

# Fuzzy-Embedded Deep Neural Network System

## With its Application in Stock Trading

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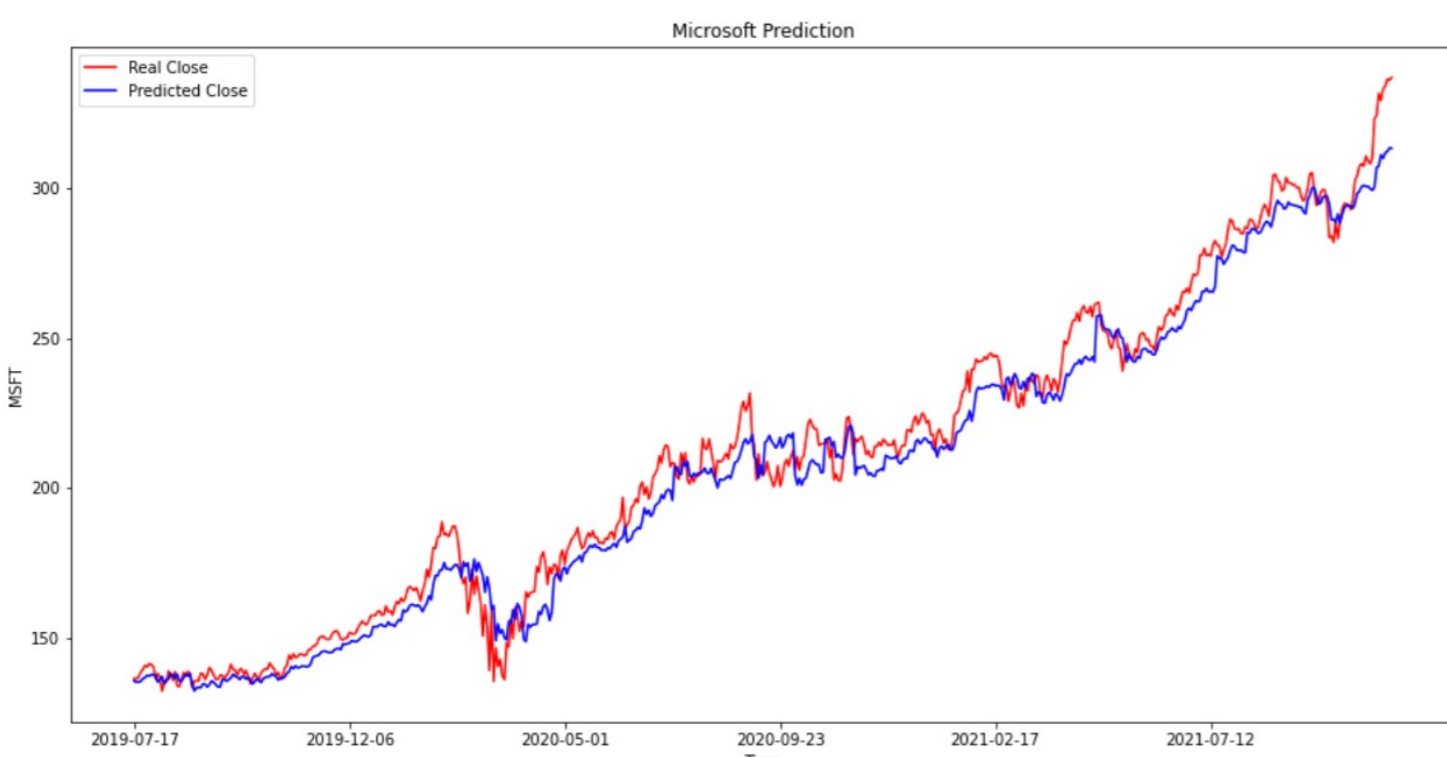
### ABSTRACT

The project proposes the creation of a fuzzy embedded Convolutional Neural Network and Long Short-Term Memory (CNN-LSTM) to accurately predict the closing prices of a stock in the stock market while offering increased interpretability. Trading system consists of 2 Genetic Algorithm optimized trading strategy that makes use of predicted stock prices.

### MOTIVATION

1. To implement a neuro-fuzzy system that can accurately predict stock prices and trends.
2. Increase the interpretability of deep learning models by using fuzzy logic in our deep learning model.
3. Improve current trading strategy with the use of forecasted MACD.

