Annotated Bibliography

Gooijer, J. G., & Hyndman, R. J. (2006). 25 years of time series forecasting. *International Journal of Forecasting*, *22*(3), 443–473. doi:10.1016/j.ijforecast.2006.01.001

This paper, published in 2006, is a study examining the developments and methods related to time series forecasting in the last 25 years. This study includes studies published in journals managed by the International Institute of Forecasters (Journal of Forecasting 1982–1985 and International Journal of Forecasting 1985–2005), while also reviewing highly influential studies on time series prediction published elsewhere during this period. The main traditional methods studied are ARIMA and exponential smoothing, and the main topics are method selection, robustness, prediction intervals, multivariate and seasonality. Before deep learning methods, which are contemporary methods, it is important to learn which traditional methods exist in the field of forecasting and to learn what difficulties traditional methods have in terms of determining which constraints contemporary methods can overcome.

Weng, T., Liu, W., & Xiao, J. (2019). Supply chain sales forecasting based on lightGBM and LSTM combination model. *Industrial Management & Data Systems, 120*(2), 265–279. doi:10.1108/IMDS-03-2019-0170

This paper proposed a new model based on lightGBM and LSTM to forecast the supply chain sales. In order to verify the accuracy and efficiency of this model, three representative supply chain sales data sets that are Rossmann store sales dataset, Corporacin Favorita Grocery sales and CCF's supply chain sales dataset of the Jollychic E-commerce Platform are selected for experiments. This paper describes an effective method for forecasting supply chain sales that can assist businesses in forecasting long-term commodity sales in a scientific and reasonable manner. Contribution of this study is that the proposed model not only inherits the ability of the LSTM model to automatically extracts high-level features, but it also has the benefits of the lightGBM model, such as high efficiency and strong interpretability, making it suitable for industrial production environments. The experimental results show that the combined model has high accuracy, efficiency, and interpretability in forecasting supply chain sales.

Shen, Z., Zhang, Y., Lu, J., Xu, J., & Xiao, G. (2020). A novel time series forecasting model with deep learning. *Neurocomputing*, *396*, 302–313. doi:10.1016/j.neucom.2018.12.084

This study proposes a novel time series forecasting model named SeriesNet that fully extracts the features of time series in different time intervals. The SeriesNet consists of two parts that are Long-Short Term Memory (LSTM) and Convolutional Neural Network (CNN). While LSTM aims to learn features in a holistic manner and reduce dimensionality in multi conditional data, CNN aims to learn different time intervals. According to study, It is mentioned that residual learning and batch normalization are used to increase the generalization power of the model. The hybrid model provides better solution compared to LSTM, ANN and SVM.

Livieris, I. E., Pintelas, E., & Pintelas, P. (2020). A CNN–LSTM model for gold price time-series forecasting. *Neural Computing and Applications*, *32*, 17351–17360. doi:10.1007/s00521-020-04867-x

A new hybrid model is proposed to accurate prediction of the gold price and movement. The hybrid model mainly consists of two main parts that are Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) network. Convolutional layers are characterized by their ability to extract useful knowledge and learn the internal representation of time-series data, while LSTM networks are effective for identifying short-term and long-term dependencies. The principal idea of our proposed model is to efficiently combine the advantages of these deep learning techniques. Although LSTM models were successful in predicting gold prices alone, it was observed that their performance increased when used with CNN thanks to this study. The easy use of the proposed new model in forecasting problems in other areas such as weather forecasting, earthquake prediction and sales predictions increases the importance of the model.

Kilimci, Z. H., Akyuz, A. O., Uysal, M., Akyokus, S., Uysal, M. O., Atak Bulbul, B., & Ekmis, M. A. (2019). An Improved Demand Forecasting Model Using Deep Learning Approach and Proposed Decision Integration Strategy for Supply Chain. *Complexity*, *2019*. doi:10.1155/2019/9067367

In this paper, an intelligent demand forecasting system is developed. This model, which is based on the analysis and interpretation of historical data, used time series techniques, support vector regression algorithm and deep learning techniques. According to this study, this is the first study to combine deep learning methodology, support vector regression algorithm, and different time series analysis models with a novel decision integration strategy for demand forecasting approach such that when the model compares to state-of-the-art studies, the proposed prediction system provides a significant improvement in accuracy thanks to combination of the support vector regression, deep learning model, and a new integration strategy. The use of time series analysis techniques with varying accuracy performance under different conditions and the use of the technique that gives the best result in demand forecasting according to the relevant situation contributes to the flexibility of the model that leads to increase the success of demand forecasting.

