Machine Learning for Probabilistic Forecasts of Renewable Generation

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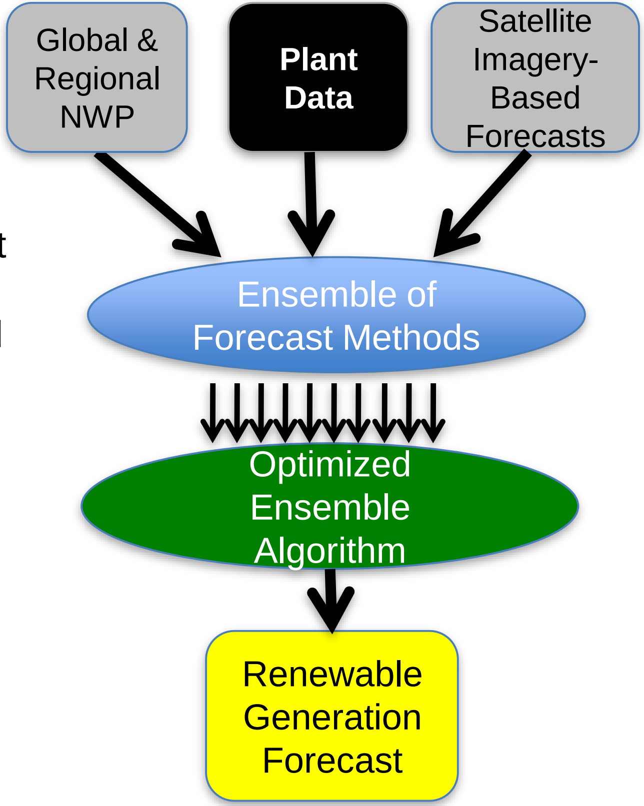
Renewable Generation Forecast System

- **Input Data**
  - Numerical Weather Prediction Forecasts
  - Geostationary Satellite Imagery
  - Plant Data
- **Ensemble of Forecast Methods**
  - Maps the information in the input data to a forecast of the target variables at a future time
  - An ensemble of machine learning methods is used to account for uncertainty in the input data and forecast methods
- **Optimized Ensemble Algorithm**
  - Statistically combines individual forecasts according to historical performance
- **Power Production Model**
  - Translates resource forecast to power forecast

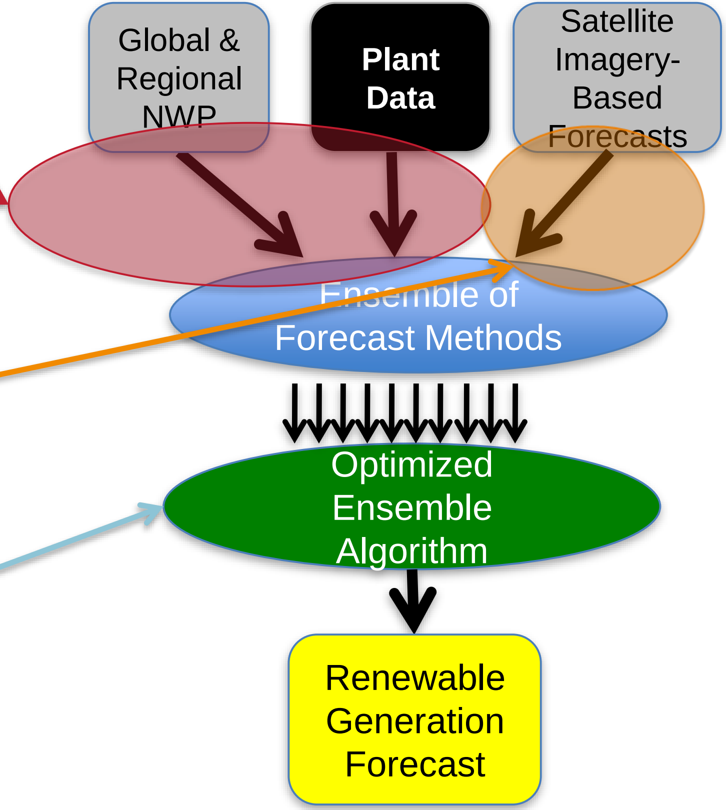


Where Does The AI Go?

