Wind Power Forecasting Using Machine Learning

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Introduction

- Problem: Improving wind power prediction accuracy
- Dataset: Wind power output and forecasts from multiple wind farms
- Task: Regression (predicting next-hour wind power)

Introduction – Dataset Overview

- Data Sources: train.csv, windforecasts_wf1–wf7.csv
- Includes timestamps, actual power output, and forecasted wind conditions.

Literature Review

- RF/XGBoost effective for tabular regression tasks.
- LSTM handles temporal dependencies well in energy forecasting.
- Our approach combines classical and deep learning methods.

Dataset Characteristics – Exploration

- Merged multiple forecast files into one dataset.
- Handled missing timestamps and NaNs.
- Time-aligned data using 'date' and 'hours' keys.

Dataset Characteristics – Preprocessing

- Feature engineering: datetime encoding, lag features.
- Forecast columns renamed for clarity (wf1–wf7).

Baseline Model

- Model: Linear Regression or simple average model.
- Purpose: Establish baseline for model comparison.
- Metrics: RMSE, MAE.

Model Definition and Evaluation

- Models: Random Forest, Gradient Boosting, LSTM
- Feature engineering: wind forecasts, lags, rolling stats, time features
- Hyperparameter tuning: GridSearchCV (RF, GB), manual (LSTM)
- Evaluation: MAE, RMSE

Results

- Ensemble models and LSTM outperform baseline

Model	MAE	RMSE
Random Forest	0.007088	0.035106
Gradient Boosting	0.006257	0.035123
LSTM	0.021484	0.058280

Challenges and Errors

- Most challenging issue: Merging forecast files, handling time alignment
- Solution: Careful merge logic, robust feature engineering
- LSTM tuning: computationally expensive

Discussion

- Improved models significantly reduce error vs. baseline
- LSTM captures temporal dependencies, ensembles handle feature interactions
- Limitations: Data size, computational resources, possible overfitting
- Future work: More advanced deep learning, external data, real-time deployment

Conclusion and Future Work

- Hybrid/ensemble approach improves wind power prediction
- Next steps: Deploy model, integrate with wind farm operations

Q&A

- Thank you!
- We’re happy to answer any questions.