Time series forecasting and scenario generation with WaveGlow

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Problem Setup

Operate this network (grid) for one month (discretized time)

Constraint: supply load with sufficient power at each interval

Objective: minimize costs → use as little generator, as much wind as possible

Robust Model Predictive Control

At each time step t, do the following:

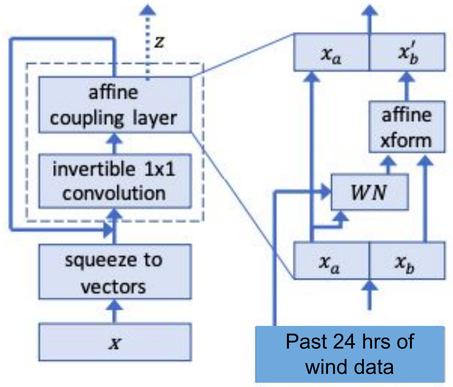
Forecast K scenarios → Optimize control plan over K scenarios → Execute first step of control plan

Proposal: WaveGlow for forecasting

- Use WaveGlow, a normalizing flow model, to generate forecast scenarios
  - Allows variance in scenarios to be linked to forecast
  - Uses conditioning data, making it a forecaster
  - Likelihoods of scenarios can be used as weights in optimization

Model Architecture

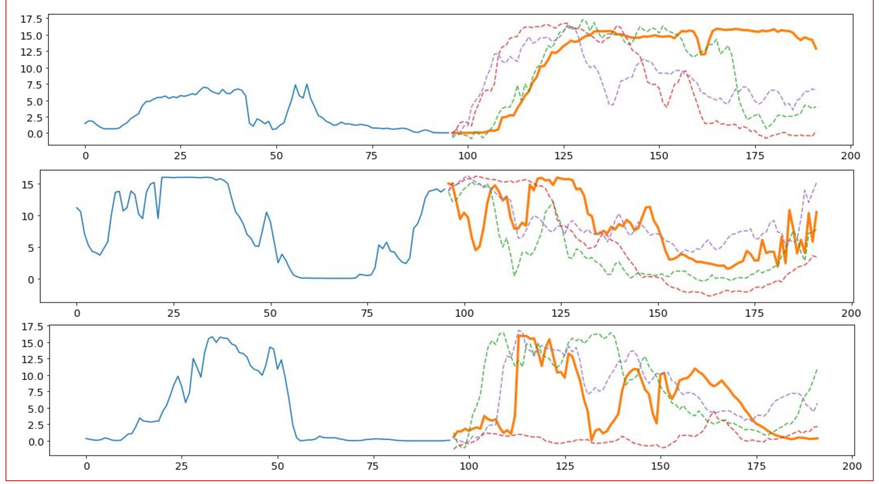
- Two layers per flow
  - Invertible 1x1 conv
  - Affine coupling
- WN block is WaveNet
  - Context data included as input to WN
  - Leads to conditioning ability



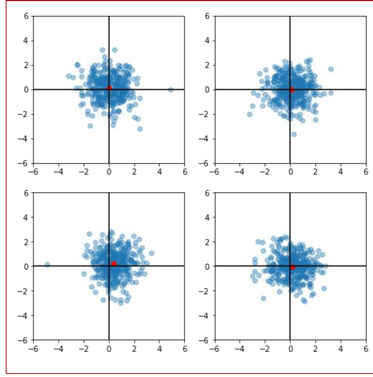
context
(last 24 hours of data)

$z_i \sim N(0,I)$ → WaveGlow → Forecast scenarios

Results: Forecast Scenarios



Results: Embedded Samples



Samples from true N(0,1) distribution, for reference

Left:

- Projections of embedded samples (96 dimensional) onto random 2D planes.
- Heuristic to verify rough "spherical-ness" of embedded samples, beyond just histogram of all samples

Results: MPC Performance

Scenario Generation Method	Average Daily Cost
Optimal	$953
Prescient MPC	$1,044
Multivariate Gaussian	$1,072
Historical Residual Sampling	$1,058
WaveGlow (also as forecaster)	**$1,027**

Conclusions and Future Work

- Model provides viable option to perform both forecasting and scenario generation roles
- For future experiments, different battery parameters (power, storage capacity) may lead to starker separations in performance
- Correct for model bias using discriminator to score samples

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