Predicting Electricity Prices Using Machine Learning

June 2021

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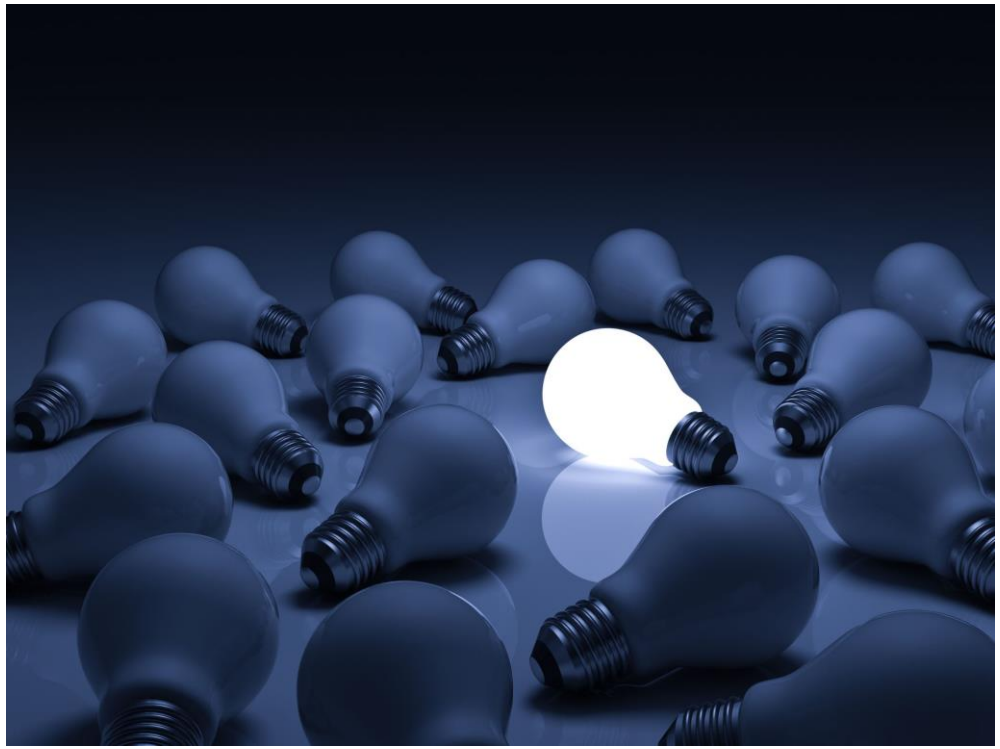
Agenda

- Business Overview
- Context and Data Acquisition
- Data Processing & Analysis
- Modeling and Evaluation
- Conclusions and Recommendations

Business Overview

Electricity

- Traded using market rules
- Unique commodity
- Depends on weather, intensity of activities, and seasonality
- Price dynamics not observed in other markets



