Bunched Random Forest in Monte Carlo Risk Simulation

Eina Ooka
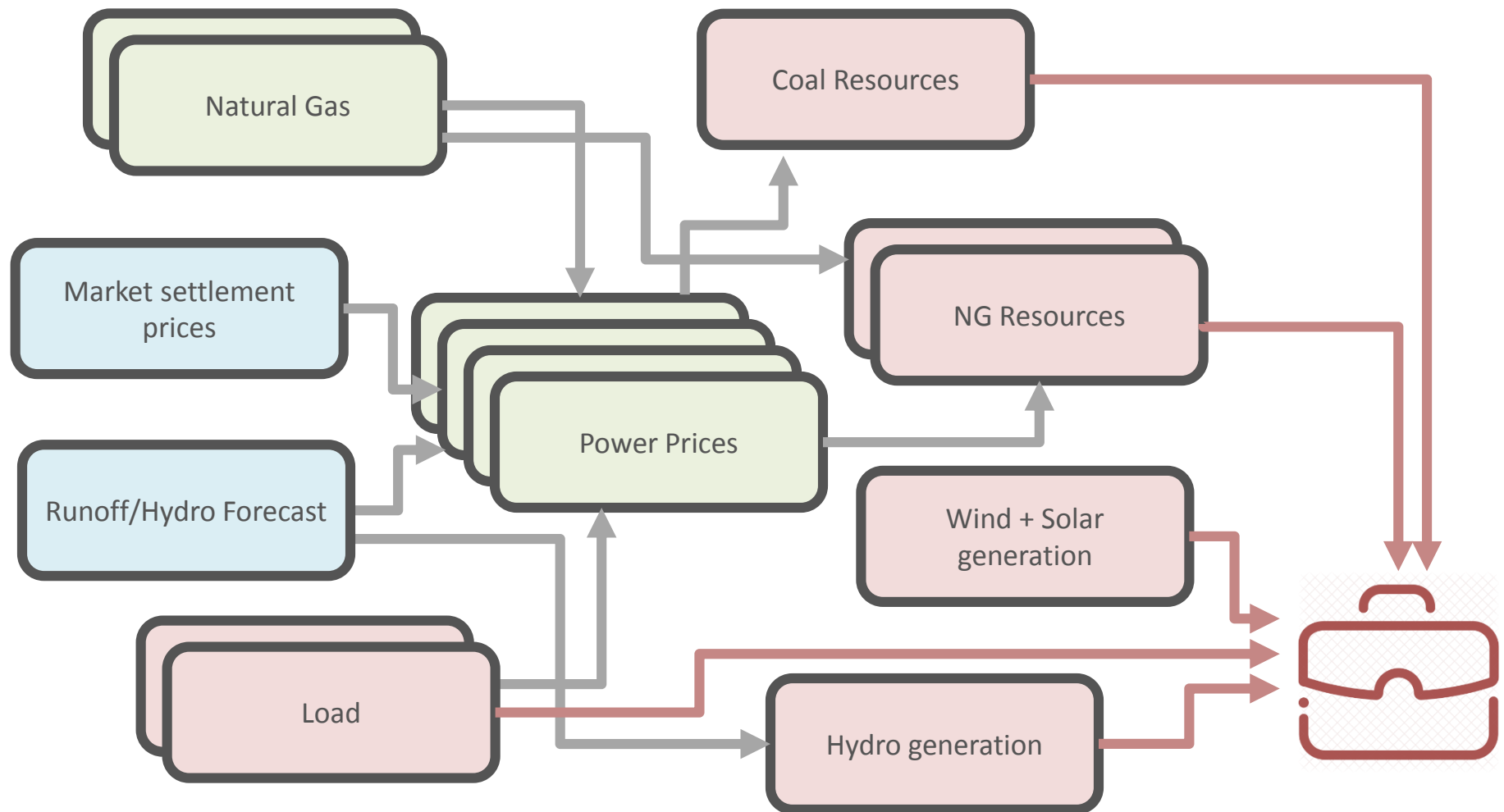May, 2017

R/Finance 2017
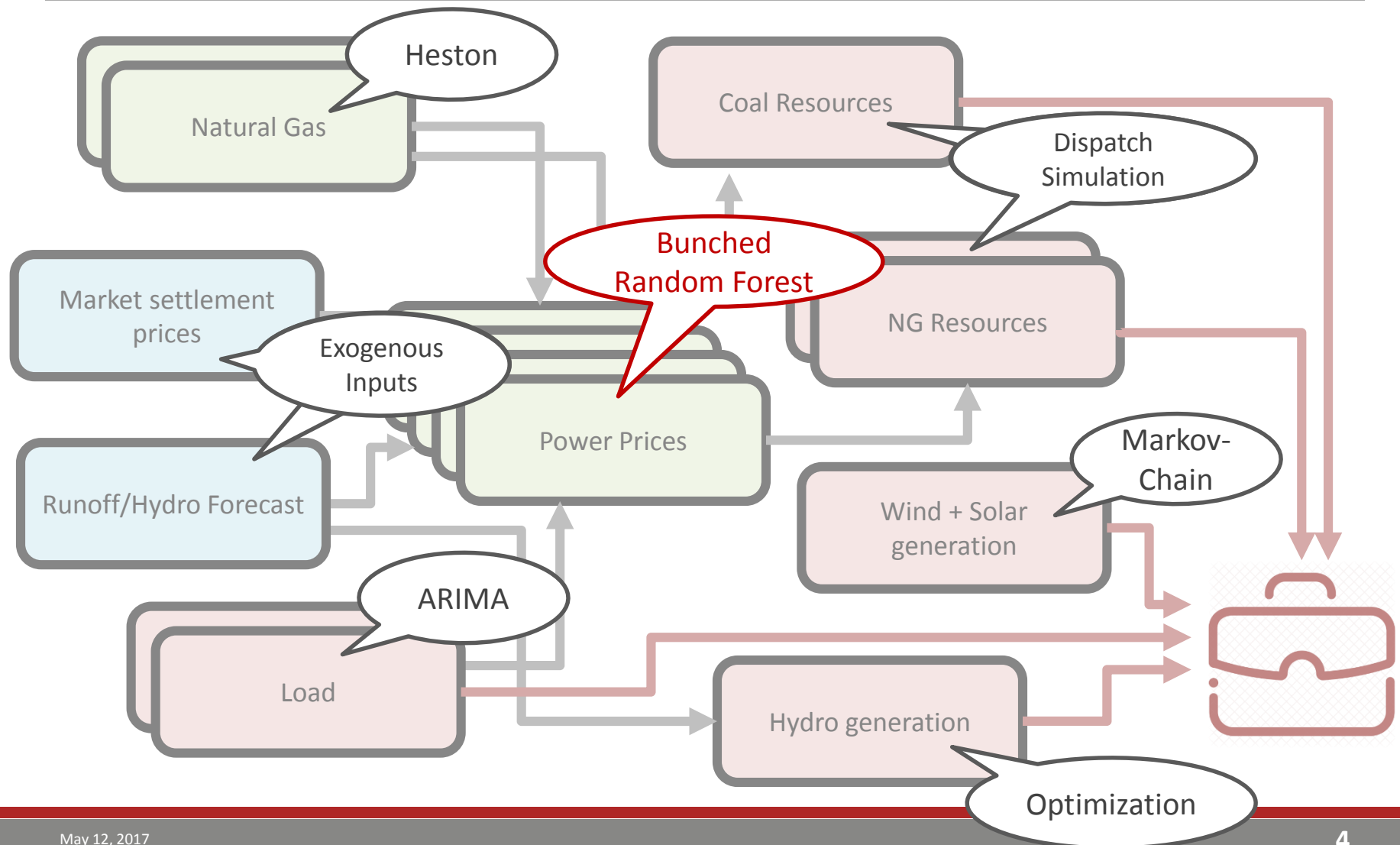**In Chicago**

Power Utility Industry

- **The Energy Authority** serves public utilities nationwide for trading and analytics.

- Mid-term (1 month – 5 years) portfolio management.

- Stochastic simulation models for energy and gas market.

MC Simulation Approach

MC Simulation Approach

Power Price TS Characteristics

- Autocorrelation
- Seasonal and weekly shapes
- Volatility & Heteroscedasticity
  - Seasonal and weekly variability
- Multivariate cross-correlation and non-linear dependency
  - NG, load, regional hydro and other variable generation

- Non-normal distributions
  - fat tails
  - Extreme peaks and drops
- Negative prices
- Consistency with market expectations
- Consistency between monthly, daily and hourly data.

