NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | School of Computer Science and Engineering, College of Engineering

Fuzzy Embedded Long Short-Term Memory (FE-LSTM)
with applications in Stock Trading

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Introduction

This project proposes and implements the **Fuzzy Embedded Long Short-Term Memory (FE-LSTM) architecture** which integrates a fuzzy inference system with a deep neural network. This hybrid architecture leverages on the strengths of both systems to achieve **high prediction accuracies with interpretable results**.

Design and Implementation

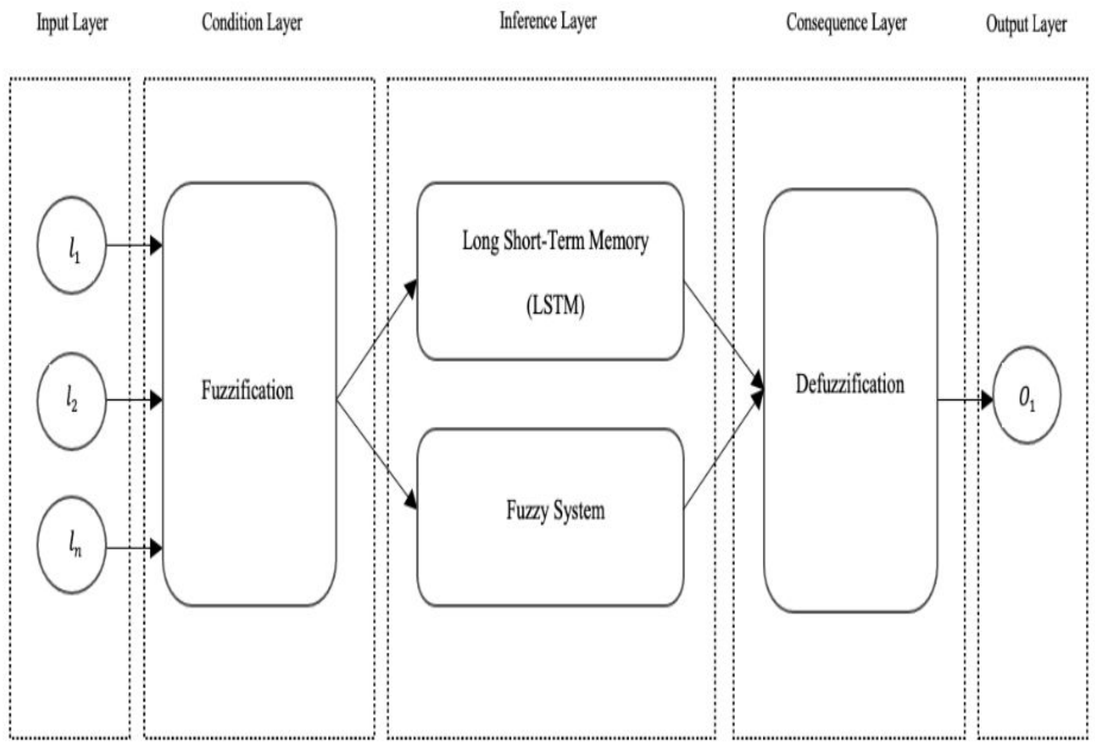
The FE-LSTM comprises of five main layers:

Input Layer: Crisp data values is fed in with each neuron representing a feature of the data point.

Condition Layer: Input data is fuzzified using a modified Discrete Incremental Clustering (DIC) algorithm. Fuzzified outputs are simultaneously fed into both the Fuzzy system and the LSTM.

