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Deep Learning for Financial Engineering

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1 Introduction

Financial operations are generally related to huge amounts of cash flow with risks and uncertainties attracting much research efforts for the development of sophisticated quantitative models to manage these financial risks. "Financial engineering" is a term coined with the help of modern information technologies. Financial engineering is a cross-disciplinary field for analysts to optimize and analyze various kinds of financial decision making such as risk management, financial portfolio planning, forecasting, trading, hedging, fraud detection, and other applications. Today, the field of financial engineering has successfully integrated a wide range of quantitative analysis disciplines, such as mathematics, statistics, time series, stochastic process, data mining, and artificial intelligence.

More and more evidence is indicating that the financial environment is not ruled by mathematical distributions or statistical models. In the field of computer science, attempts have been made to develop financial engineering models using soft computing approaches in order to build up more flexible financial engineering models. Bio-Inspired computing is a way of developing computer systems by taking ideas from the biological world. Many of the ideas taken from natural processes have been applied to machine learning and deep learning, leading to new developments in artificial intelligence. The pursuit of Bio-Inspired computing technology is a recent trend in which technologies, including artificial immune systems, particle swarms, ant colony, bacterial foraging, artificial bees, harmony search, nano computing, multi-objective, dynamic, and large-scale optimization are applied to daily life. The Bio-Inspired computing could be realized and construct simple systems which are able to evolve into more complex ones.

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2 Fewer Research Questions, Diverse Fields

The first theme of this special issue focuses on "Theories, models, and algorithms for deep learning technologies". Chen and Hsu (2022) collected both bank- and country-level data from the banking sectors of 47 Asian countries from 2004 to 2019. In this research, the Boone index was used to linkage profits with average cost and results proven the national governance mechanisms have an most impact on bank performance. Eğrioğlu and Fildes (2020) proposed a new bootstrapped hybrid artificial neural network (B-HANN) for forecasting the FTSE, BIST and SP500 stock exchange datasets. The results had the better forecasting performance than long short-term memory (LSTM) deep artificial neural network and pi-sigma artificial neural network (PSGM). Gao (2021) used the analytic hierarchy process (AHP) to extract the financial risk evaluation index from five aspects of debt solvency, operating ability, profitability, growth ability and cash flow ability. In advance, this research adopted the Hash-based IUA algorithm (HIUA), Incremental Updating Algorithms (IUA), and Apriori rule to construct the prediction model. This research can act as the theoretical reference for the research of enterprise financial risk prevention. Huang et al. (2021) combined the deep learning and canonical correlation analysis (CCA) to build novel rating prediction systems. The datasets adopted in this research are belonged to enterprise financial statement from the Taiwan securities market which collected from Taiwan Economic Journal (TEJ). Finally, the results illustrated the new proposed classification models can achieve the higher accurate than traditional data mining approaches. Li et al. (2021) proposed the GA (genetic algorithm)—optimized BPNN (backpropagation neural network) model to predict the business risk of commercial banks. Liu et al. (2021) adopted the swarm intelligence algorithm and fuzzy theory to construct the financial fuzzy time series models. The experimental results showed that the combination of theoretical methods and financial time series forecasting model can significantly improve the forecasting performance for the Shanghai Stock Exchange Index. Lu et al. (2021) integrated with the autoregressive moving average model-generalized autoregressive conditional heteroskedasticity (ARMA-GARCH) model to construct the VaR risk measurement model. In addition, the time-series datasets were trained and tested by deep neural network and the LSTM model. This research can provide the reference as exchange rate forecasting and financial risk prediction. Tak (2021) presented a novel time series forecasting method that integrated the fuzzy c-means, autoregressive moving average model (ARMA), and grey wolf optimizer (GWO) in type-1 fuzzy functions. Finally, the proposed approach was validated and tested by using 16 practical time-series and showed its capability for the selected datasets of the stock exchange. Tong and Yin (2021) investigated the prediction of financial time series and adaptive trading based on LSTM model to increase the international cooperation in agricultural finance. Ünvan and Ergenç (2021) used the fuzzy COPRAS (Complex Proportional Assessment) as a fuzzy multi-criteria decision-making technique to investigate the financial performance analysis for the banks. Wu (2021) built a decision tree model, a random forest model, and a gradient boosting model to construct the trading financial system to control the over-financialization risks. Wu et al. (2022) established an option trading system on settlement dates that adopted Kelly criterion, support vector machine (SVM), and random forest to improve the trading

performance and monitor the investment risk. Yılmaz et al. (2021) proposed the Pi-sigma artificial neural networks (PS-ANN) which training the model by differential evolution algorithm (DEA). In this research, two different datasets were used to verify the forecasting performance of the proposed DEA-PS-ANN method. The experimental results showed the proposed method can outperform than traditional artificial neural network models.

The second theme of this issue focuses on "New deep learning framework for financial engineering services". Ding (2021) built the enterprise intelligent audit system by using artificial intelligence and it can also monitor the enterprise revenue and expenditure timely and accurately. Lin (2021) integrated the GA optimization technique with the BPNN to construct an Internet credit risk early warning model. As the results, the prediction accuracy of early warning model can reach more than 90%. The same research methodologies by Liu et al. (2022). Safara (2020) built the prediction model to anticipate the consumer behavior in online shopping during the COVID-19 pandemic. This research compared five classification methods namely: support vector machine (SVM), decision tree (DT), sequential minimal optimization (SMO), artificial neural network (ANN), and Naïve Bayes (NB). Finally, the decision tree has the best accuracy for the consumer behavior prediction. Yadav et al. (2020) provided a technical survey of different areas of blockchain-based applications. The goal is to investigate the current development of the blockchain innovation and how this new technology can revolutionize the "business as normal" activities. Yu et al. (2022) adopted the artificial intelligent algorithm to construct the congestion charging prediction system by collecting massive real-time global positioning system (GPS). This system can offer the real-time road dynamic pricing and facilitate the performance of congestion charging in smart cities. Zhao et al. (2021) presented a novel approach for measuring the systemic importance of financial institutions (SIFIs). This research used the adjacency information entropy to develop the identification algorithm for direct/indirect connections among financial institutions. The results showed the proposed algorithm can increase the accuracy of identifying SIFIs significantly. Xu and Hsu (2021) conducted the sentiment analysis to predict future agricultural product price trends by collecting weather data, international oil price data and social news. The empirical results illustrated the proposed emotional scores and oil prices can improve the prediction accuracy for agricultural product prices effectively. Yen et al. (2021) presented a novel sentiment analysis method for companies' future financial performance. It integrated the linguistic inquiry and word count method to execute the sentence segmentation and word tokenization for text retrieved from a variety of online news media and stock forums.

3 Conclusion

Overall, the twenty-two selected papers in this special issue demonstrate financial engineering innovations for the theories, models, and algorithms perspectives. This special issue continues the bio-inspired computing approach for solving real problems in economics and finance. Papers focused on the following issues: (a) computational approaches to solve financial problems; (b) concepts and bases for intelligent systems

for financial engineering; (c) techniques for implementing and evaluating information systems on economic and financial domains, forecasting, and analysis; (d) deriving theories of artificial intelligence (AI) modeling, constructing an AI model and applying it to the financial market, develop techniques for linking an AI model with other types of models.

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