MidC On-Peak Power Price
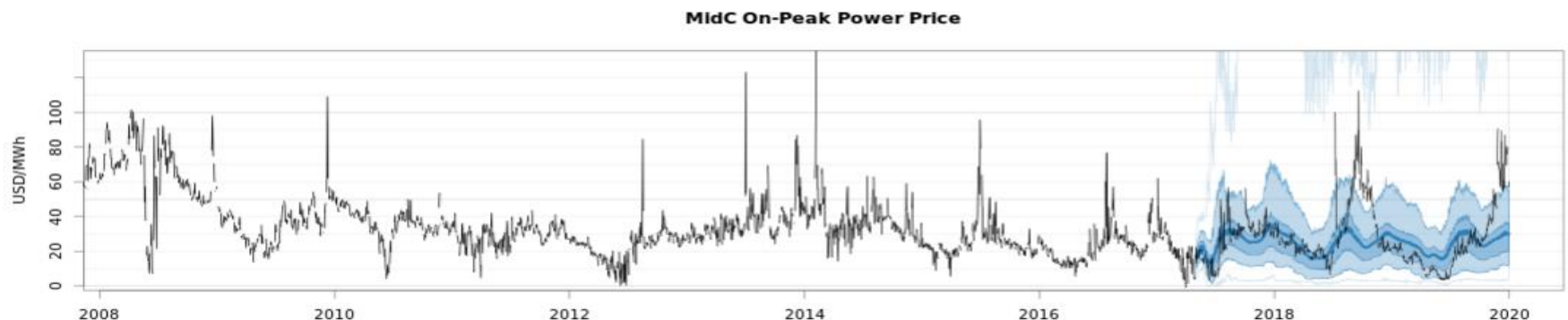
Bunched Random Forest

- Traditional Approach for MC
  - $Price = f(\ldots) + Error(\ldots)$

- Random Forest
  - Aggregation of a few hundred trees moderate values too much → **Low volatility**
  - a single tree encompasses too little predictability → **High volatility**