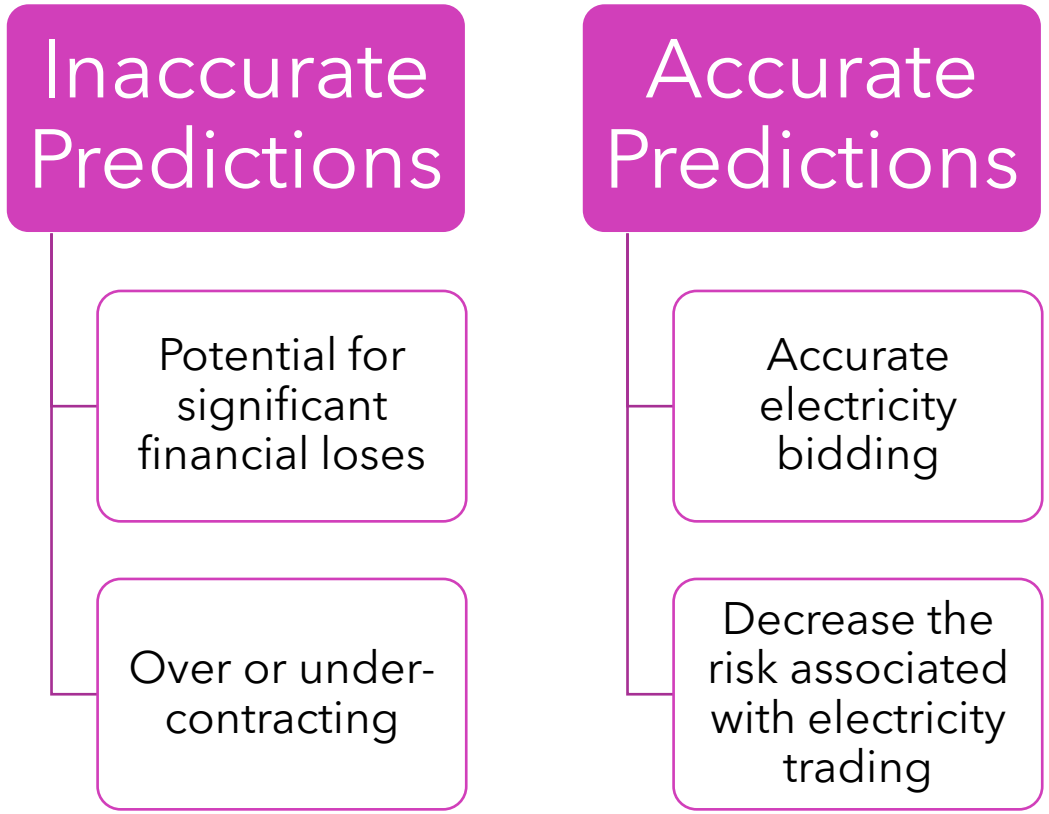
Electricity Price Forecasting (EPF) - Motivation

- Extreme price volatility has forced market participants to hedge volume and price risks
- The cost or over- and under-contracting can lead to significant financial losses
  - California Crisis (2000-2001): $45 billion
  - Texas Energy Crisis (2021): $195 billion

EPF has become a fundamental input to energy companies' decision-making process

Business Evaluation

- Outcome
  - Accurate prediction of electricity price
- Action
  - Accurate power bidding/scheduling
- Judgement
  - Can the models' accuracy be trusted to make critical business decisions?



Context and Data Acquisition

Context

- Data from a Data Centre at Cork Airport
- Covers periods from 2011 to 2013
- Main sources of energy are Oil, Gas, and Wind
- The average person in Ireland consumes 6,407 kWh per year

Data Understanding - Features

- Dates & time
- Wind Energy Production
- System Load
- Temperature
- Windspeed
- CO_2 intensity
- Electricity Price (Actual & Forecasted)

Data Limitations and Assumptions

- No information about consumers or stakeholders
- No units provided for some columns, assumed euro cents per kWh for electricity price and SI units for the rest
- Data are accurate and collected properly