Abbasimehr, H., Shabani, M., & Yousefi, M. (2020). An optimized model using LSTM network for demand forecasting. *Computers & Industrial Engineering, 143*. doi:10.1016/j.cie.2020.106435

This paper proposes a demand forecasting method that predicts fluctuating demand data with high performance and multi-layer LSTM networks is constructed as demand forecasting method. The proposed method uses the grid search technique to create the best demand prediction model by choosing the appropriate combinations among the different model hyperparameters. This ability allows the discovery of patterns in nonstationary and nonlinear time series. The proposed method is compared with benchmark statistical and computational intelligence methods such as ARIMA, ETS, RNN and single layer LSTM using demand data of a furniture company. According to experimental results, the proposed model gives better results in performance measures than others.

Faloutsos, C., Gasthaus, J., Januschowski, T., & Wang, Y. (2019). *Classical and Contemporary Approaches to Big Time Series Forecasting*. Paper presented at International Conference on Management of Data (SIGMOD '19), Amsterdam, Netherlands.

This study provides an outline of the most important methods and tools required to solve large-scale forecasting problems and it examines the state of the art in three areas that are classical modeling of time series, scalable tensor methods and deep learning for forecasting. According to the paper, in recent years, a paradigm shift has been occurred in forecasting techniques and applications from based on computer-aided models to data-based and fully automated models. This change can be depended on the existence of large and varied time series and it may result in a series of challenges such as constructing statistical models to effectively learn to forecast from large and diverse data sources.

Zhao, B., Lu, H., Chen, S., Liu, J., & Wu, D. (2017). Convolutional neural networks for time series classification. *Journal of Systems Engineering and Electronics, 28*(1), 162–169. doi: 10.21629/JSEE.2017.01.18

One of the challenges of time series analysis is that time series data are inherently high-dimensional, high-volume, and constantly updated. Time series classification is one of the important tasks in the field of time series analysis. Novel Convolutional Neural Network (CNN) framework is proposed for time series classification in a way that CNN can discover and extract hidden information to generate representative features of the input time series automatically by using convolution layers and pooling operation. This paper includes two groups of experiments for simulated datasets and eight groups of experiments for real-world datasets. Lastly, experimental results show that the proposed model outperforms state of the art methods regarding classification accuracy and noise tolerance. The use of CNN for the time series classification problem is an original work unprecedented in this annotated bibliography.

Punia, S., Nikolopoulos, K., Singh, S. P., Madaan, J. K., & Litsiou, K. (2020). Deep learning with long short-term memory networks and random forests for demand forecasting in multi-channel retail. *International Journal of Production Research, 58*(16), 4964–4979. doi:10.1080/00207543.2020.1735666

This paper proposes a novel forecasting method that combines Long Short-Term Memory (LSTM) networks as deep learning method and Random Forest (RF) as machine learning method. The proposed method can represent temporal and regression type patterns which gives it an edge in accuracy over other forecasting methods. The new model is applied for real-world multivariate dataset from a multi-channel retailer. The forecasting performance of the new model is compared with neural networks, multiple regression, ARIMAX, LSTM networks, and RF. Furthermore, the proposed method can order the explanatory variables in terms of their relative importance thanks to RF. Comparison of performance measures between the proposed model and benchmark models using the statistical tests that are Pesaran and Timmermann (PT) test and the Diebold and Mariano (DM) test can be evaluated as the contribution of this paper to the literature.

