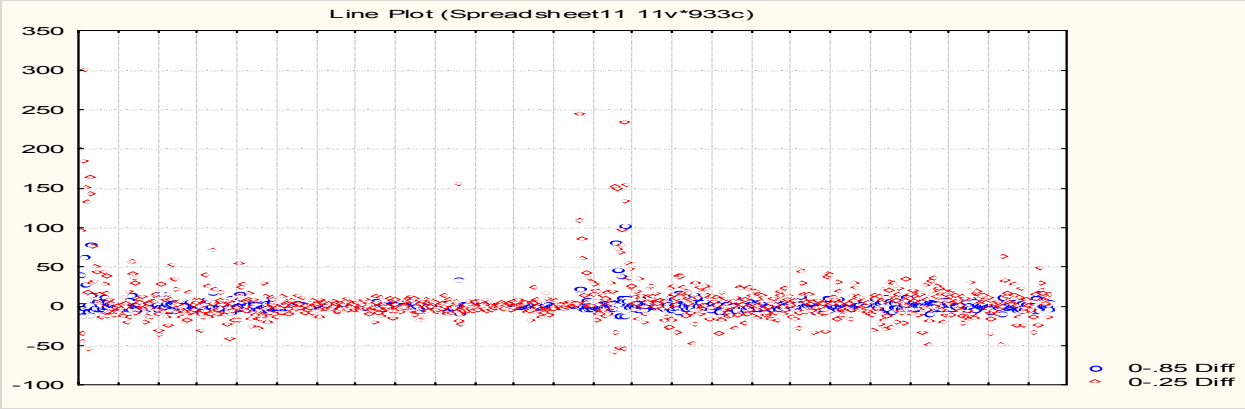
Temporal Locality?

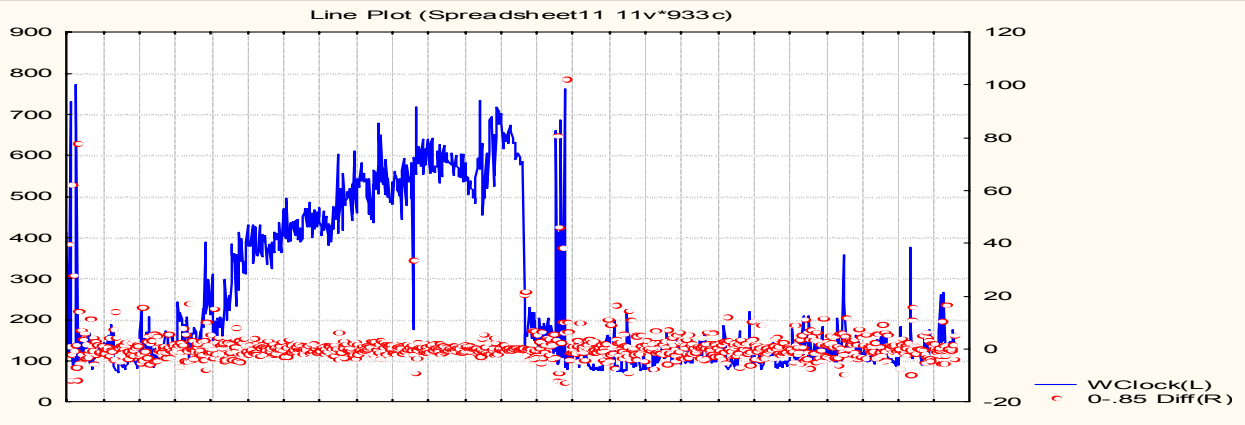


Anomalies

- Detect sudden, significant and sustained changes in the quality of predictions
- Detecting them
  - Using a self-tuneable system
  - Flexible definition of an anomaly
- Dealing with them
  - Shorten the prediction horizon
  - Reduce the confidence interval