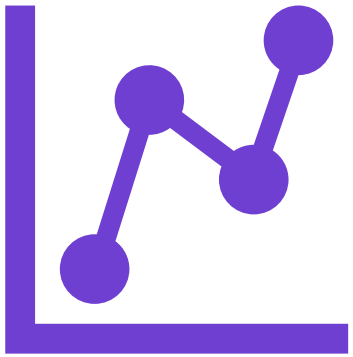
Data Processing & Analysis

Data Cleaning and pre-processing

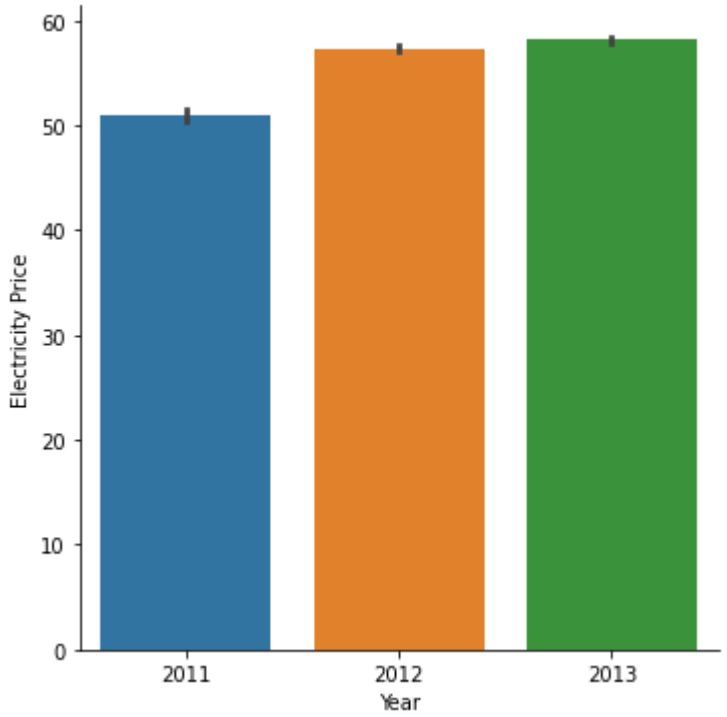
Check problems with data

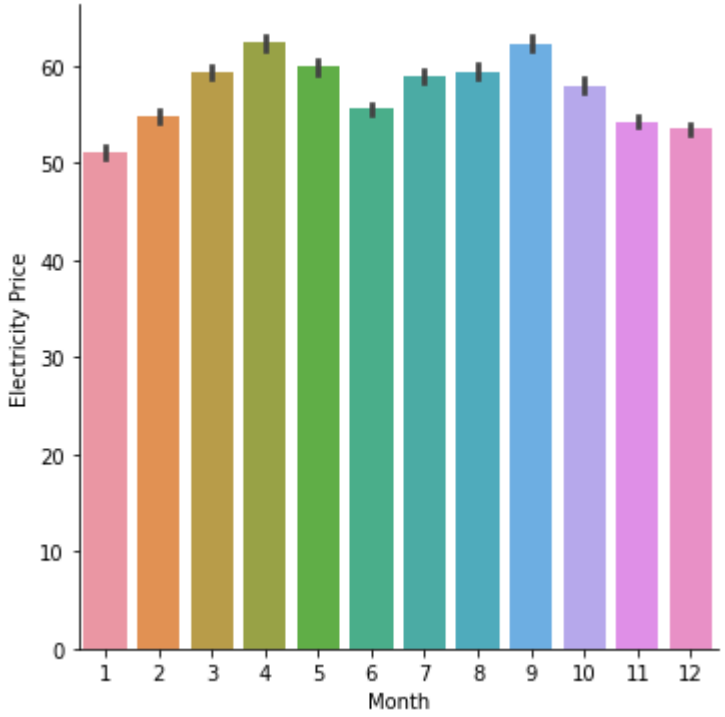