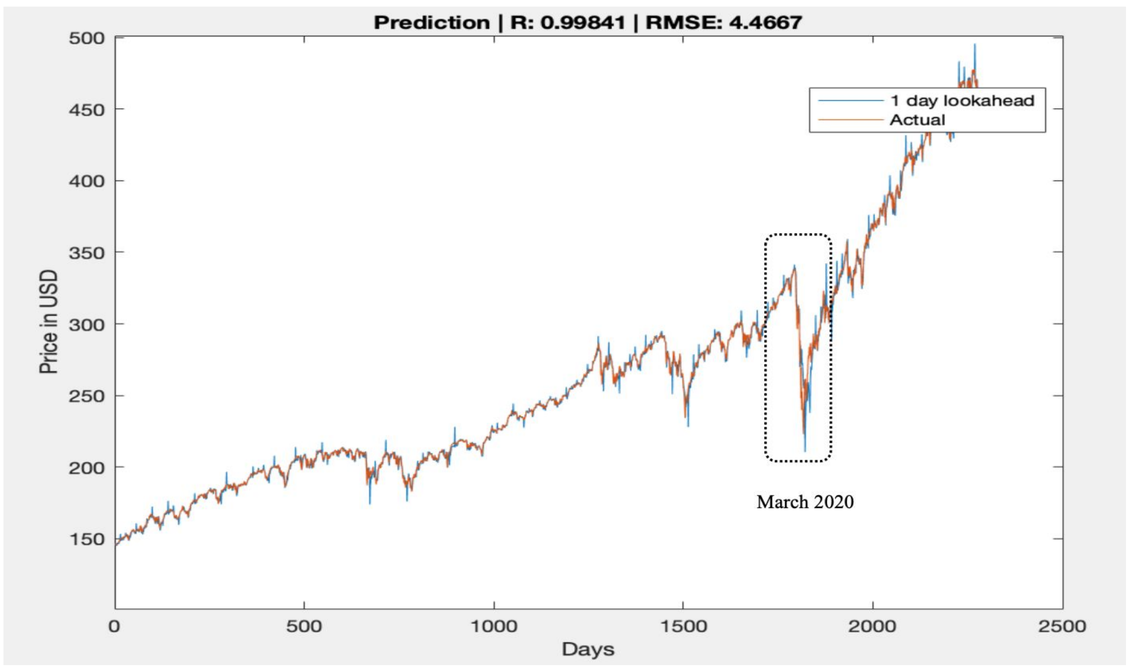
Hidden Layers: The embedded LSTM performs knowledge extraction through back-propagation and is connected to the fuzzy system via a tagging mechanism.

Defuzzification: Crisp output values is obtained through a center-of-area defuzzification method.



Architecture of the FE-LSTM

Application: Stock Prediction



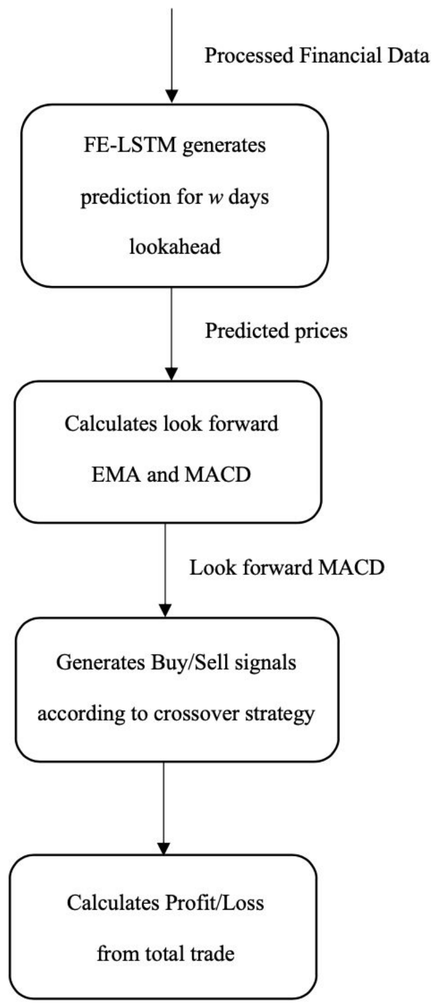
Predicted t+1 Results of FE-LSTM for S&P 500

Stock	Training Data Range	Testing Data Range	Lookahead Days	RMSE	R
S&P 500	2/2/1993-1/2/2012	1/2/2012 -1/2/2022	1	4.467	0.998
			7	7.954	0.989

Summarized Results of the S&P 500 Price Prediction Experiment

The proposed FE-LSTM obtained high R-squared values with low RMSE when tested on the S&P 500 and AAPL stock prices. Multiday lookahead predictions of up to *t+7* achieved similar high prediction accuracies.

Application: Stock Trading



Flowchart of the implemented trading system

A Look Forward MACD trading indicator was created with the FE-LSTM as a price predictor to reduce time lags faced by the traditional MACD. The trading strategy was able to generated higher returns relative to traditional Buy-Hold and Vanilla MACD strategies.