Classroom Usage Forecasting (Occupancy Based)

Overview

This project forecasts next-hour classroom electricity draw using sensor-based occupancy data. The system processes high-frequency room sensor readings, converts them into an hourly time series, trains a simple ARIMA model, and predicts the next-hour usage. The dashboard visualizes recent classroom usage, the forecasted value, and the confidence interval to indicate prediction uncertainty.

Problem Statement

Classrooms often consume electricity even when unoccupied, leading to energy wastage. The objective is to use occupancy information derived from sensor data to model classroom usage patterns and forecast the next-hour room electricity draw. The prediction helps enable smart energy management by identifying low-usage periods.

Dataset

The dataset contains room sensor measurements collected approximately every 30 seconds. Key attributes include Date, Time, multiple temperature, light, sound, CO_2, PIR motion sensors, and the ground-truth Room_Occupancy_Count. Timestamp is created by combining Date and Time. Room_Occupancy_Count is used as a proxy for electricity usage because higher occupancy typically increases lighting, HVAC, and device consumption.

Workflow

Load the dataset, create a timestamp from Date and Time, set it as the time-series index, and select Room_Occupancy_Count as the target variable. Resample the high-frequency data into hourly averages to reduce noise. Use recent data to capture current behavior. Train a simple ARIMA(1,1,1) model on the hourly occupancy series. Forecast the next-hour usage and compute the confidence interval. Visualize recent usage, the predicted value, and the confidence band on a Streamlit dashboard.

Technologies Used

Python, Pandas, Statsmodels (ARIMA), Matplotlib, Streamlit.

Installation

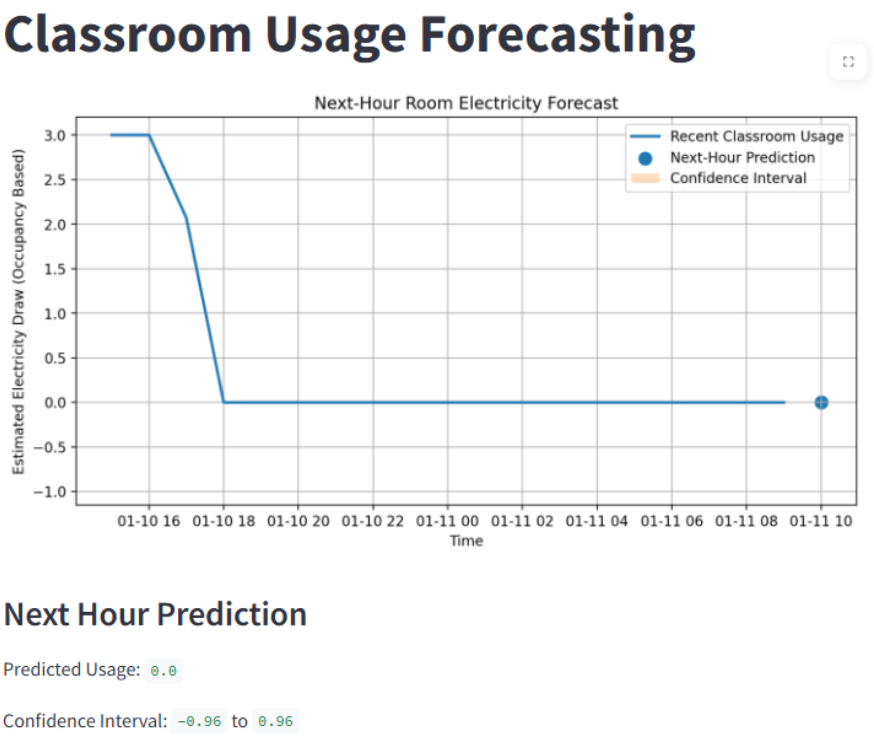
Install dependencies using: pip install pandas matplotlib statsmodels streamlit

How to Run

Place the dataset file (e.g., room_occupancy.csv) in your project folder, update the file path if needed, and run: streamlit run app.py

Output

The dashboard displays recent classroom usage (hourly occupancy), the next-hour predicted usage, and a shaded confidence interval indicating uncertainty. A numeric summary shows the predicted value and its lower and upper bounds.



Key Features

Uses sensor-derived occupancy as a proxy for electricity draw, performs hourly time-series forecasting with a simple ARIMA model, provides next-hour prediction, and visualizes confidence intervals for decision support.

Applications

Smart campus energy management, automated control of lights and HVAC, identification of underutilized classrooms, and short-term demand planning.

Limitations

Relies on occupancy as a proxy instead of direct electricity meter data, uses a univariate ARIMA model without external variables, and performance depends on data regularity and recent patterns.

Future Enhancements

Integrate actual electricity meter readings, include exogenous variables such as temperature and schedule, extend forecasting horizon, and deploy for real-time building automation.

Conclusion

The system demonstrates that sensor-based occupancy time series can be used to forecast next-hour classroom electricity draw with quantified uncertainty, supporting efficient and proactive energy management in smart campus environments.