NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

School of Computer Science and Engineering
College of Engineering

DNN-FES + FOLE Objective Loss Estimator for Integrating Deep Neural Networks into Fuzzy Systems
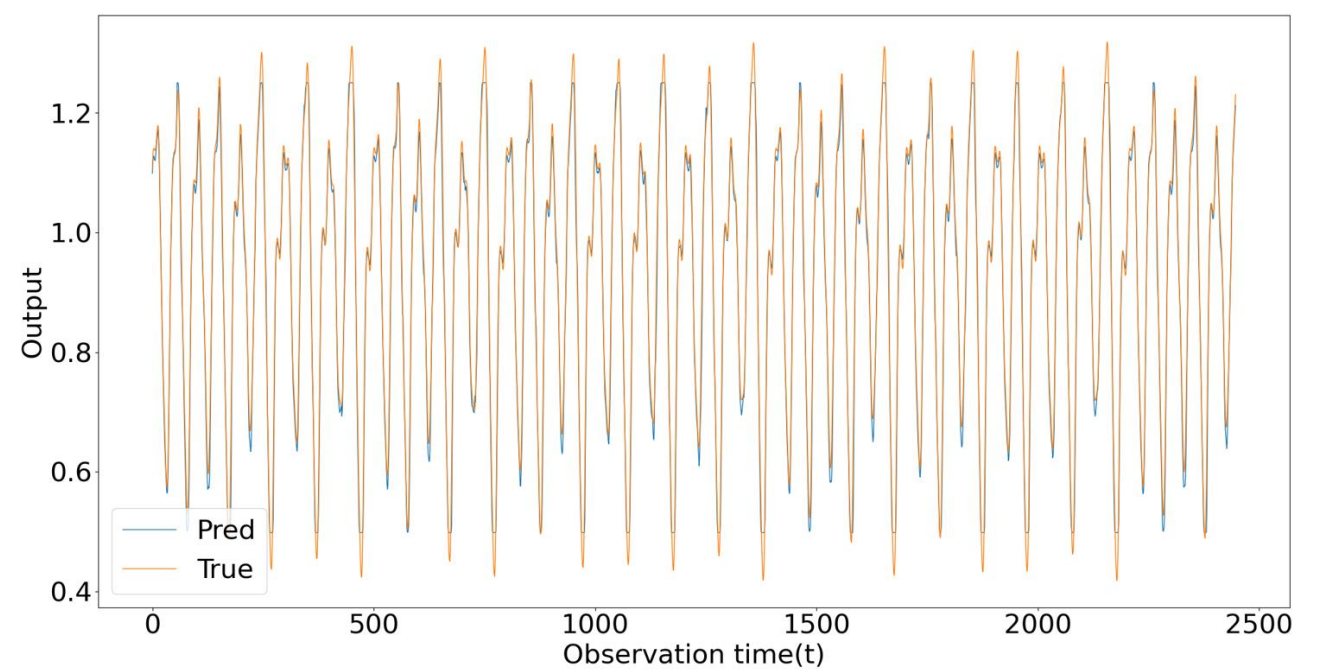
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ABSTRACT

This research project focuses on developing a loss function that can enable the integration of Deep Generic Neural Networks into Fuzzy Embedded System. The project introduces **FOLE**, an objective loss estimator designed for the above said purpose and a novel Deep Neural Network Fuzzy Embedded System (**DNN-FES**). The final model provides both **high performance** from neural network implication and **interpretability** from fuzzy rule base.

DESIGN & ARCHITECTURE

Fuzzified input values are propagated to neural network and the fuzzy rules. The loss is calculated using FOLE :

$$l_w = \begin{cases} log_{10}(\mathcal{L}_{mse}) + \lambda, & \mathcal{L}_{mse} > \Phi \\ log_{10}(\mathcal{L}_{mse}), & \text{otherwise} \end{cases}$$

$$\mathcal{L} = \mathcal{L}_{mse} + 10^{l_w} \cdot \mathcal{L}_{cross\ entropy}$$

The MSE loss is the loss in model performance while the cross-entropy loss is the loss in interpretability arising from making an inadmissible rule.

