# Stock Price Forecasting Based On TRUST-TECH Enhanced ANNs

CornellEngineering
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## Introduction

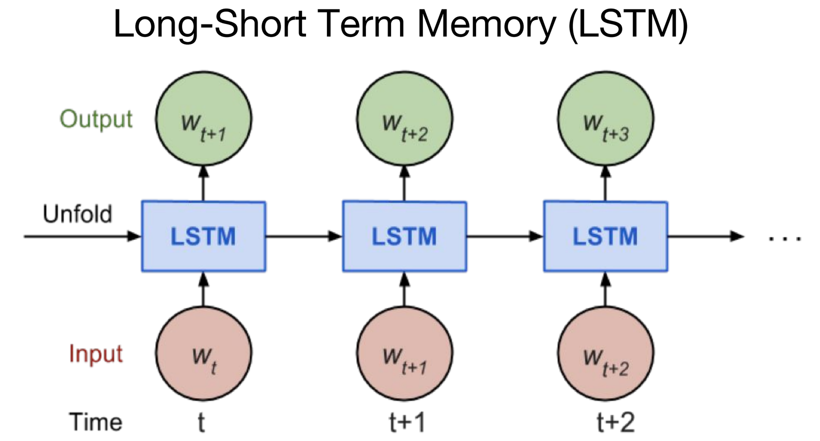
Mathematical models like Deep learning, as a purely data-driven approach, proved to be powerful in big data analysis and is of great significance to future markets.

Traditionally, Long-short Term Memory is to be used to make predictions in time series financial fields like stock price. The innovation introduced is applying the Transformation Under Stability-retaining Equilibrium Characterization (TRUST-TECH) into the deep learning neural networks training process, whose main features include its capability in identifying multiple local optimal solutions in a deterministic, systematic, and tier-by-tier manner.

## Background

### Stock Price Forecasting

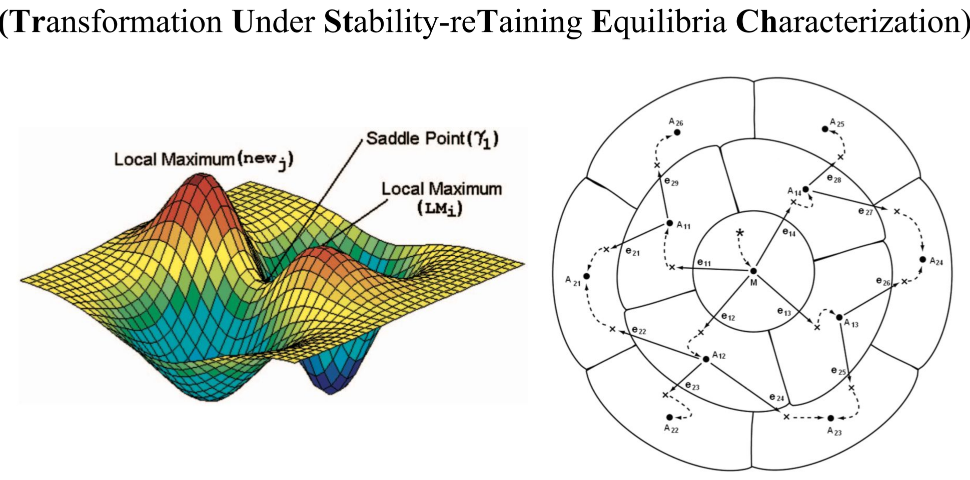
Long-Short Term Memory (LSTM)




- Suitable for stock market prediction for the trading, e.g. buying and selling of financial instruments
- A challenging short-term time-series prediction due to its noise and volatile features
- Training may easily fall into a local optimum

TRUST-TECH Methodology

(**T**ransformation **U**nder **S**tability-re**T**aining **E**quilibria **Ch**aracterization)