- Tree-based models
- Automated Feature selection

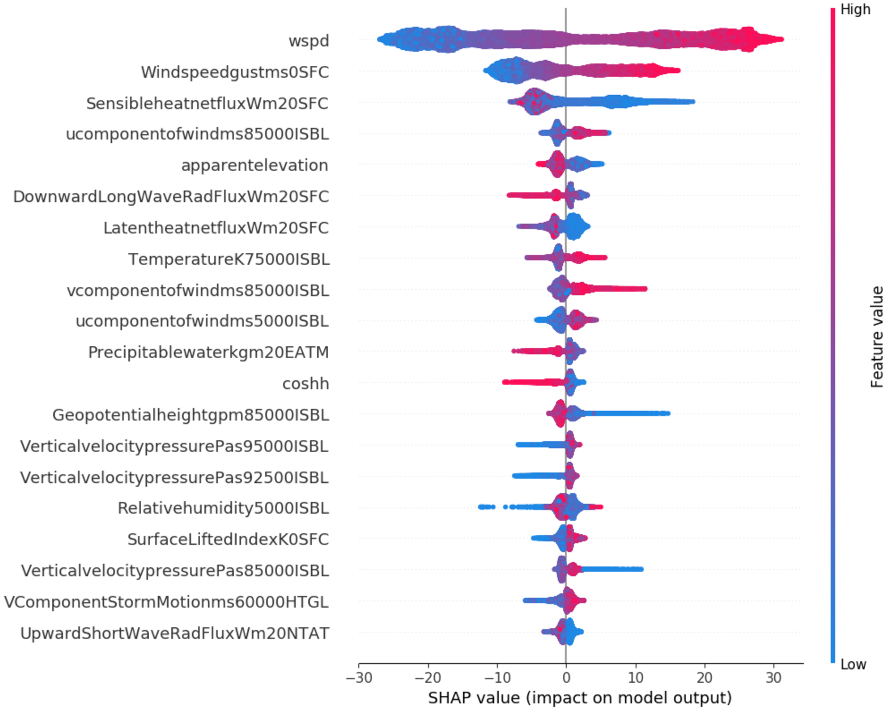
- Automated feature matching and motion detection
- Tree-based models

- Skill-weighted linear combination
- Tree-based models

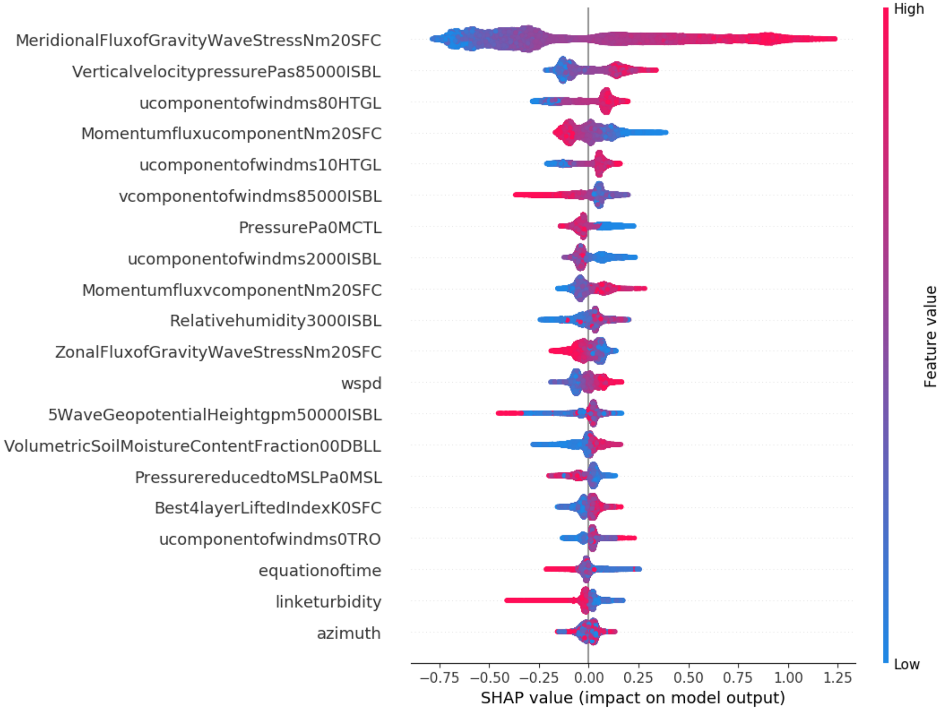


What Does Machine Learning See That Old Statistical Methods Did Not?