RESULTS & APPLICATION

DNN-FES + FOLE for predicting t+85 timestamps ahead in Mackey Glass time series.
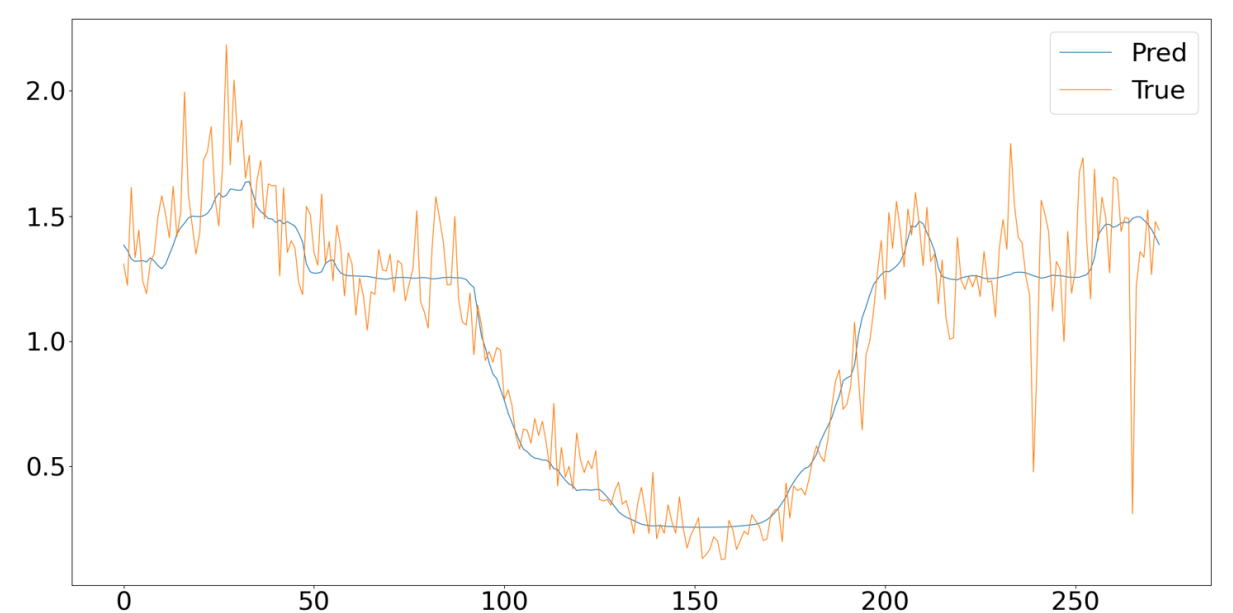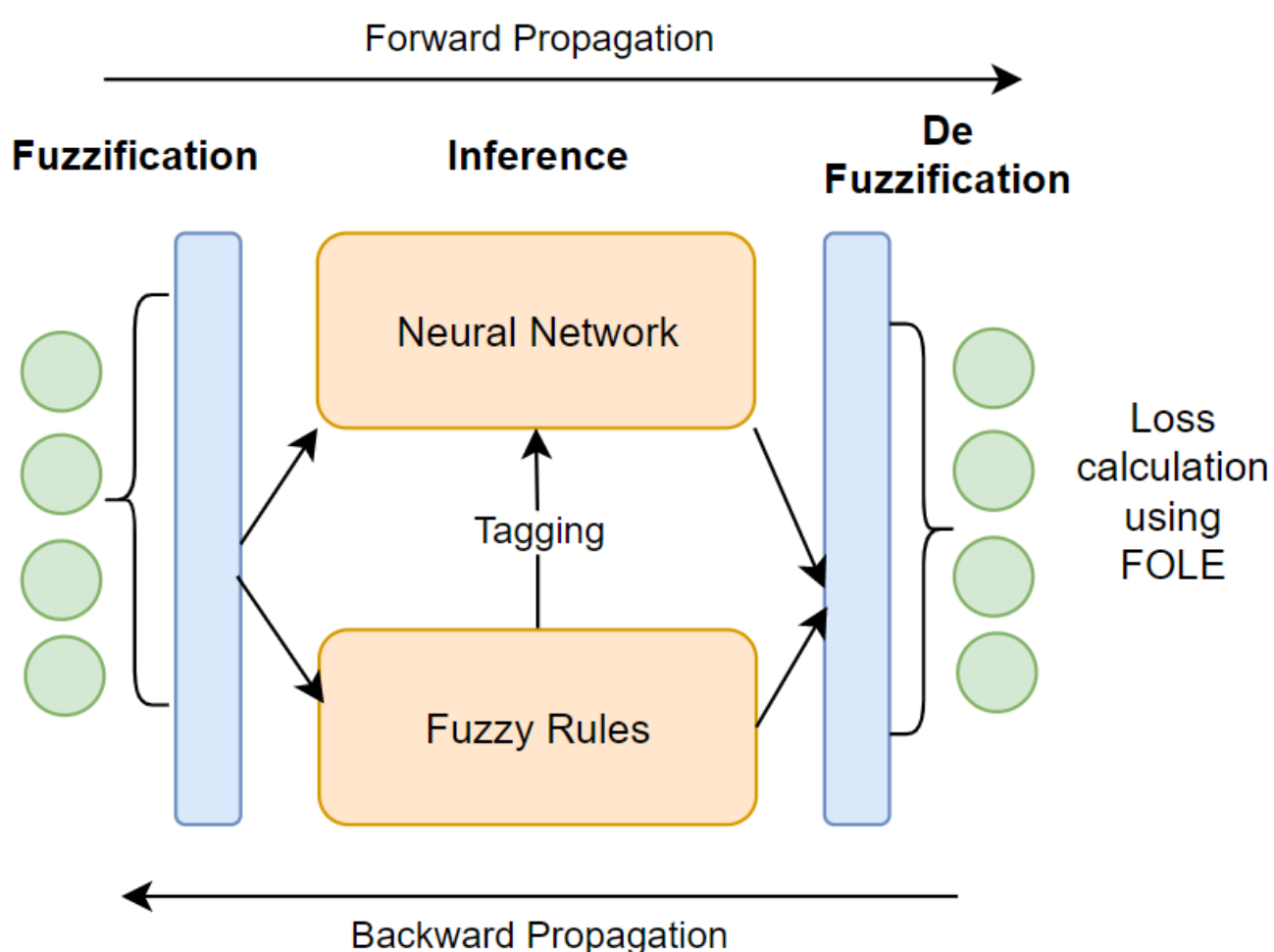
DNN-FES + FOLE for forecasting Traffic Volume using the Traffic Dataset