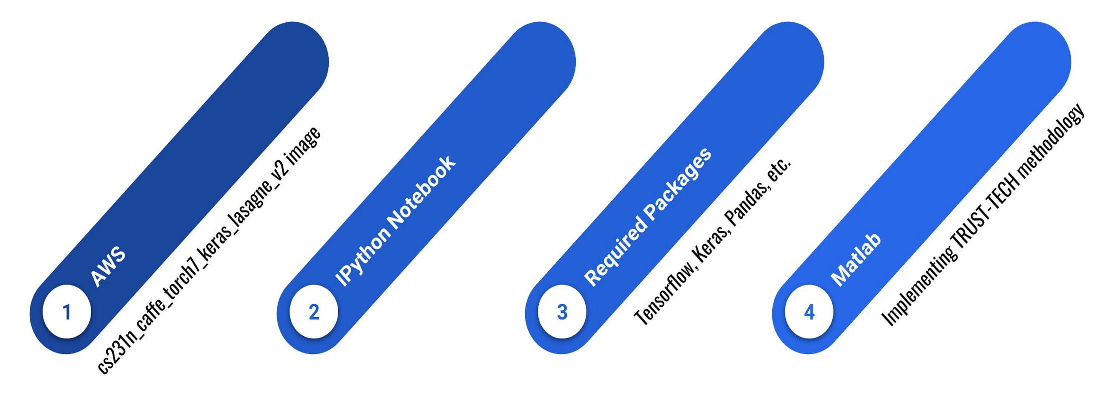
- Motivation: Use local optimum to find global optimum
- One-to-one correspondence: local optimal solution & Stable Equilibrium Point (SEP) in dynamical system
- Jump to Tier-1 EP iff the solution is better

## Implementation

### Preparation and Setup

| YAHOO! FINANCE S&P 500 (^GSPC) | | | | | | |
|---|---|---|---|---|---|---|
| Date | Open | High | Low | Close | Adj Close | Volume |
| 6-year-data (12'-18'), | Time-series, | Daily stock price in USD, | Care about 'close' | | | |

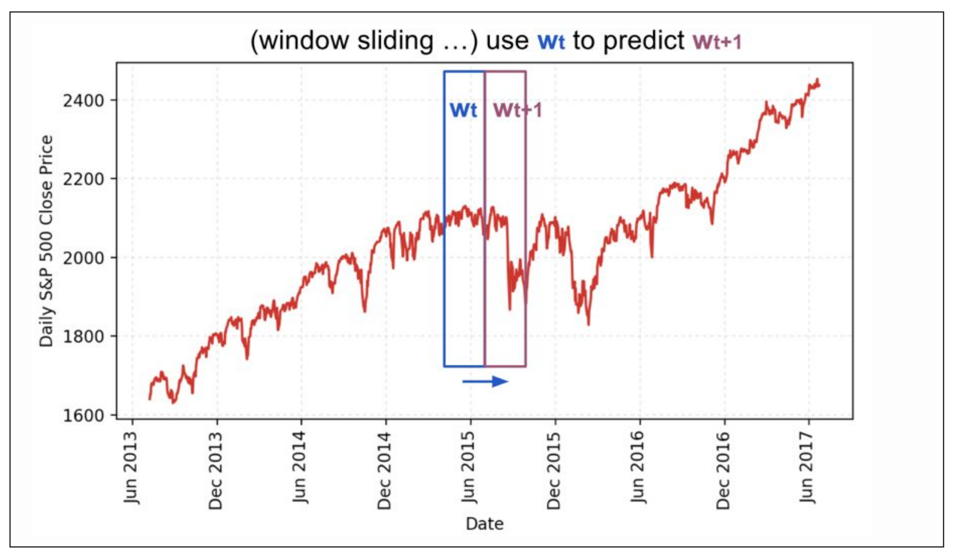
Dataset




Environment Setup

### Naive LSTM Model for Stock Price Prediction

Windowing is utilized in this project. To predict future stock price, raw data is first converted to time series data in each of whose entries features contains open, high, low and close price of 5-day period, label is loaded with the close price on the 6th day. 2 layers of LSTM with 0.2 dropout and 2 dense layers with activation functions are constructed when 0.1 validation is set to validate the score.




