

# Frequency Regulation Services and Electrical Price in Hornsdale Power Reserve

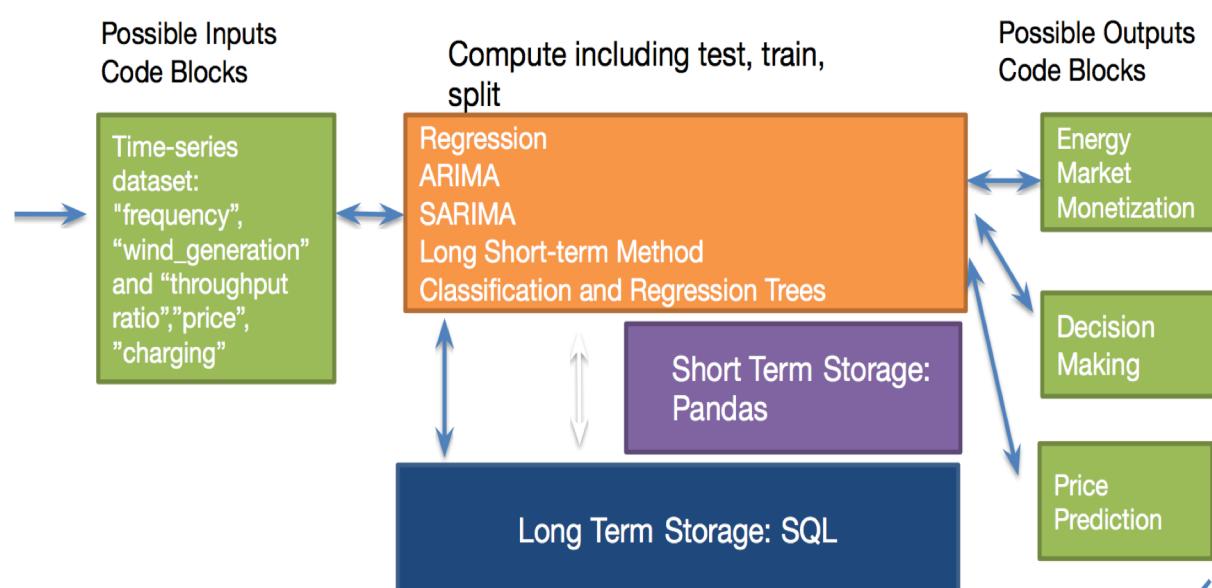
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The Hornsdale Power Reserve is a facility comprising of a Tesla Powerpack system in South Australia. Tesla's giant batteries Powerpacks become the spotlight in the electricity market with its ability to keep constant grid frequency in a quicker and more cost-effective way than traditional generators. Our team has been working on using machine learning algorithms to predict regulation throughput ratio, a key component in grid frequency regulation. The next aspect of our work is to predict the price of future hours in order to make the best decision on whether or not to buy or sell electricity.

## Data Description and Preparation

- Grid frequency time-series dataset:** "frequency", "wind\_generation" and "throughput ratio".
  - The date is converted to Australian Eastern Standard Time (AEST).
  - The frequency data is processed to generate average frequency, median frequency, the cumulative sum of frequency and difference between the initial and last frequency.
  - The energy throughput ratio is comprised as every 5-minute interval.
  - Filled in empty cells with the average value and combine the data to one single file.
- For the battery price dataset:** "battery operation"
  - The data composes as every half hours electricity price. The prediction is based on this data.