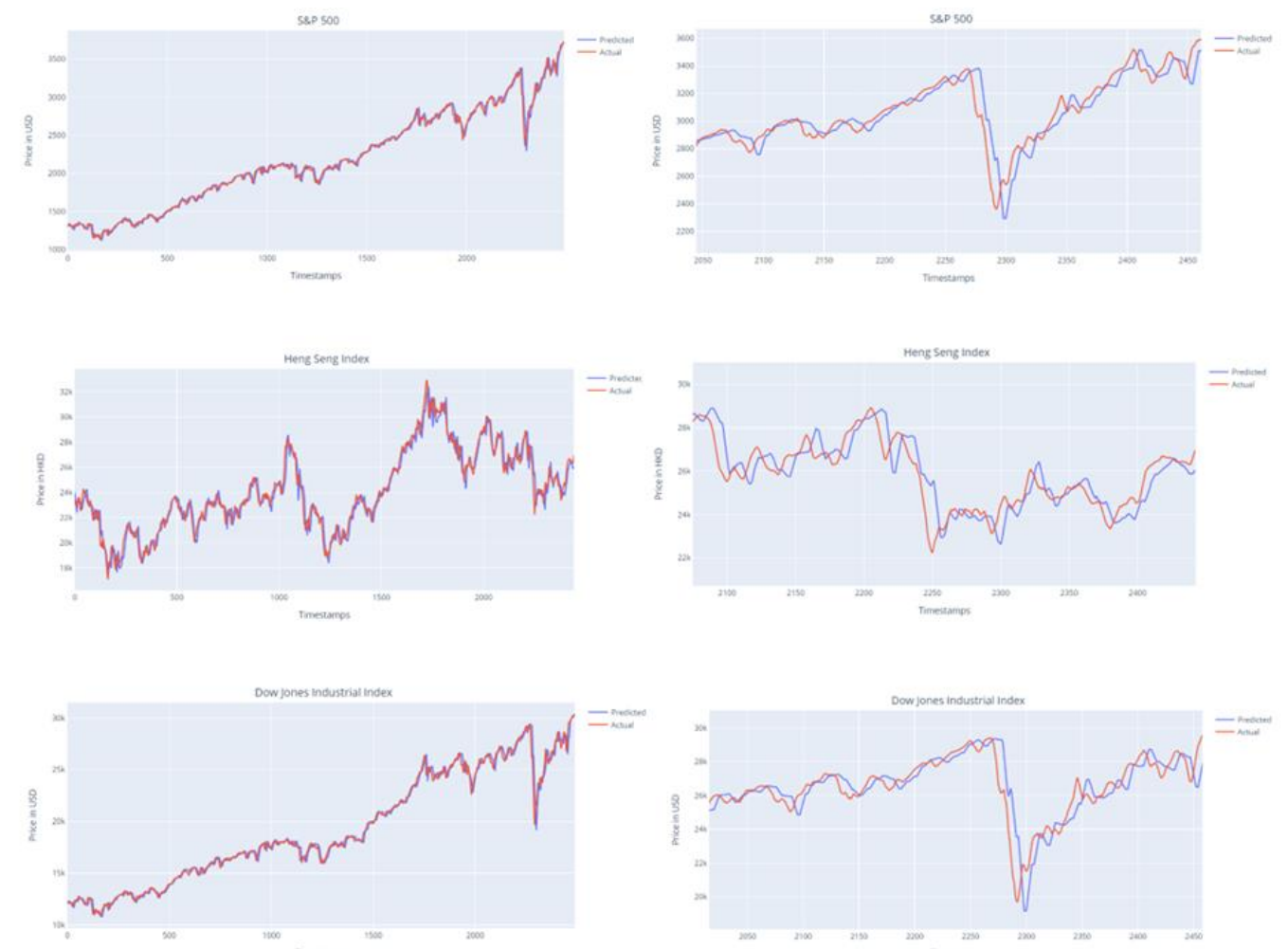
Application of the research in stock market prediction of three indexes : S&P500, DJIA and HIS.
Model able to predict the market crash happened during COVID-19 quite accurately