Prediction of Energy consumption in a building using Machine Learning

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Abstract

- Data set of energy meters from non-residential buildings with a range of two full years.
- Project describes the process of data collection, cleaning, and convergence of time-series meter data, the meta-data about the buildings, and complementary weather data.
- This data set can be used for further prediction bench marking and prototyping as well as anomaly detection, energy analysis, and building type classification.

Motivation

- Machine learning and prediction techniques are a vital component of many of the ways of finding savings opportunities and quantifying the risk and reward of undertaking opportunities to save energy, reduce carbon emissions of buildings, and reduce the operating costs of building.
- When it comes to machine learning innovation in academia, one of the most significant assets can be large and open data sets that the community can use to prototype and quantitatively compare techniques in ways that show better value in terms of speed, accuracy, or implementation ease.

Data Cleaning and prepossessing

- Raw Data was provided by University Of Madison -Wisconsin.
- The data set had over **20 million** data points which were collected over a period of 3 years
- Data set had over 20 features which were used to predict our target variable **Meter Reading** in kilowatt hour.
- Most influencing factors of the data set were - size, year of build, air temperature.
- It took 58 minutes to run the complete python script, starting from cleaning, prepossessing, training and predicting on a t2.2xlarge (32 GB memory,8 vCPUs)

Architecture

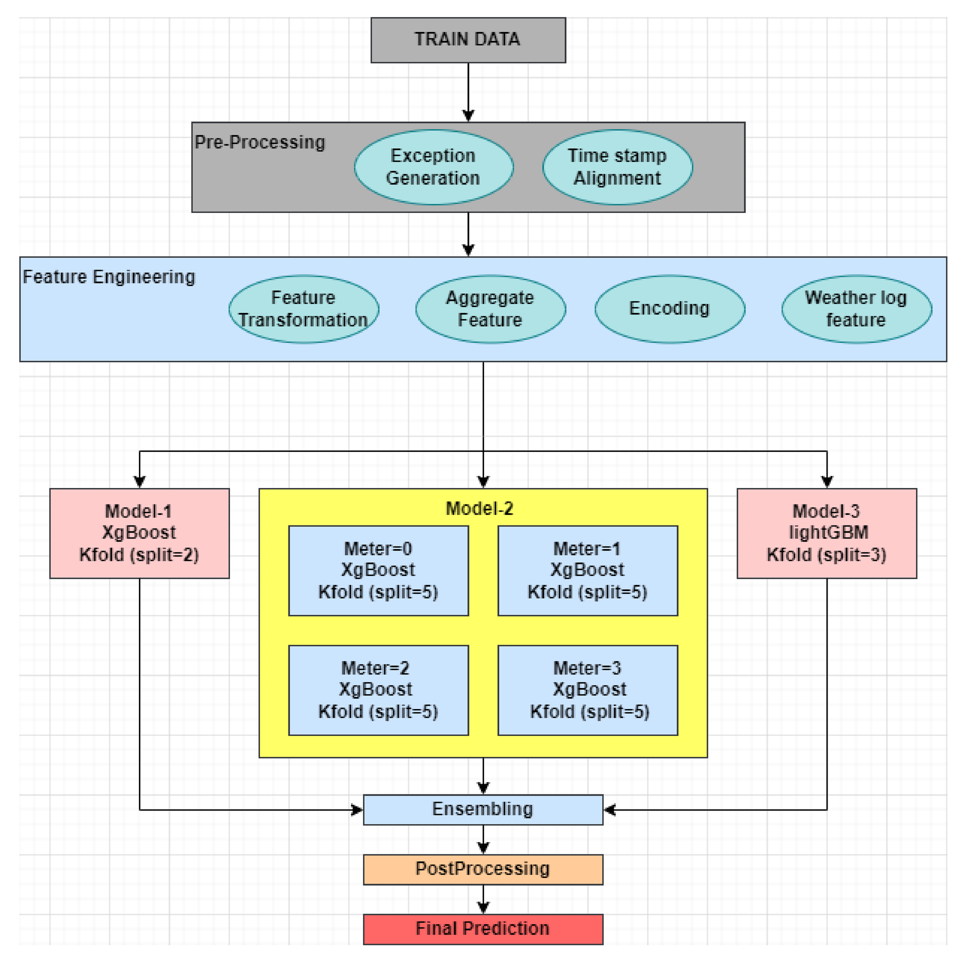

Figure 1:Process flow architecture

Correlation & Results ML Models

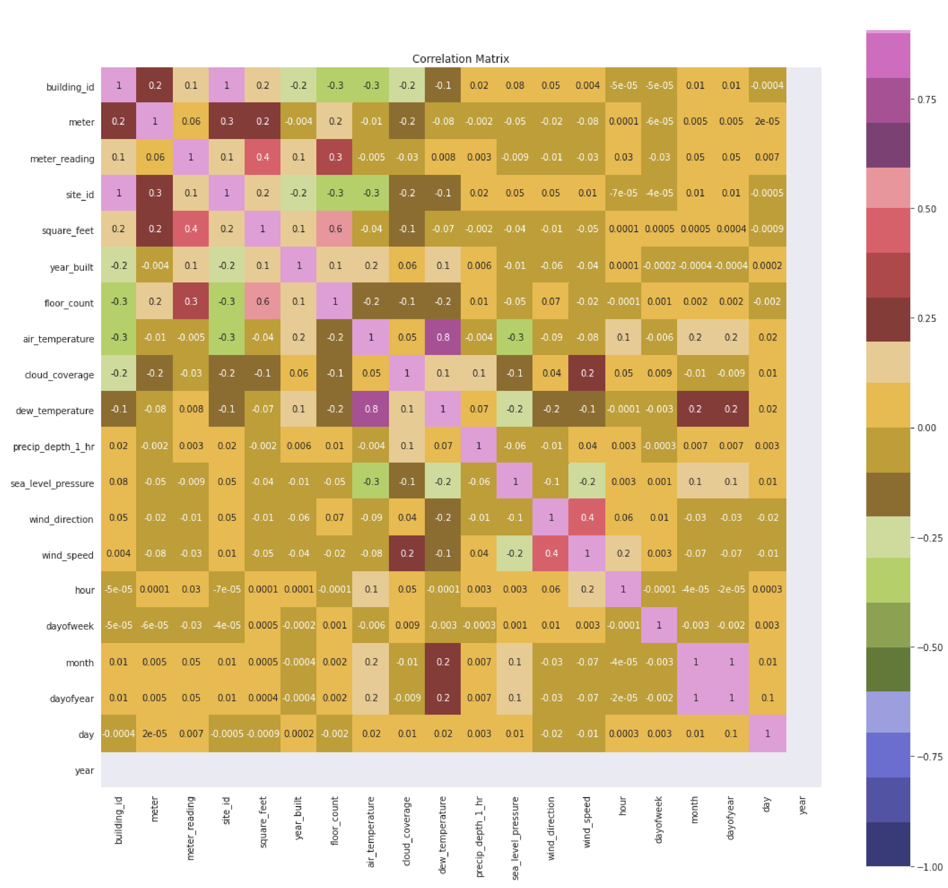

Figure 2:correlation matrix of the features available

Model	RMSLE Score
Decision Tree	1.786
CatBoost	1.628
LGBM GBDT	1.599
Custom Model	1.599