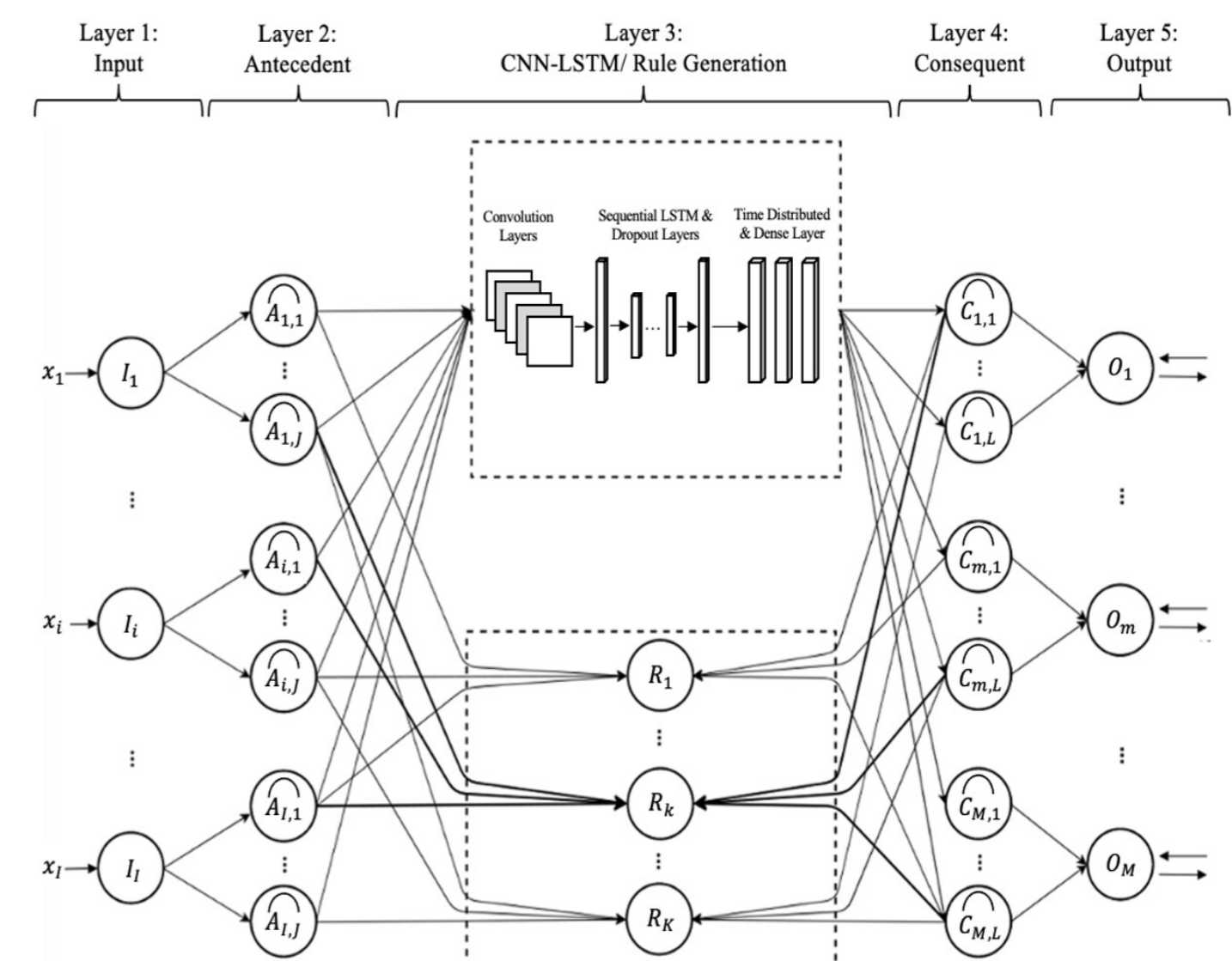
### RESULTS & ANALYSIS



- High  $R^2$  score (0.90-0.98) indicates predicted prices close to actual prices.
- Independent and tuned models used to predict stock prices for different days.

### DESIGN & IMPLEMENTATION

- Fuzzification of crisp inputs using Self-Organizing Map (SOM).
- Prediction of membership functions using the CNN-LSTM.
- CNN-LSTM derives fuzzy implication for the consequent part of the rule.
- Defuzzification of membership values back to crisp outputs using center-of-area defuzzification method.



### APPLICATION IN STOCK TRADING

Predicted stock prices used to calculate the Exponential Moving Average (EMA) used in MACD calculation. Forecasted MACD value applied in 2 different stock trading strategies:

1. The MACD Signal Crossover Strategy (SC)
2. The MACD-RSI Breakout Strategy (MR)

Genetic Algorithm used to find best trading hyperparameters to maximize percentage profit.

| Ticker | Trading Profit (%) - SC |                 | Trading Profit (%) - MR |                 |
|--------|-------------------------|-----------------|-------------------------|-----------------|
|        | FE-CNN-LSTM             | Normal Strategy | FE-CNN-LSTM             | Normal Strategy |
| AAPL   | 267                     | 159             | 203                     | 88              |
| MSFT   | 268                     | 33              | 135                     | 50              |
| GME    | 530.5                   | 245             | 7822                    | 2               |