Predictive Mechanism

| Layer (type) | Output Shape | Param # |
|---|---|---|
| lstm_1 (LSTM) | (None, 5, 32) | 4736 |
| dropout_1 (Dropout) | (None, 5, 32) | 0 |
| lstm_2 (LSTM) | (None, 16) | 3136 |
| dropout_2 (Dropout) | (None, 16) | 0 |
| dense_1 (Dense) | (None, 1) | 17 |
| dense_2 (Dense) | (None, 1) | 2 |
| Total params: 7,891 | | |

Model Layers

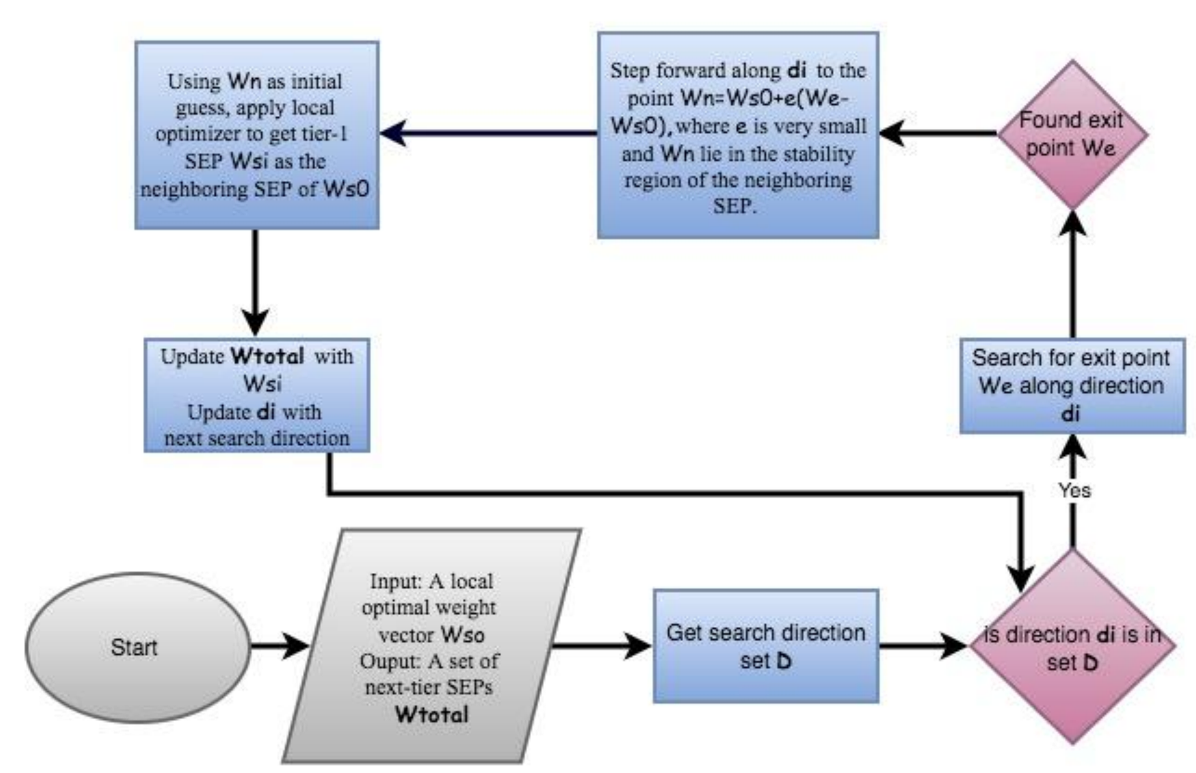
### TRUST-TECH Assisted Model Refinement

The purpose is to minimize the above MSE function, where Yi is a function consisting of input data and weights of LSTM.

$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}(\hat{Y}_i - Y_i)^2$$

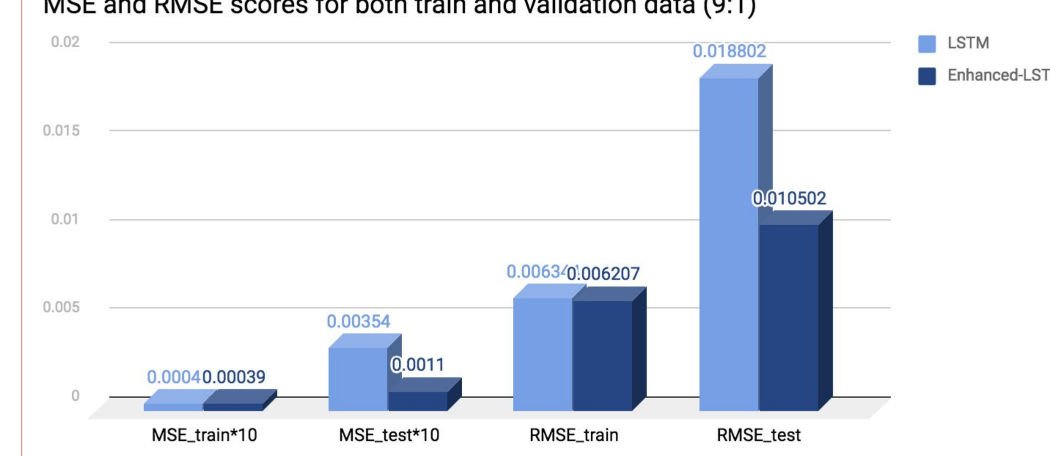
TRUST-TECH solves this optimization problem by first defining a dynamical system such that the SEPs in the system have one-to-one correspondence with local optimal solutions. We convert the problem to finding multiple stability regions in the defined dynamical system, each of which has a distinct SEP. Then an SEP can be computed with the trajectory method.