Elsheikh, A. H., Saba, A. I., Elaziz, M. A., Lu, S., Shanmugan, S., Muthuramalingam, T., Kumar, R., Mosleh, A. O., Essa, F. A., & Shehabeldeen, T. A. (2021). Deep learning-based forecasting model for COVID-19 outbreak in Saudi Arabia. *Process Safety and Environmental Protection, 149*, 223–233. doi:10.1016/j.psep.2020.10.048

In this study, Long Short-Term Memory (LSTM) network as a robust deep learning model is proposed to forecast the number of total confirmed cases, total recovered cases, and total deaths in Saudi Arabia regarding COVID-19 pandemic so as to help policymakers to control the disease. Root mean square error (RMSE), coefficient of determination (R2), mean absolute error (MAE), efficiency coefficient (EC), overall index (OI), coefficient of variation (COV), and coefficient of residual mass (CRM) are used for assessing forecast accuracy of the proposed model as statistical assessment criteria. Some of them such as RMSE and MAE are used in many time series forecasting studies in this annotated bibliography. However, many of them like EC, OI, COV and CRM are not widely used in forecasting studies in this annotated bibliography. Therefore, this study enriches the contents of this annotated bibliography by considering statistical assessment criteria. Moreover, the paper's datasets include six different countries' cases such that these countries have different epidemic trends since they apply different policies.

Pacella, M., & Papadia, G. (2020). *Evaluation of deep learning with long short-term memory networks for time series forecasting in supply chain management*. Paper presented at 14th CIRP Conference on Intelligent Computation in Manufacturing Engineering, CIRP ICME '20, Naples, Italy.

In this study, it is suggested to establish an LSTM model for demand forecasting in supply chain management. The two most important difficulties of time series are non-stationarity and non-linearity. To solve these statistical complexities throughout time series analysis, this study proposes LSTM, one of the deep learning methods. Conducting experiments with real data sets is one of the contributions of the study to the literature. Also, the use of both forward LSTM and bidirectional LSTM differs from other studies in this annotated bibliography.

Xue, N., Triguero, I., Figueredo, G. P., & Silva, D. (2019). *Evolving Deep CNN-LSTMs for Inventory Time Series Prediction*. Paper presented at 2019 IEEE Congress on Evolutionary Computation (CEC), Wellington, New Zealand.

This paper offers hybrid deep learning models for inventory forecasting that is important component of effective inventory management. The proposed model consists of Long Short-Term Memory (LSTM) to uncover long temporal dependencies and Convolutional Neural Network (CNN) to learn local features. To optimize hyperparameters of LSTM-CNN without any human interactions, three metaheuristics that are Particle Swarm Optimization (PSO) and two Differential Evolution (DE) variants employs. The automatic hyperparameter tuning without using researcher expertise is an activity not included in other studies in this annotated bibliography. The proposed LSTM-CNN model is benchmarked for Seasonal Autoregressive Integrated Moving Average (SARIMA) models for inventory forecasting problems and the results obtained from the inventory forecasting problem using time series data indicate that the proposed evolutionary approaches outperformed the SARIMA's prediction accuracy.

Unlu, R. (2019). A Comparative Study of Machine Learning and Deep Learning for Time Series Forecasting: A Case Study of Choosing the Best Prediction Model for Turkey Electricity Production. *SDU Fen Edebiyat Fakültesi Fen Dergisi*, *23*(2), 635–646. doi:10.19113/sdufenbed.494396

This paper offers usage of different methods including traditional machine learning algorithms, Support Vector Regression (SVR) and Multi-Layer Perceptron (MLP), and a deep learning algorithm, Long Short-Term Memory (LSTM) to create a better model for the Turkey monthly electricity generation as time series analysis. According to study, Turkey has been paying special attention to electricity generation to meet its needs in recent years such that the researchers applied different statistical-based and artificial intelligence-based methods to accurately predict future electricity production and demand. On the other hand, a limited number of researchers have focused on Turkey's electricity generation prediction problem as a time series analysis. This study shows that LSTM outperforms SVR and MLP approaches in terms of commonly used statistical error evaluation metrics such as MAE and RMSE. Comparative analysis of traditional and modern time series forecasting solution approaches is one of the important contributions of the paper.