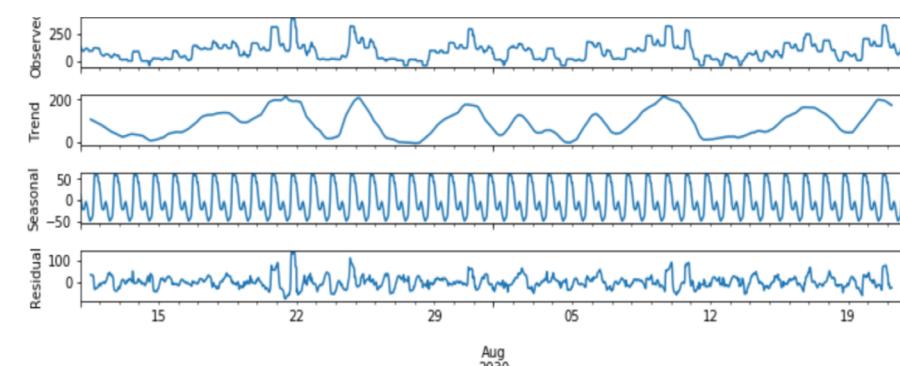
## Methodology



## Results

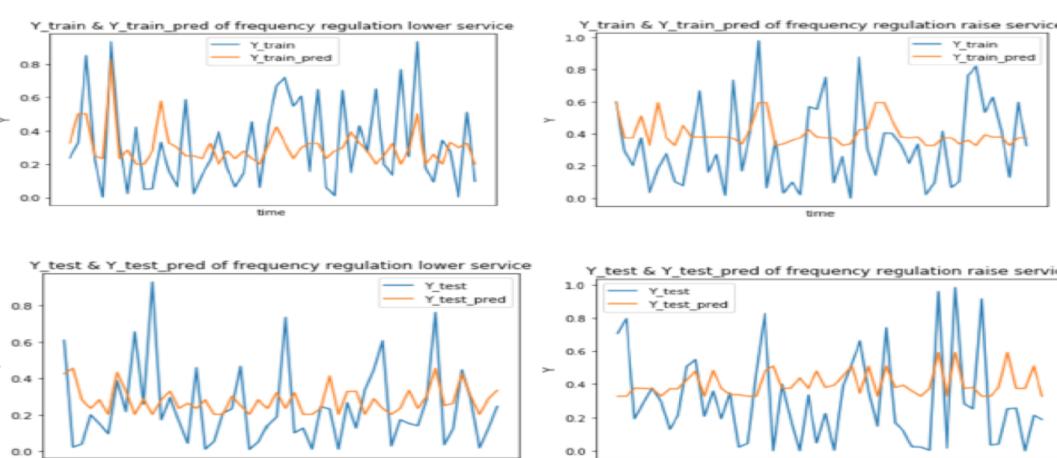
### 1. Components Study for Electricity Price

- Observed = Trend + Seasonal + Residual

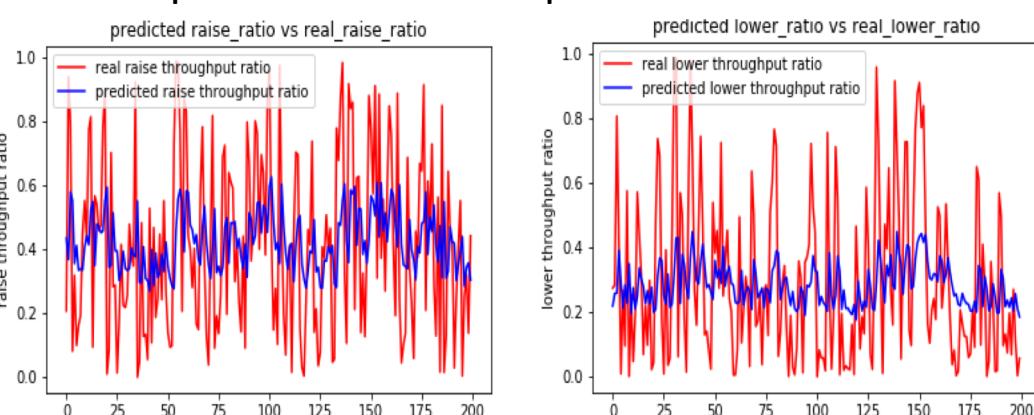


### 2. Future Forecast for Throughput Ratio

CART binary decision tree with the depth of five

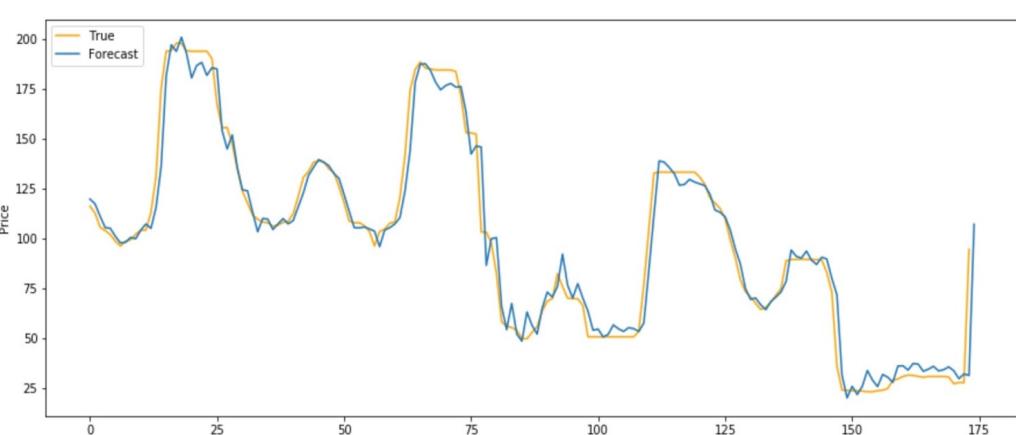


LSTM with 4 units and sigmoid activation function is built with Keras (Tensorflow backend). The model is trained over 20 epochs with Adam optimizer.