Plains wind farm



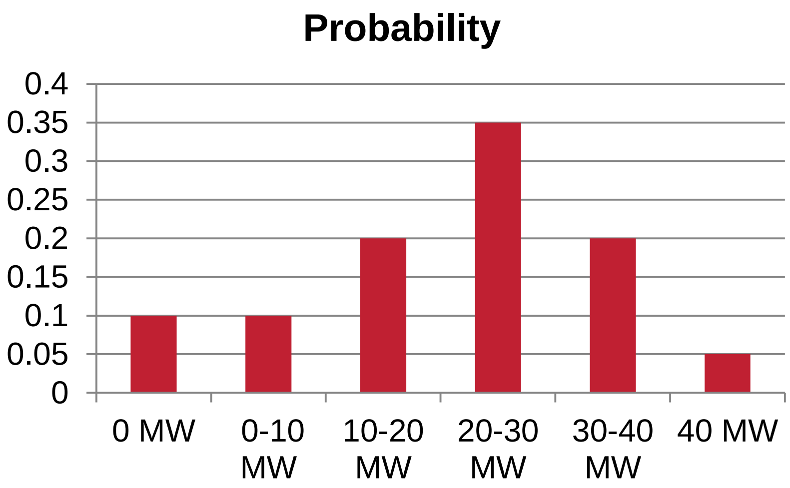
Valley wind farm

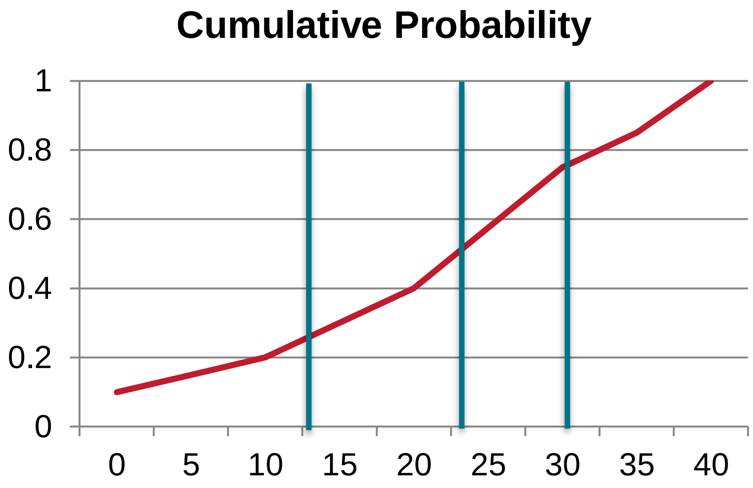


Machine Learning for Probabilistic Forecasting

Most machine learning algorithms do not have native support for probability of exceedance forecasts, but they *are* very well suited to categorical forecasts.

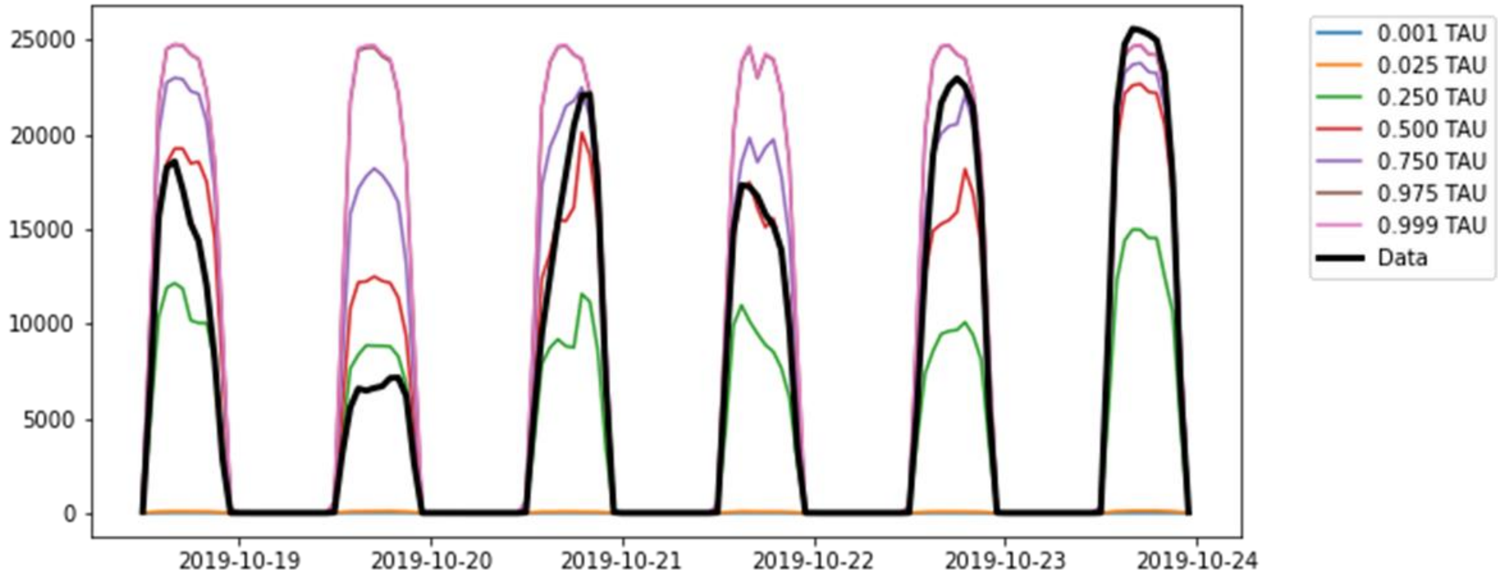
By dividing the range of possible generation values into categories, and predicting the probability of each category, we can interpolate among the probabilities