Yang, H., & Chen, Y. P. (2018). Hybrid Deep Learning and Empirical Mode Decomposition Model for Time Series Applications. *Expert Systems With Applications, 120*, 128–138. doi:10.1016/j.eswa.2018.11.019

This paper proposes a novel time series forecasting model which can predict future aspects in a timely manner. In order to obtain multistep ahead forecasting, hybrid deep learning (stacked auto-encoders, SAE) and empirical mode decomposition (EMD) model, namely EMD-SAE, offers to predict the traffic flow and random time series since time series contain nonlinear and nonstationary features that make it difficult to predict time series. SAE method can extract the low dimensional representation of input data and it also reduces processing time and eliminate overfitting in the developed models if some input features are redundant or correlated. EMD can decompose a complex time series into a collection of simpler ones, intrinsic mode functions (IMFs) and residuals, which provide assumptions that allow time series prediction. Lastly, this paper illustrates the power of combination of the deep learning and empirical mode decomposition to time series forecasting.

Hajirahimi, Z., & Khashei, M. (2019). Hybrid structures in time series modeling and forecasting: A review. *Engineering Applications of Artificial Intelligence, 86*, 83–106. doi:10.1016/j.engappai.2019.08.018

This paper offers to examine hybrid structures by looking at more than 150 papers that used hybrid models in time series modeling and forecasting. Hybrid models are classified in this paper using three major combination structures that are parallel, series, and parallel–series. The reviewed papers are then thoroughly examined in terms of the unique characteristics of the hybrid structure employed. Moreover, the parallel–series hybrid structure produces more accurate and promising results than other hybrid structures. According to this paper, although several review papers have focused on the use of hybrid models and their benefits in improving forecasting accuracy compared to individual models in a broad range of fields, no research has attempted to categorize and review papers from a systemic standpoint in numerous established studies.

Mouraud, A. (2017). INNOVATIVE TIME SERIES FORECASTING: AUTO REGRESSIVE MOVING AVERAGE VS DEEP NETWORKS. *ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES, 4*(3), 282–293. doi:10.9770/jesi.2017.4.3S(4)

This paper proposes to concentrate on statistical and machine learning approaches that learn relationships between signals in a way that this study comprises accuracy performance comparison of a classic Auto Regressive Moving Average (ARMA) approach to a Deep Highway Network (DHN) on time series forecasting. The power of ARMA model is that it has no need for other information as input in order to predict future values of time series and the power of the DHN is more stable comparing to other deep learning techniques in learning when increasing the number of hidden layers. The performance result shows that although DHN is less adaptive to changes in data pattern, it can improve accuracy. Furthermore, accuracy performance of DHN is better than ARMA with less computation cost.

Golla, K. (2019). *Product Demand Forecasting Using Deep Learning* (M.S.), Lamar University. Retrieved from https://www.proquest.com/docview/2409686625/162462CACA004D15PQ/1?accountid=13014

This paper is intended to present the developing a fast, reliable, accurate model to predict the products' demand for a certain period of time. Demand forecasting is considered a very challenging problem because it requires considering many factors such as patterns of sales demand that means time-series data has no fixed style or consistent pattern, and the existence of temporal dependence between the data. In this study, the deep learning models are used to solve the time-series forecasting since deep learning models can deal with more complex time-series forecasting problems such as missing data, complex nonlinear relationships, and multiple input variables. Moreover, different models like CNN, LSTM, Hybrid model (CNN-LSTM) have been developed and compared to find the model with the accurate prediction and best performance for the demand forecasting system. The forecast accuracy is measured using the sMAPE loss function. By considering all the parameters, the results show that CNN would be the best deep learning model for demand forecasting by considering error value and computation time.

Lakshmanan, B., Raja, P. S. N. V., & Kalathiappan, V. (2019). *Sales Demand Forecasting Using LSTM*. Paper presented at 4th International Conference on Artificial Intelligence and Evolutionary Computations in Engineering Systems, Kattankulathur, India.

