Project Proposal:
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Forecasting Short-Term Foreign Exchange Rates Using an LSTM Network

THE PROBLEM & WHY?

The world we live in today, is one of open economies. On a given day, financial flow around the world can exceed a country's total production on that day. The nominal exchange rate is the rate at which one currency trades for another to facilitate international trade. In the long-run, changes in exchange rates are associated with large macroeconomic variables, like monetary policy, production, and fiscal policy. Typical macroeconomic reports are published on a monthly basis; therefore, modeling the fluctuations of exchange rates between different currencies during the intra-day and intra-week periods can be beneficial to organizations that rely on international trade of goods and services. If it were possible to describe how the exchange rate between currencies responds to shocks to the market, then we would have an economic model of exchange rate determination. The presence of nonrandom-walk behavior offers an opportunity to add value.

Time series analysis is a useful application for machine learning techniques; however, traditional statistical techniques for forecasting have reached their limitation in application. Machine learning techniques are particularly suitable for predicting outcomes based on inputs. The high volatility, complexity, and noisy market environment lead to the suggestion of using neural network techniques for forecasting purposes.

THE DATA

The project team will leverage freely available daily data on Foreign Exchange ("Forex") spot prices provided by the United States Federal Reserve Economic Database ("FRED"). These datasets contain daily observations of the Forex spot prices of major global reserve currencies compared to the US dollar. Most of these time series are available from 1971 to present, and have around 12,500 observations which seems sufficiently large enough to train our neural network. This leaves 8,750 observations for training the network and an additional 1,875 observations (i.e. multiple years-worth) of data for testing and validating the network under the 70%/15%/15% convention of the early stopping model. The project team plans to utilize historical foreign exchange rate data from the following currencies:

- ↘ **Chinese Yuan / US Dollar**
- ↘ **Swiss Franc / US Dollar**
- ↘ **Brazilian Reals / US Dollar**
- ↘ **South African Rand / US Dollar**

THE NETWORK

The analysis will utilize a standard Long-Short Term Memory ("LSTM"), Recurrent Neural Network ("RNN") to develop a non-linear forecast of the Forex rate for currencies listed above. To train the network, the project team will leverage the deep learning library known as KERAS to implement rapid prototyping and fast experimentation.

REFERENCES

For reference material, we plan to leverage the RNN literature in the *Journal of Forecasting* that has become more prevalent over the previous two decades. Additionally, we will use two main books of source material – *Foreign-Exchange-Rate Forecasting with Artificial Neural Networks* and *Neural Networks for Business Forecasting* -- to ground our model in a strong theoretical background.

NETWORK PERFORMANCE

The LSTM network for forecasting future Forex changes will be validated through the performance of two key metrics. First, as is convention with time series research, we will evaluate how the network minimizes autocorrelation and cross correlation across future lags. Second, we will evaluate the LSTM network's accuracy in reducing the mean square error in predicted values of the test set.

SCHEDULE & DELIVERABLES

The project team plans to utilize the following timeline to model and test our simulation. A summary of the findings will be provided in the form of an in-person presentation and will be accompanied by formal documentation in the form of a written report. All final material will be submitted by August 20th, 2019. Below is an outline project schedule.

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Project Schedule