Table 1:Improvement DL over random sampling

Experiment & Results

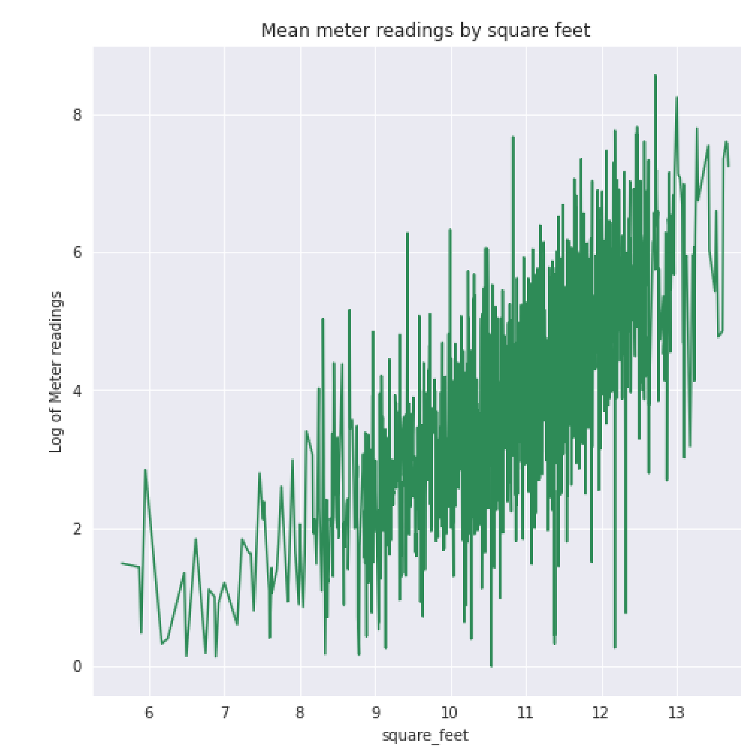

Figure 3:Mean meter readings by square feet

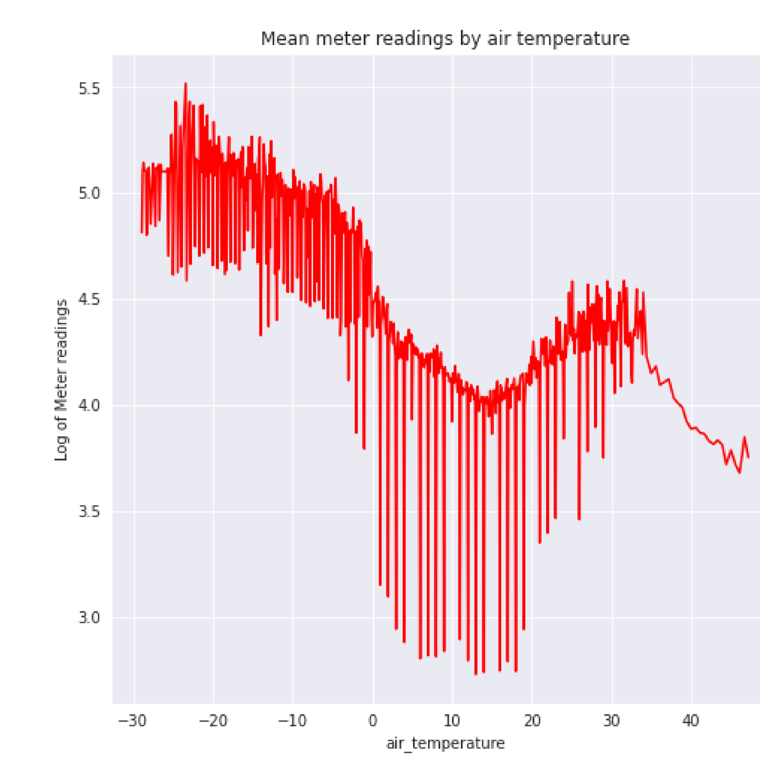

Figure 4:Mean meter readings by temperature.

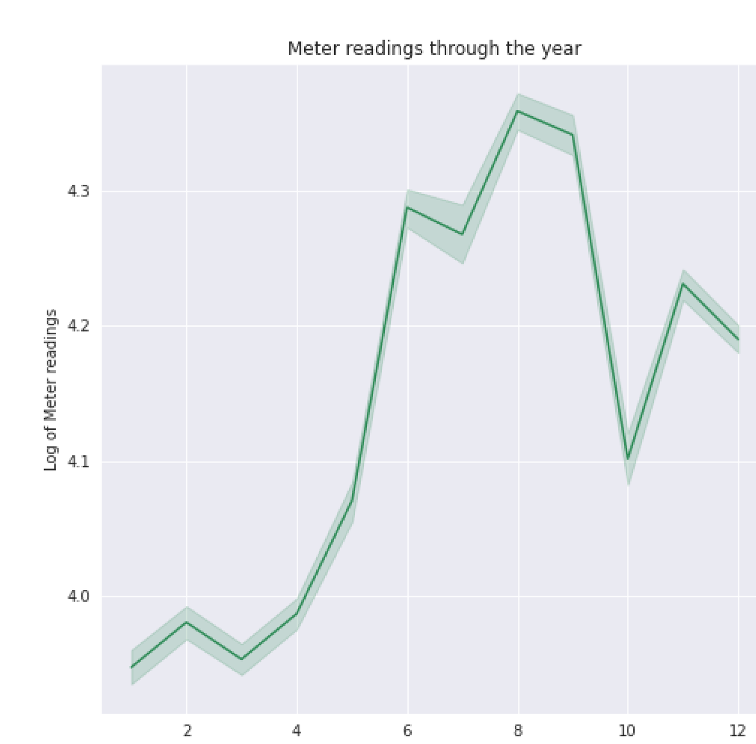

Figure 5:Meter readings through the year .

Conclusion & Future Work

We were able to extract

- There is clear positive relation between size and consumption. As the size of the building increases, the meter consumption also increases.
- Year built is also having a slight positive correlation as older buildings tend to consume more energy than the newer ones.
- The average meter readings are high when the temperature is negative, once it starts increasing, the meter consumption reduces. It again increases when the temperature rises above 15 deg C.
- The average monthly consumption is minimal in the initial months and then rises after April in the onset of spring. It peaks in August and starts dropping again in the Autumn and winter months.
- consumption drops to a minimum in the early hours of the day and then rises after 6am. It hits the peak in the afternoon and then drops after 7pm.
- Educational institutes have the peak usage in August and September
- consumption for entertainment as well as food sales buildings rises is minimum around March and maximum in August.

Related Work

- `https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Energy_Efficient_MayoralNote_2014.pdf`**Improving Energy Efficiency** in Buildings

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