Extract relevant information

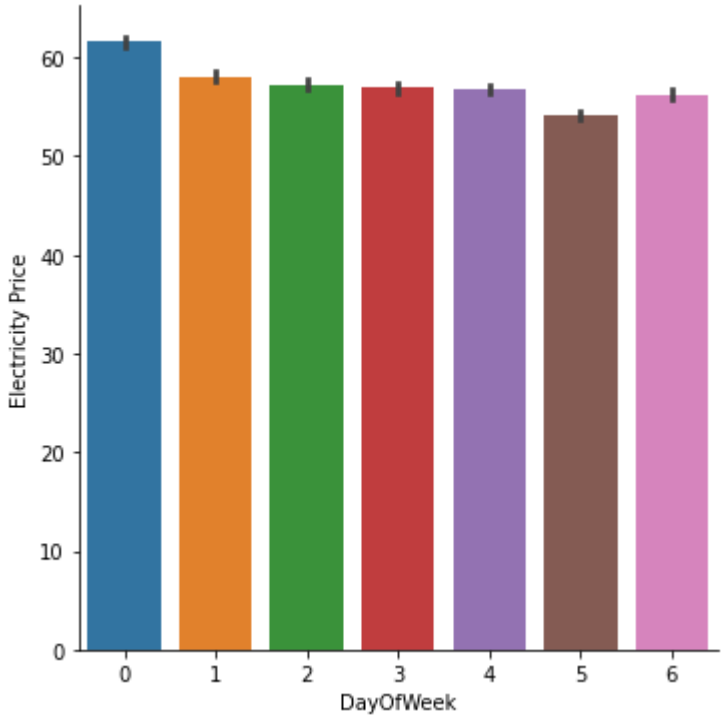
Preliminary results



Exploratory Data Analysis







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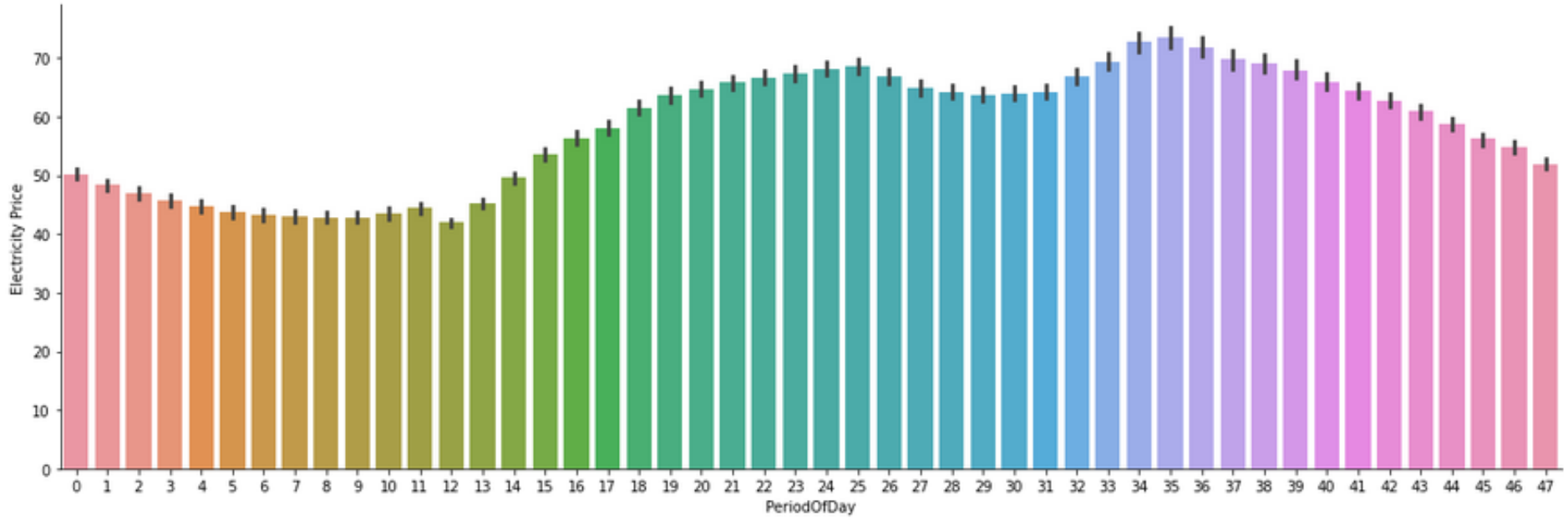