Anomaly Detection – Exp Smoothing



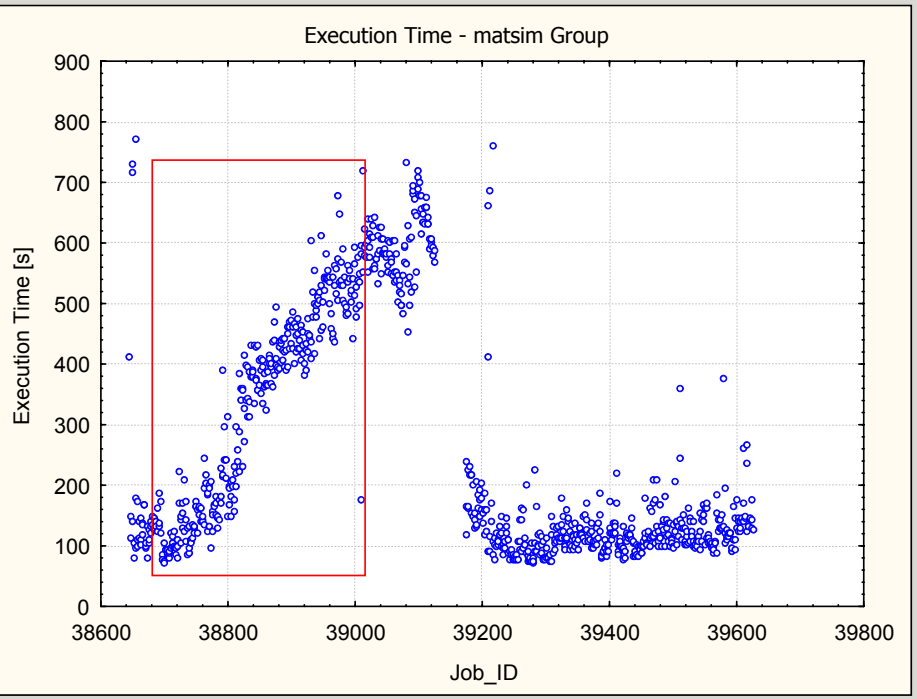


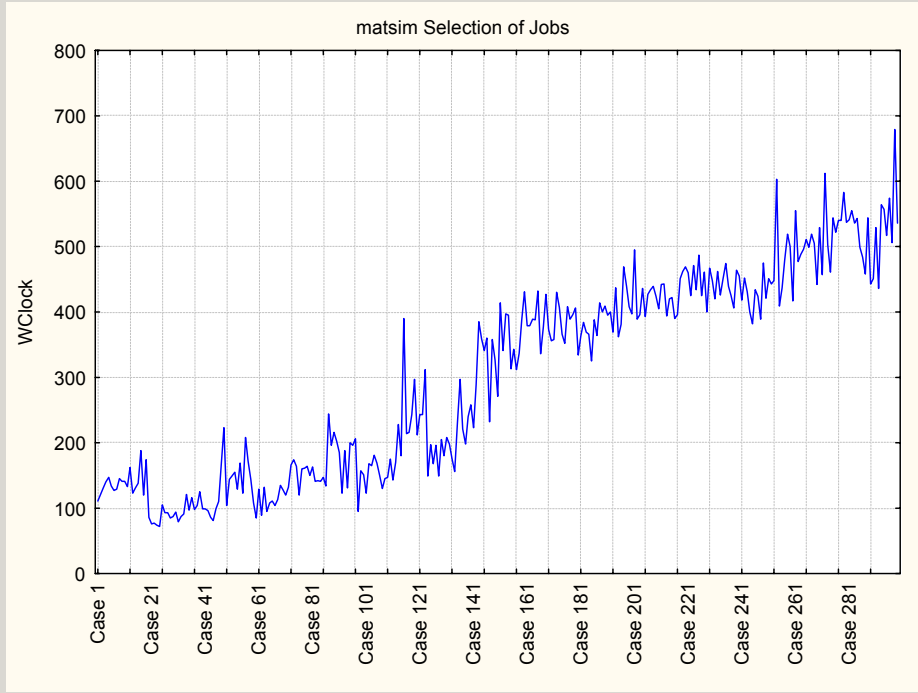
Prediction Methods

- Trend prediction (linear, polynomial…)
- Time-series
  - Exponential Smoothing (Holt, SES, etc)
  - Autoregressive & Moving Average
  - ARIMA (Box-Jenkins)
- Bayesian Statistics
- Wavelets
  - "All models are wrong, but some are useful"