- Bunched RF in MC
  - Aggregating a selected number of trees for each Monte Carlo iteration
  - Achieve plausible volatility in each MC series, while maintaining the same predictability as RF in the whole MC simulation.
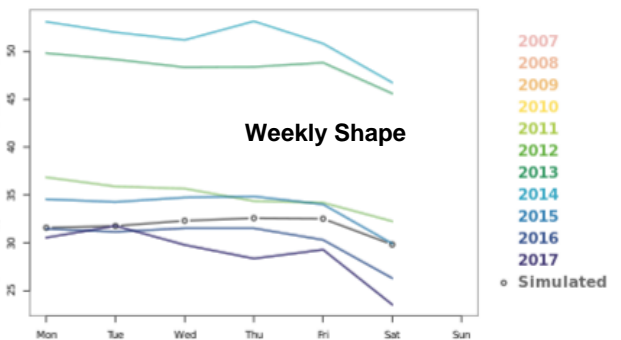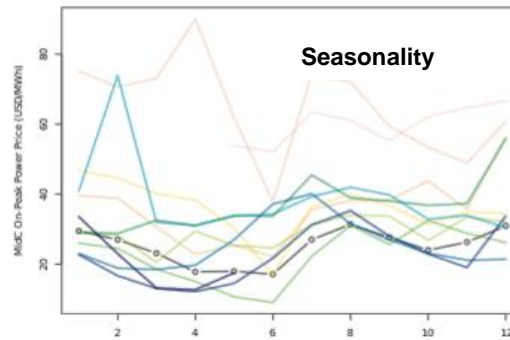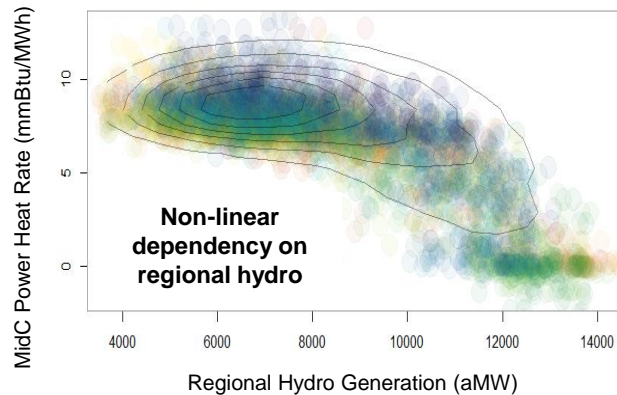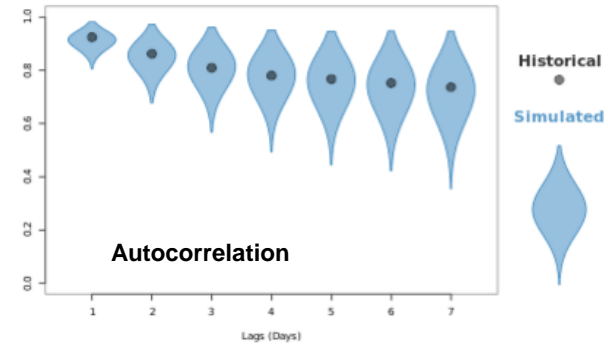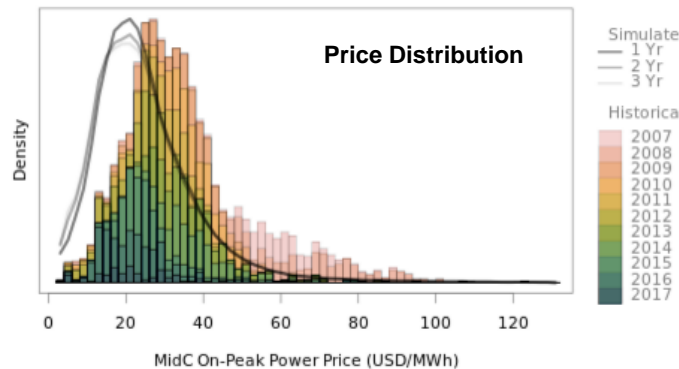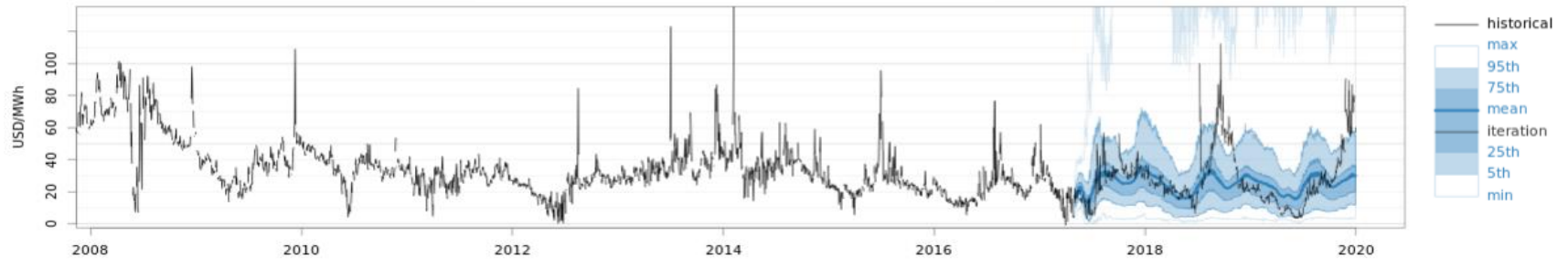
  - Implementation
    - randomForest::predict.randomForest() includes individual tree outputs.
    - After figuring out the bunching number based on historical volatility, sample and aggregate suitable number of individual tree outputs.
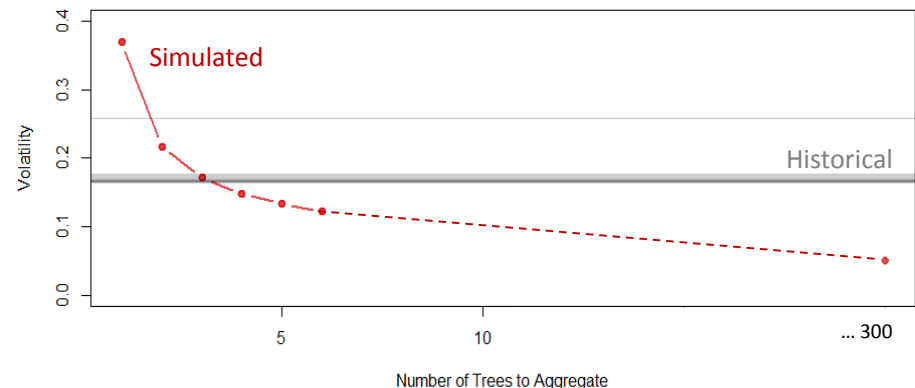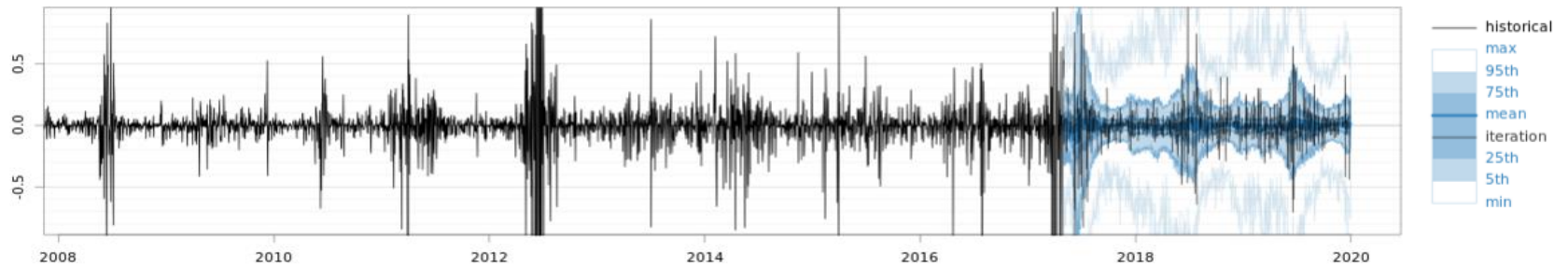
Results