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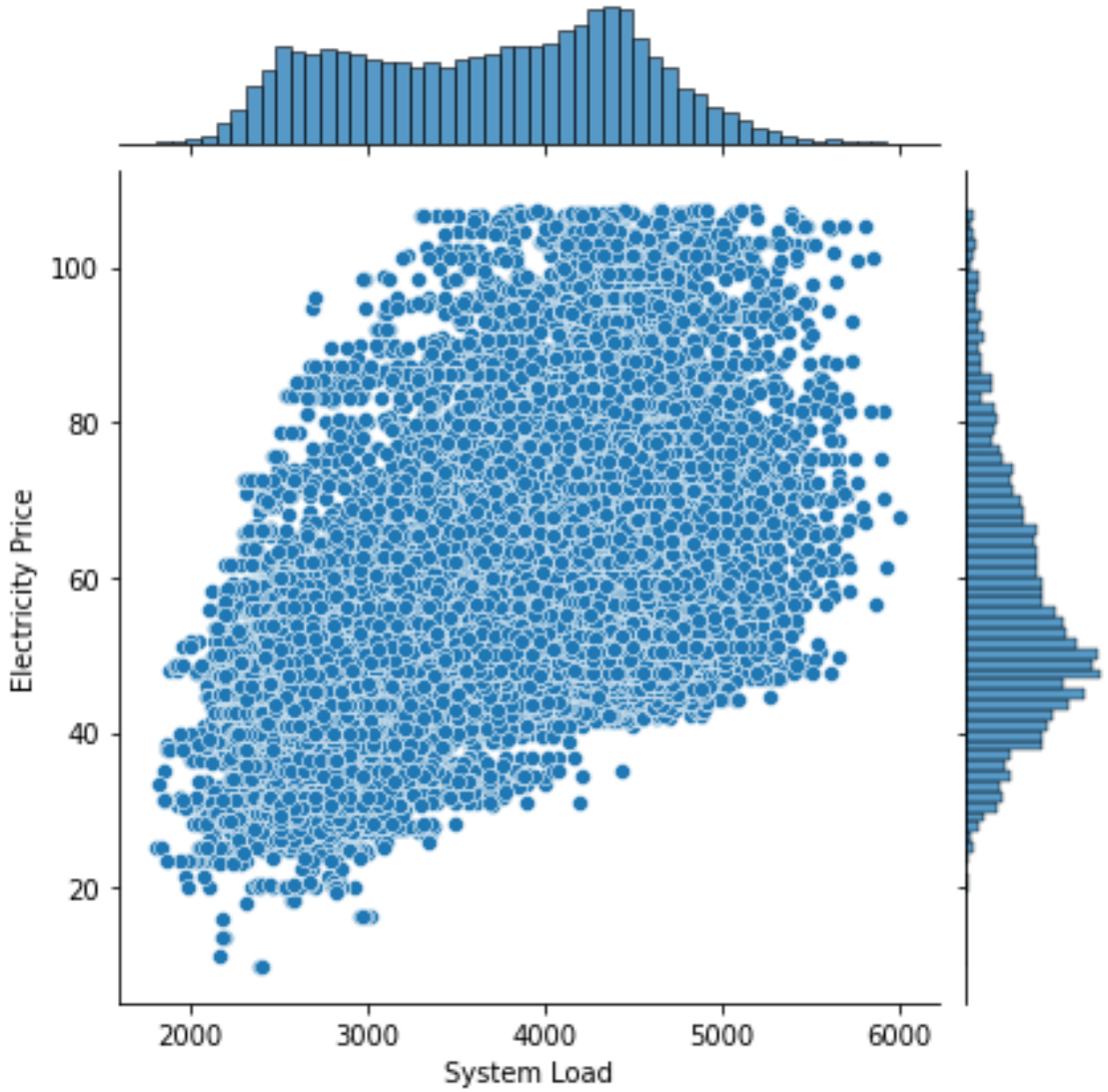
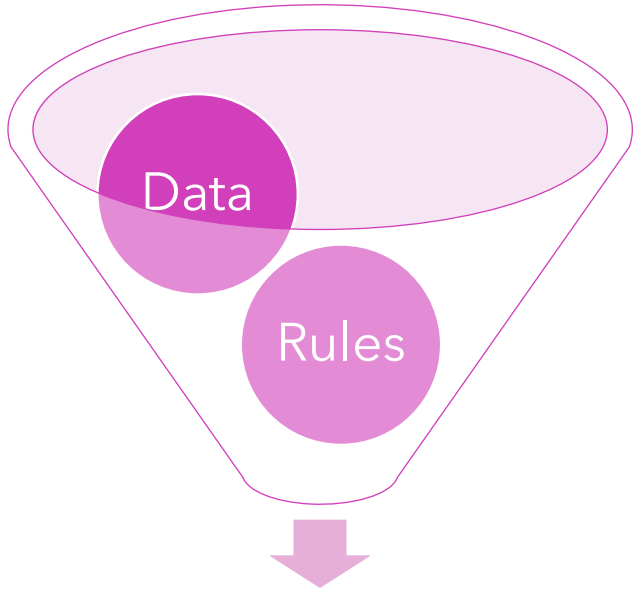