George E.P. Box, Professor Emeritius

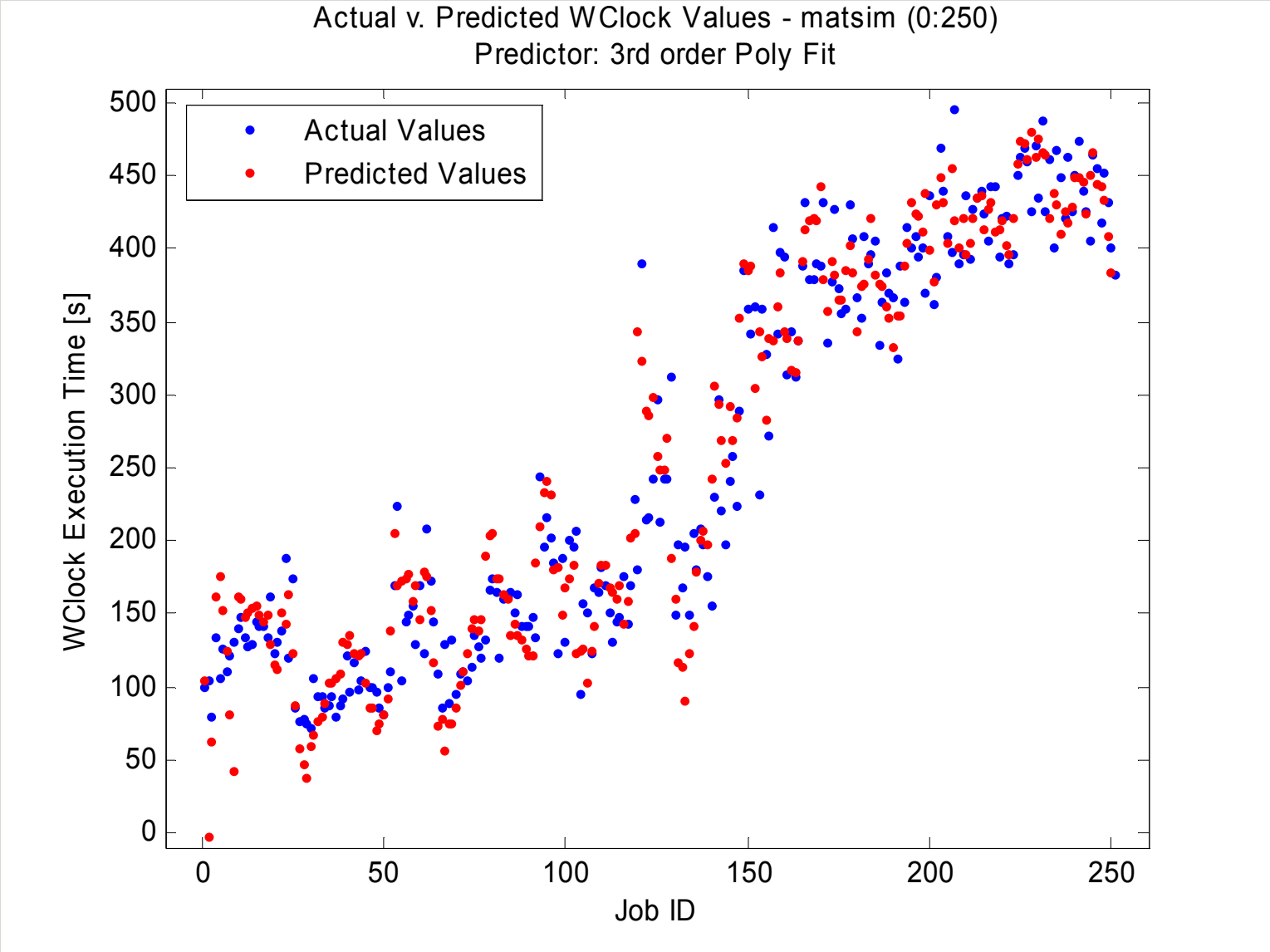
Forecasting



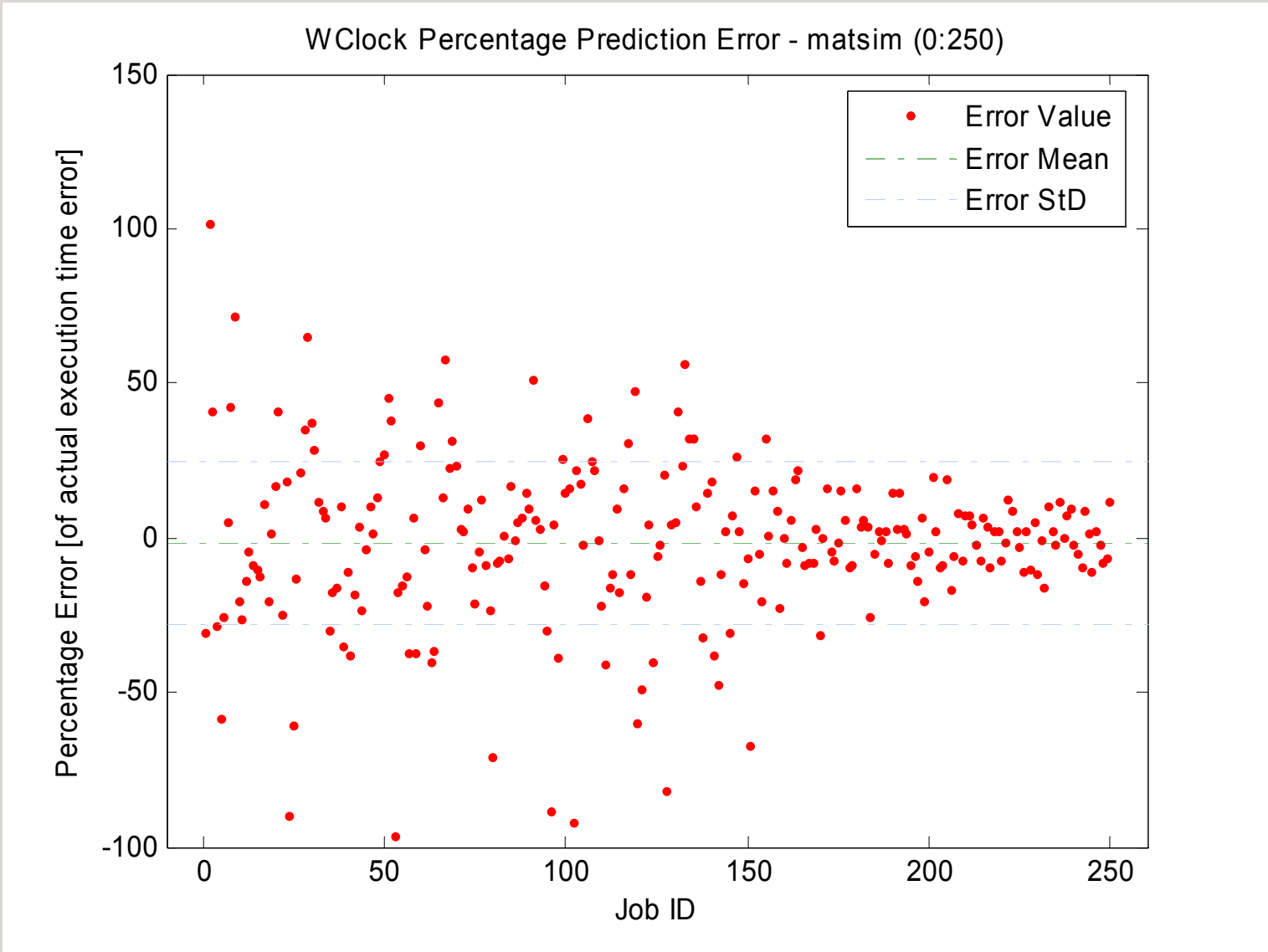


- Forecasting method analysis done on a subset of *matsim* jobs (highlighted)

Trend Based Predictions – *matsim*



Trend Based Predictions – *matsim*



Conclusions

- Clear and pressing need for better Grid scheduling
- Patterns do develop in Grid utilisation
- These patterns vary between “groups”, and in time
- User-independent predictions with reasonable accuracy are possible
- Impact to the Grid utilisation, job workflow and administrative policies may be significant