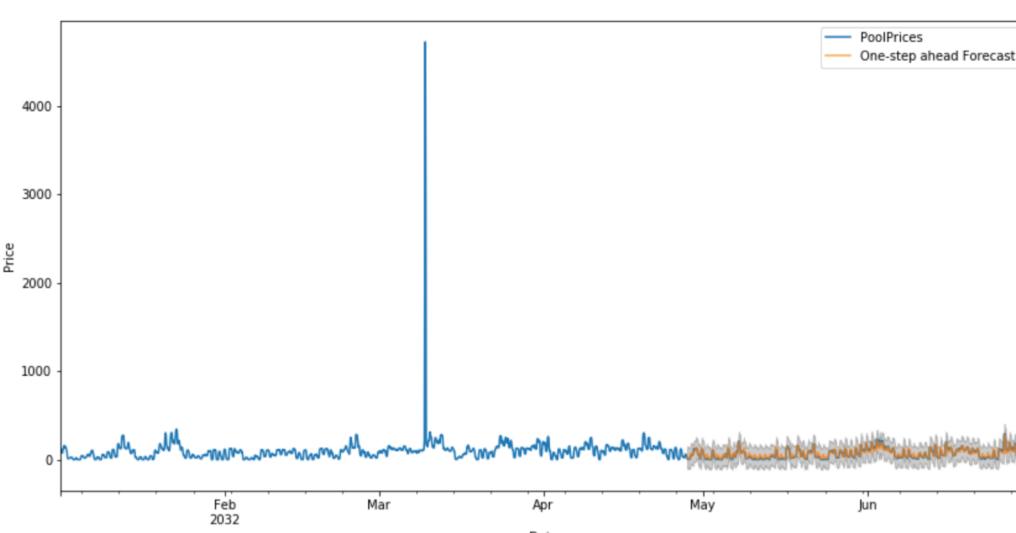


### 3. Future Forecast for Electricity Price

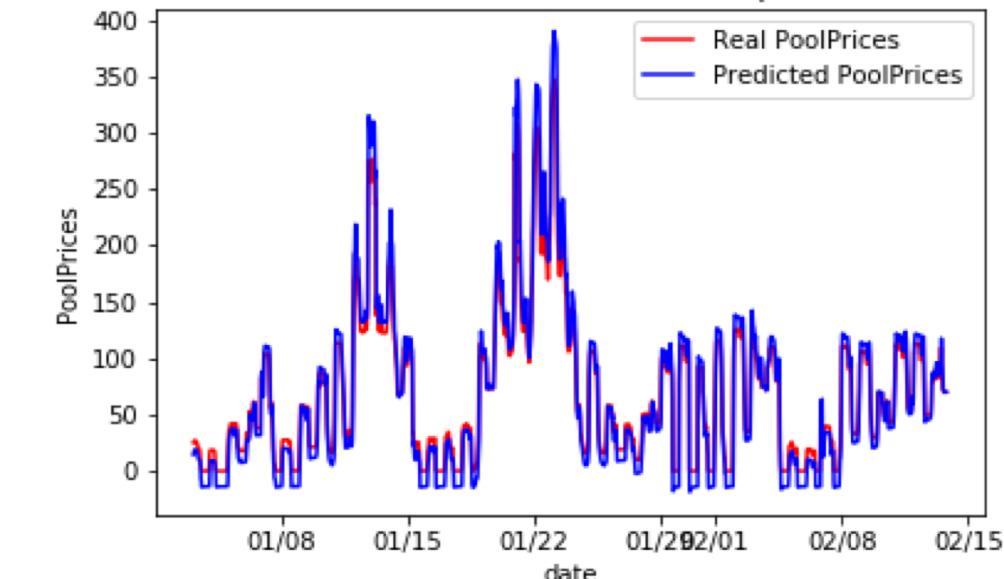
Rolling ARIMA model with p, d, q values of (8,0,4)



SARIMA model with parameters (2, 0, 1)x(2, 1, 2, 12)

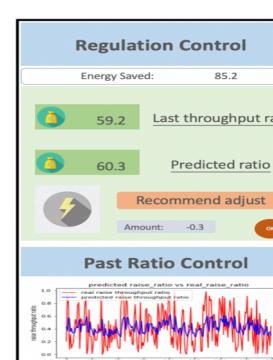


LSTM is trained with Adam Optimizer and epoch of 50



## Application

- This mobile app aims to give a visualization of how predictions can be viewed by managers or operators so that they can make the decisions in advance to make max profit
- Provides seasonal regulation report and help the investors to understand any unusual changes in the grid
- Forecasts the future electricity price to buy in at the max price and sell at the lowest price



## Conclusion and Future Work

- LSTM has the best performance on capturing the trend of the throughput ratio when comparing with regression models (CART and linear regression).
- Both Rolling ARIMA and SARIMA can predict well on the one step forecast of the energy price, but their performance is less promising when making predictions in the further future.
- To improve the model performance, more features (e.g. economic status) and constraints (e.g. Battery capacity, charging efficiency) are needed.