Topic Proposal

📝 Topic Name:

⚡ GridGenius – AI-Powered Energy Optimization

(Energy Demand Forecasting Using Machine Learning)
A data-driven approach to predict and optimize urban energy consumption.

Description

This project aims to develop a machine learning model to accurately forecast energy demand in urban areas using historical power consumption data. The goal is to help energy providers optimize supply, reduce wastage, and lower operational costs.

Key Challenges

1. **Handling high-dimensional time-series data** with seasonal trends.
2. **Ensuring model scalability** for large datasets.
3. **Balancing model complexity** and interpretability.

Potential Impact

- Improve energy efficiency and reduce carbon footprint.
- Assist city planners in developing data-driven policies.
- Help utility companies optimize infrastructure planning.

Existing Papers

Below are some relevant research papers on energy demand forecasting using machine learning:

1. "Energy Demand Forecasting Using Machine Learning Perspective Bangladesh"

- **Authors**: Avijit Paul Piyal, Khan Fahad Rahman, Siam Ahmed, Abu S. M. Mohsin
- **Link**: View Paper
- **Description**: Overview of various ML approaches applied to energy forecasting in Bangladesh.

2. "Building Energy Use Prediction Using Time Series Analysis"

- **Authors**: ZHOU Ruijin, PAN Yiqun, HUANG Zhizhong, WANG Qiujian
- **Link**: View Paper
- **Description**: Deep learning methods for forecasting energy consumption in buildings.

Dataset Details

The project will utilize historical power consumption data from Tetouan City to train and validate machine learning models.

Primary Dataset:

Name	Source (e.g., Kaggle, UCI, etc.)	Link	Description / Notes
Power Consumption of Tetouan City	UCI	Dataset Link	Hourly power usage data for different city zones

Estimated Features in the Dataset

1. Energy consumption in different city zones.
2. Environmental parameters like temperature and humidity.

3. Time-based attributes (day, hour, season).

Models to Build

The following models will be implemented and evaluated for forecasting:

1. Time Series Models

- ARIMA (AutoRegressive Integrated Moving Average)
- Prophet
- Seasonal Decomposition of Time Series (STL)

2. Machine Learning Regression Models

- Linear Regression
- Random Forest Regressor
- Gradient Boosting Machines (GBM)
- XGBoost
- Support Vector Machines (SVM)

3. Deep Learning Models

- Long Short-Term Memory (LSTM)
- Gated Recurrent Units (GRU)

Novelty of the Project

1. **Combining traditional ML models with deep learning** to enhance prediction accuracy.
2. **Use of external environmental data** to improve model performance.
3. **Scalability of the model** for real-world urban energy planning.

Challenges

1. **Data Preprocessing Complexity**
   - Dealing with missing values, noise, and anomalies in the dataset.
2. **Feature Engineering**
   - Identifying relevant external factors affecting energy consumption.
3. **Model Interpretability**
   - Ensuring that stakeholders can trust and understand the model's predictions.
4. **Real-Time Prediction Feasibility**
   - Optimizing models for deployment on edge devices for smart city applications.

Other Resources

Resource Type	Description	Link
Blog / Tutorial	Introduction to Time-Series Forecasting	Resource Link
Tool / Framework	scikit-learn for ML modeling	Resource Link

To-Do

- [ ] Search for additional datasets.
- [ ] Identify more research papers.
- [ ] Experiment with baseline forecasting models.
- [ ] Develop a proof-of-concept implementation.

Additional Notes

- Consider adding real-time data pipelines for continuous prediction.
- Evaluate the trade-off between accuracy and interpretability for stakeholders.