Modeling and Evaluation

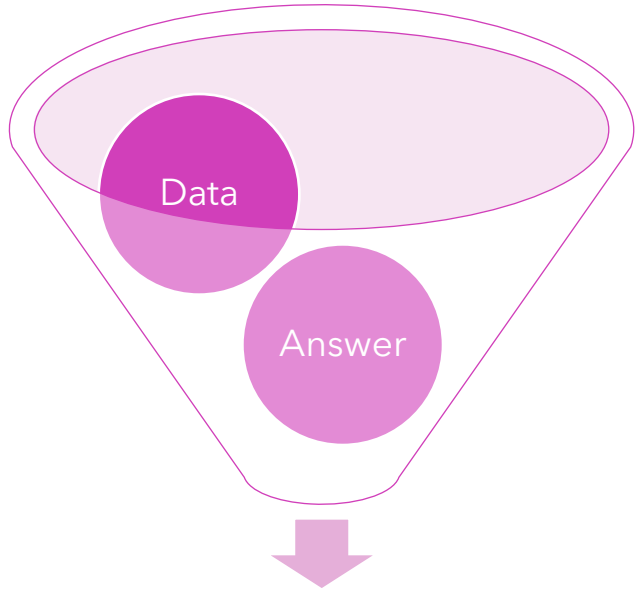
Machine Learning Overview

Classical Programming



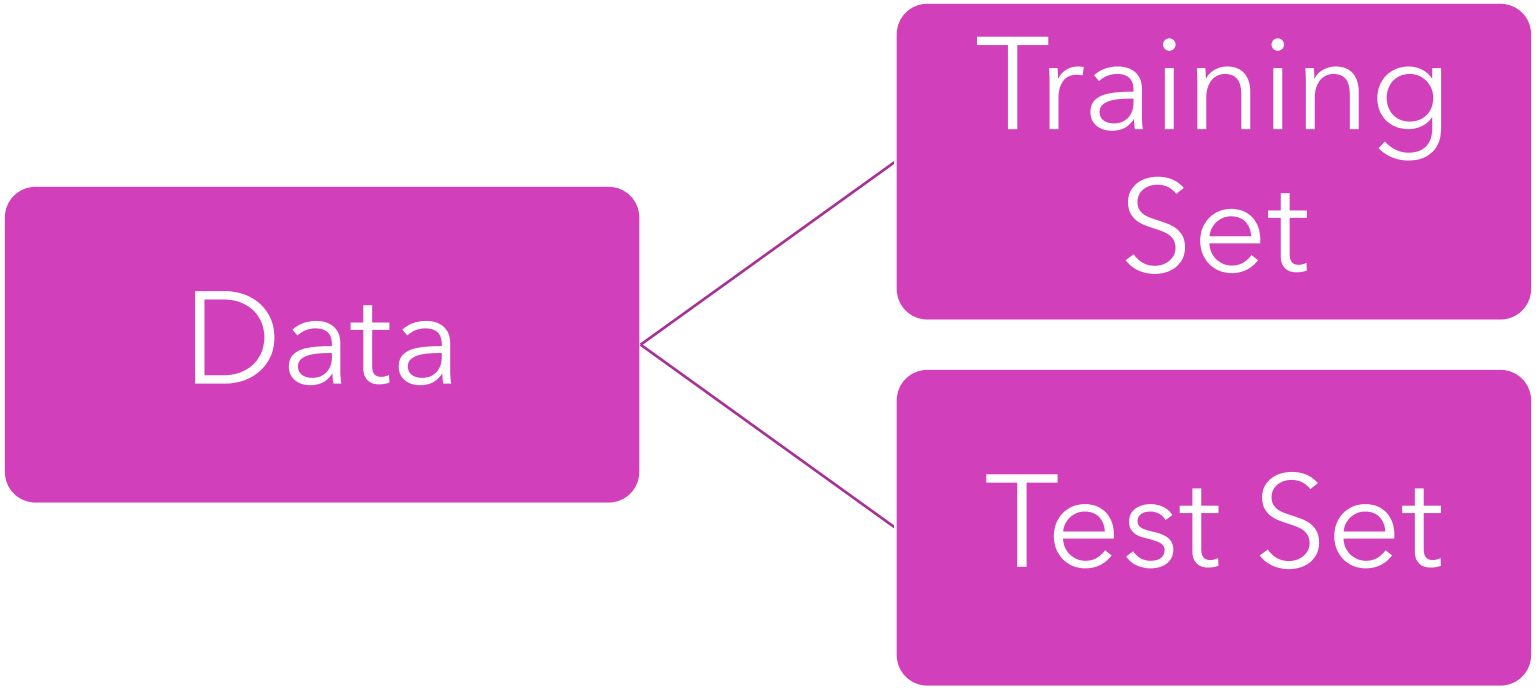
Answer

Machine Learning

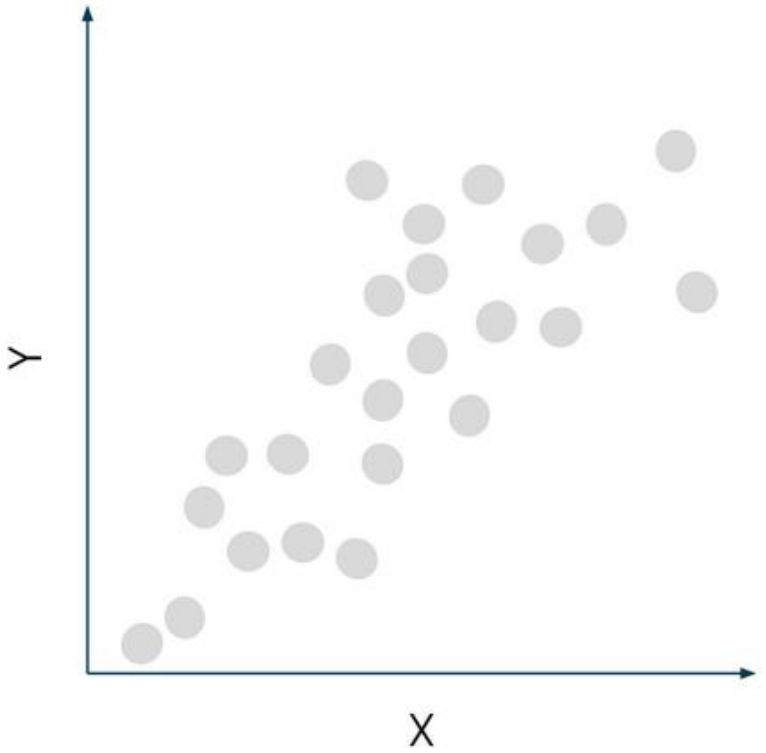


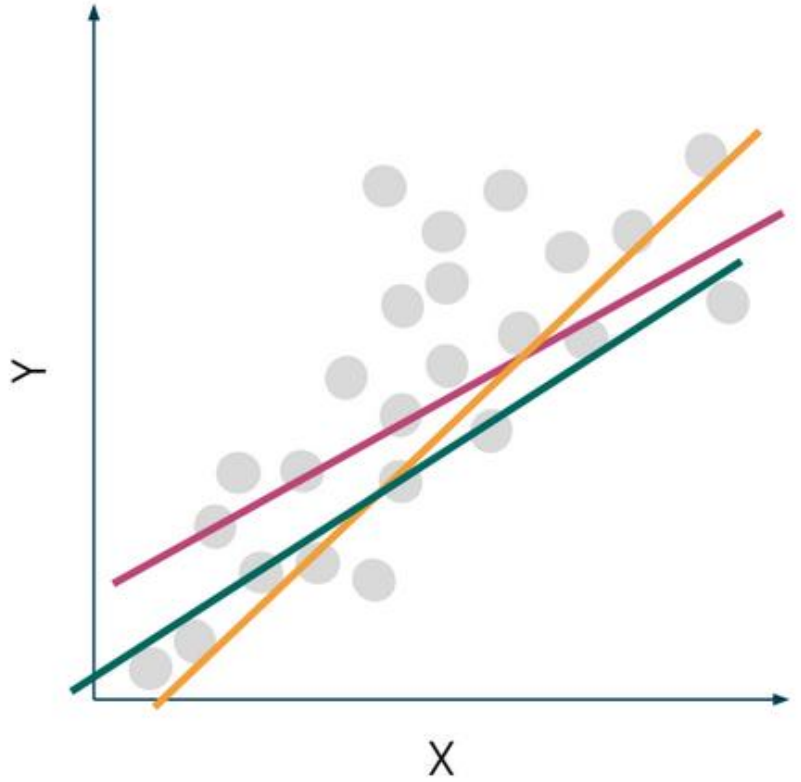
Rules

Splitting The Data

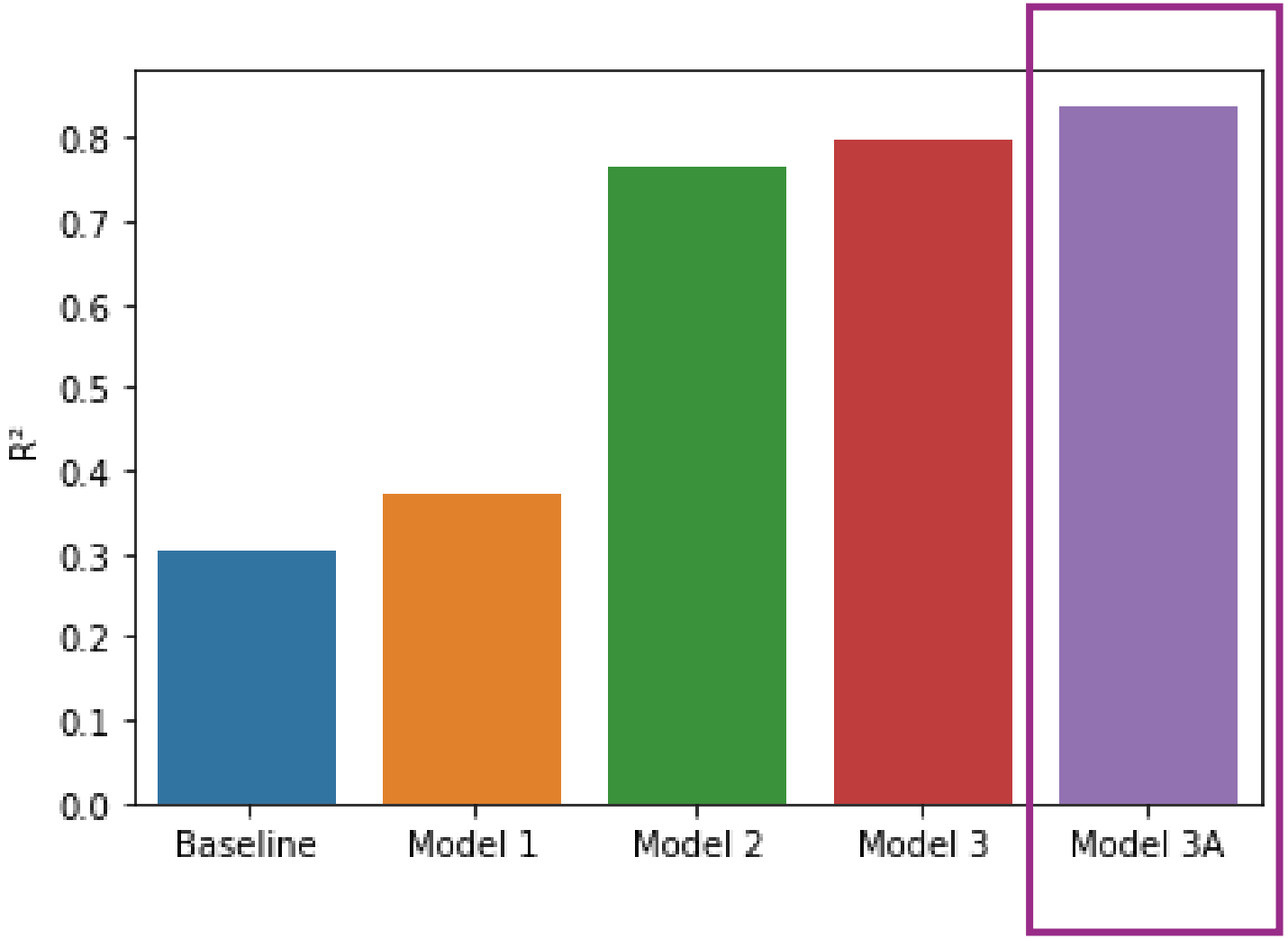


Linear Regression Overview





Model Comparison



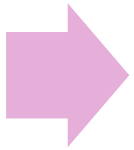
Modeling - Business Outcome

- Power Generators
- Power Suppliers
- Energy Traders

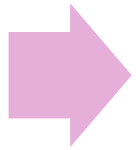
Modeling - Business Outcome

For every 1% reduction in the error of prediction there are $300,000 per year in savings*

Error (base) = 17.5%



Error (3A) = 8.1%



$2,820,000 per year in savings

*for a utility with 1GW peak load

Conclusions

The baseline model can be improved using Machine Learning by as much as 50%

Estimated savings of $2,820,000 per year were shown

This model could be used to decreased the risks associated with electricity trading

Recommendations

Refine the model using more data to improve its robustness

Test other modeling approaches

Interface with business development to calculate ROI and other business metrics