# Stochastic Energy Market Price Forecasting with Neural Networks

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## ABSTRACT

This project proposes to construct a neural network that will forecast energy prices in the California Independent System Operator (CISO). Accurate forecasting of energy prices in the CISO provides an economic opportunity for energy providers to incur profit and buyers to purchase at the lowest possible price. Traditional methods for forecasting have been used for many years to forecast these prices, but the recent advances in neural network time series forecasting presents a possible way to improve upon existing methods. The problem statement of this project is how to design a neural network to accurately predict stochastic energy prices.

## KEYWORDS

machine learning, stochastic forecasting, neural networks, energy markets

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## 1 INTRODUCTION

Instructions:

- Provide motivation to the project topic. That is tell the reader about why you want to work on this topic. Set the context and objective of the project here.
- Frame the problem statement and/or the research question for your project.
- Summarize the contributions of your work, that is explicitly state what the expected outcomes will be.

Outline:

- Large population of California depends on energy market every day.
- Problem is interesting because it is data rich, and quite complex.
- The basic economic principle of buy-low sell-high allows a natural economic opportunity that arises to participate in the energy market with accurate forecasts.
- Modern advances in neural networks have shown good results in time-series forecasting (references).
- For the previous reason, we believe we can use neural networks to predict energy prices.
- Problem statement: how to construct a neural network that accurately predicts stochastic, periodic prices in the CISO.
- To answer this problem statement we will:
  - Build a time-series forecasting neural network.
  - Benchmark the NN against existing research.
  - We expect that a NN will perform at a higher level than existing traditional methods.


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## 2 APPROACH

Instructions:

- Briefly describe your proposed approach here
- Discuss what methods you will use and why

Outline:

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### 2.1 Data Sources

The dataset for this project was kindly provided by the Dowling Lab for Uncertainty Quantification and Mathematical Optimization at the University of Notre Dame in the Department of Chemical and Biomolecular Engineering. The dataset is comprised of over 6500 energy vendors, called nodes, participating in the California ISO. There is a full year's worth of data for each node in 2015, and price measurements are recorded at 1 hour, 15 minute, and 5 minute intervals. Latitude and longitude coordinates are known for around 2000 of these nodes for visualization purposes.

## 3 EVALUATION PLAN

Instructions:

- How will you evaluate the proposed work?
- What does success mean for the class project?

Outline:

- Evaluate vs. literature values.
- Split dataset into training and testing sets.
- Compare CPU time with current methods in literature.
- Success would be building a neural network that forecasts prices of energy markets.
- Success is not if the NN beats traditional methods, but rather the testing of a new method.

## 4 PROJECT IMPLEMENTATION PLAN

Instructions:
How do you plan to implement your project and achieve the outcomes, including validation plan? Specify your deliverables on different milestones, draft, and deliverable.

Outline:

- Milestone 1: Initial architecture of NN identified and implemented on a small scale for forecasting (Jupyter Notebook).
- Milestone 2: Implementation of NN across all nodes in dataset and error analysis performed (Jupyter Notebook).
- Paper draft
- Final deliverable: Paper detailing the implementation of a NN for energy price forecasting with reproducible code as well.
- What does success mean for the class project?
  - Success would be building a neural network that forecasts prices of energy markets.
  - Success is not if the NN beats traditional methods, but rather the testing of a new method.

## 5 RELATED WORK

- Here provide the relevant references for your work.

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