Mid-C Power Price (Historical + Simulated)

Results

Power Price Log-Returns (Historical + Simulated)

Scoring
- Pinball-loss scoring for stochastic forecasting
- Need to achieve all time series characteristics.
  - Volatility, seasonality, moments, …
- A visual inspection with heuristic reasoning is sometimes necessary.
- Backcast and feed the generated power prices to Natural Gas dispatch model, and look at pinball-loss scoring on generation outputs.
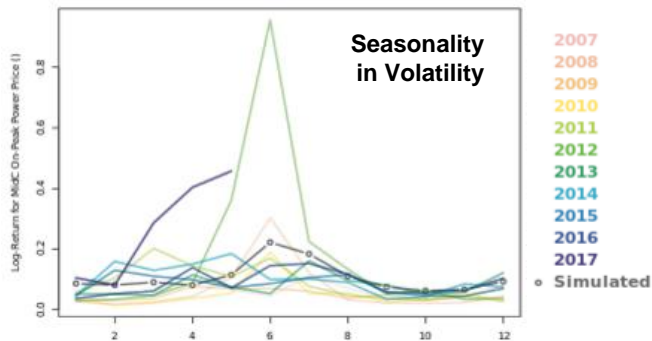
Natural Gas Resource Dispatch (Historical + Simulated)
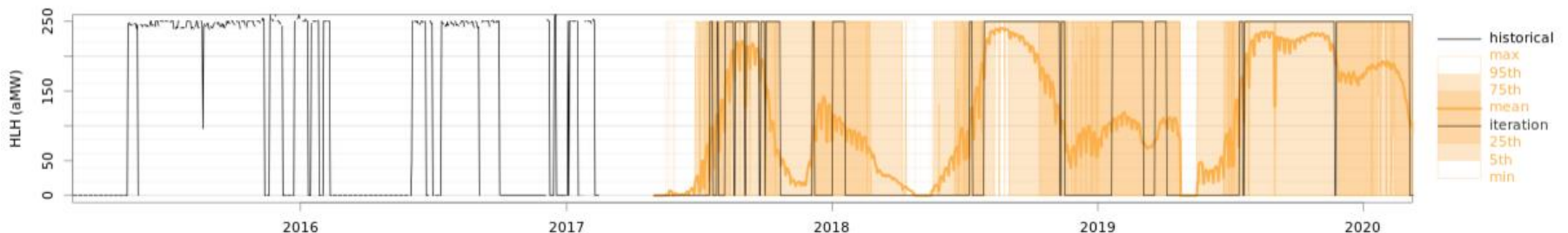
More on utility
portfolio modeling on
my poster from
UseR 2016:
https://github.com/
einaooka/useR2016

Thank you!

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! The Energy Authority is looking for an intern.