This paper presents a model for forecasting sales in the marketplace and compares it to different machine learning models for predicting demand in the future. This paper proposes a Long Short-Term Memory (LSTM) network that takes historical product sales data as input and forecasts the demand for each product over the next three time series. According to the study, LSTM is the most preferable option for a time series sales prediction because Memory-associated networks are required by considering that the forecast is based on a historical sales data. Lastly, the proposed model's accuracy was found to be 96.77%, outperforming all other machine learning models such as Multi-Layer Perceptron (MLP) and Back-Propagation Network (BPN).

Namini, S. S., Tavakoli, N., & Namin, A. S. (2020). *The Performance of LSTM and BiLSTM in Forecasting Time Series.* Paper presented at 2019 IEEE International Conference on Big Data (Big Data), Los Angeles, USA.

This study proposes the comparison of LSTM and bidirectional LSTM (BiLSTM) such that main concern of this study is that whether the gates included in the LSTM architecture already provide a good prediction and whether additional data training is required to improve the prediction. By traversing the input data twice, BiLSTM allow for additional training. Thus, main goal of this study is that whether additional layers of data training have significant impact on improving the precision of time series forecasting. The results show that BiLSTM employing additional data training outperforms regular LSTM-based models. While the other studies included in this annotated bibliography use classical LSTM, this study shows that BiLSTM is better than classical LSTM in predictive power. Therefore, this paper offers a perspective that is not included in other studies by proposing a different method.

Zhang, G. P. (2003). Time series forecasting using a hybrid ARIMA and neural network model. *Neurocomputing, 50*, 159–175. doi:10.1016/S0925-2312(01)00702-0

This paper proposes a hybrid methodology that combines both ARIMA and ANN models so as to capitalize on the unique strengths of ARIMA and ANN models in linear and nonlinear modeling. While main advantage of ARIMA for times series forecasting is due to the well-known Box–Jenkins methodology, main limitation of ARIMA is that nonlinear patterns cannot be captured by the ARIMA model. Moreover, the main advantage of ANN is their flexibility in nonlinear modeling. This study employs three well-known data sets that are Wolf's sunspot data, Canadian lynx data and British pound=US dollar exchange rate data to show the efficacy of the hybrid method. The empirical findings from three real data sets show that the hybrid model outperforms each individual model.

Du, S., Li, T., & Horng S. J. (2019). *Time Series Forecasting using Sequence-to-Sequence Deep Learning Framework*. Paper presented at 9th International Symposium on Parallel Architectures, Algorithms and Programming (PAAP), Taipei, Taiwan.

This paper proposes a sequence-to-sequence deep learning system for multivariate time series forecasting , which uses an LSTM-based encoder-decoder architecture to point out the complex, spatial-temporal, and nonlinear characteristics of multivariate time series data. PM2.5 multivariate time series which includes meteorological data is used for prediction and under single-timestep and multi-timestep forward forecasting conditions, the estimated PM2.5 value can be closely matched to the ground truth value. According to this study, The air quality time series data experiments indicated that the proposed model has good forecasting performance and generalization ability.

Sagheer, A., & Kotb, M. (2019). Time Series Forecasting of Petroleum Production using Deep LSTM Recurrent Networks. *Neurocomputing, 323*, 203–213. doi:10.1016/j.neucom.2018.09.082

In this paper, we propose a deep learning methodology capable of overcoming the drawbacks of conventional forecasting methods while still delivering reliable predictions. As an extension of the standard recurrent neural network, the proposed solution is a deep long-short term memory (DLSTM)

architecture. In order to configure DLSTM's optimal architecture, a genetic algorithm is used. Two case studies from the petroleum industry domain are carried out for assessment purposes by using production data from two real oilfields. The output of the proposed solution is compared to many standard approaches, either statistical or soft computing in order to achieve a reasonable evaluation. The empirical findings show that the proposed DLSTM model outperforms other conventional approaches using various measurement parameters. The usage of genetic algorithm to infer optimal selection for the proposed model hyper-parameters is a technique that makes a difference regarding other studies in this annotated bibliography.