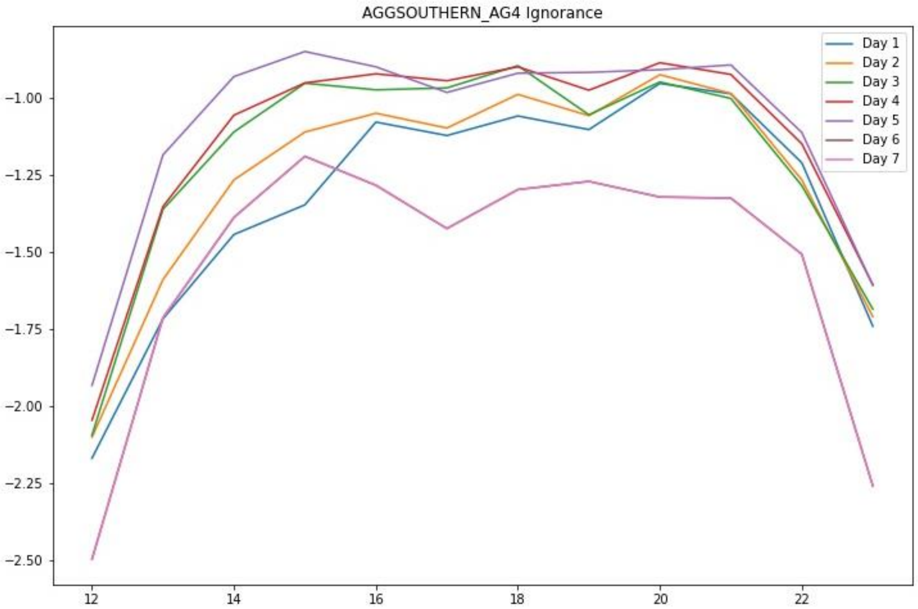
Sample Probabilistic Forecast

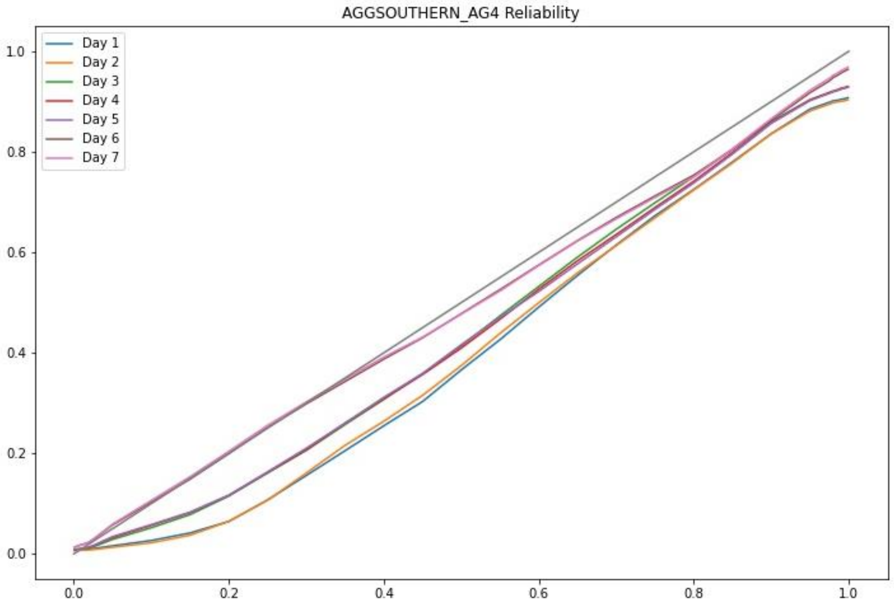
Here are four consecutive 24-hour solar generation forecasts, showing the 0.1%, 2.5%, 25%, 50%, 75%, 97.5% and 99.9% probability of exceedance forecasts, along with the actual generation for a large utility territory, with total installed capacity of 30.4 GW.



Sample Probabilistic Forecast

Ignorance and Reliability skill metrics for the forecast shown above.





Conclusions

We’re working hard to make the most of the generation data and NWP forecast and satellite imagery archives we’ve built up over the years. Machine learning techniques have made real contributions to our skill in using these archives to train forecasts of renewable generation, but we believe we’re at an early stage in realizing their full potential.