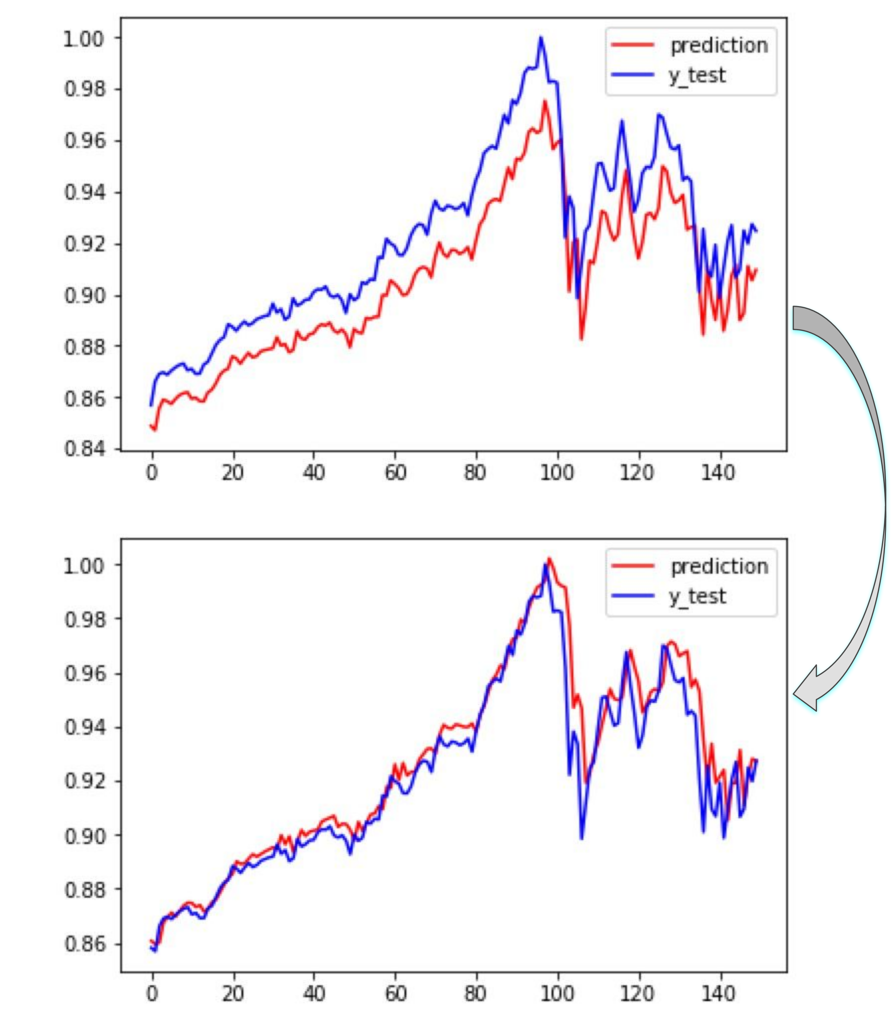
$$\frac{dw}{dt} = -gradient(MSE) = -R(W)^{-1} * \nabla MSE$$




Tier-1 TRUST-TECH Search Algorithm Flowchart

## Result




## Discussion

- Dimensionality of each time slot data
- Unpredictable economical changes
- If training may easily fall into a local optimum, potential power of Neural Net has not been fully explored

MEng team project
Cornell University
Morning Poster Session

## References

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