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Artificial intelligence hybrid models for improving forecasting accuracy

Nisrine Zougagh^{a,*}, Abdelkabar Charkaoui^b, Abdelwahed Echchatbi^c

^aHassan First University of Settat; Faculty of sciences and Techniques; IMII; 26000; Settat; Morocco

^bHassan First University of Settat; Faculty of sciences and Techniques; IMII; 26000; Settat; Morocco

^cHassan First University of Settat; Faculty of sciences and Techniques; IMII; 26000; Settat; Morocco

Abstract

Forecasting accuracy is necessary for advanced process planning and for fighting uncertainty in forecasting environment. Even if there are many methods for minimizing this uncertainty by using artificial intelligence AI but this problem, still be a crucial issue.

The objective of this paper is to highlight AI hybrid models used for forecasting accuracy. Seventy articles are reviewed, classified and synthesized in order to provide recommendations and suggestions for future research.

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1. Main text

1.1. Introduction

With the digital revolution advanced data, artificial intelligence are becoming essential and necessary for companies to increase their productivity and to improve their performance indicators.

* Corresponding author. Tel.: +212-605-005-948;

E-mail address: n.zougagh@uhp.ac.ma

Accuracy of forecasting has been a crucial issue since years ago. The relevance of most administrative decisions in the short, medium or long term depends, directly or indirectly, on the level of accuracy of the predictions.

The demand comes from outside and it varies according to several variables (seasonality, culture, natural disasters, etc...) because demand is sensitive to general economic and politics conditions.

For instance, In supply chain management, forecasting accuracy provides vital intelligence for supply chain stockholders to support their planning and decision making [1]. In addition, the power of forecasting accuracy in supply chain management lies in the finding of the optimal point between satisfying customer needs and generating additional costs related to overproduction/overstocking due to overestimation. Inaccurate forecasts may cause unnecessary costs in procurement and transportation, manpower, service level, and inventory [3].

In pharmaceutical supply, forecasting accuracy is still a huge challenge [2]. With the spread of the Covid-19 pandemic, the pharmaceutical sector is one of the sectors most likely to double its activity. Demand forecasting has increased, especially for medicines of immunity chronic disease, the medicines that have been developed as part of the virus treatment protocols and demand for medical supplies such as masks, disinfectants and sterilizers. This variance in demand creates an uncertain environment of forecasting

In tourism, the majority of demand forecasting studies fall under the well-established category of quantitative approach, which constructs the model from training data on past tourist arrival volumes and various tourism demand-forecasting factors [4]

The purpose of this document is to assess the artificial intelligence hybrid methods used for improving forecasting accuracy. In other word, we aim to identify current trends in AI model hybridation for improving forecasting accuracy

1.2. Methodology

- Design

The methodology is identified through several phases. In the first phase, we use the ERIC, Scopus, IEEE and Google scholar electronic databases to locate articles in English. We use this expression “forecasting accuracy using hybrid methods” for collecting articles published after 2005.

The first results of our research are Scopus =240; IEEE=45; ERIC= 95; Google scholar=18500. After eliminating duplicate articles, and taking in account the relevance as inclusion criteria, this search produced 161 articles. After analyzing the titles and abstracts from the search results 31 articles are excluded, and 60 articles are excluded during full paper analysis. In the final list, we have 70 articles. To analyze the articles, we will extract the publication year, research area, AI hybrid model used, and the model utility. Each article will be analyzed separately in a table. At the end, we will discuss all the findings focusing on our previously established objective. Finally, we have the list of articles selected for analysis (See Appendix A)

- Data analysis

For the analysis of the articles, we made a classification of each article according to publication year, the hybrid model, the research area, and the hybrid model utility.

1.3. Results

- Interest in AI hybrid model:

From figure 1, we can see that the number of articles on AI hybrid models has been growing steadily over the years, with a significant increase in recent years. This shows the considerable interest on this topic in the field of scientific research.

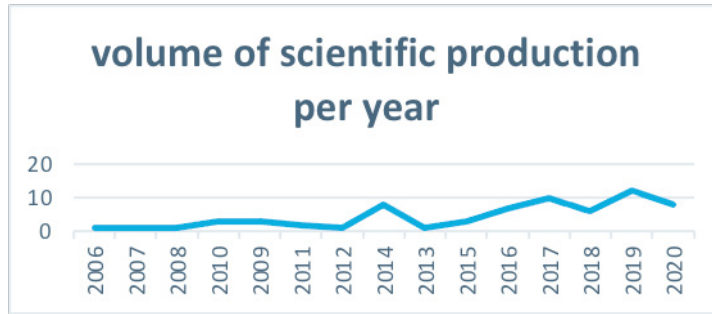


Fig. 1. Volume of scientific production per year

- Research area:

From an analysis according to the field of research, it is clear that the field of renewable energy/energy has attracted the attention of the authors. In second position are the forecasts of the supply chain and water consumption.

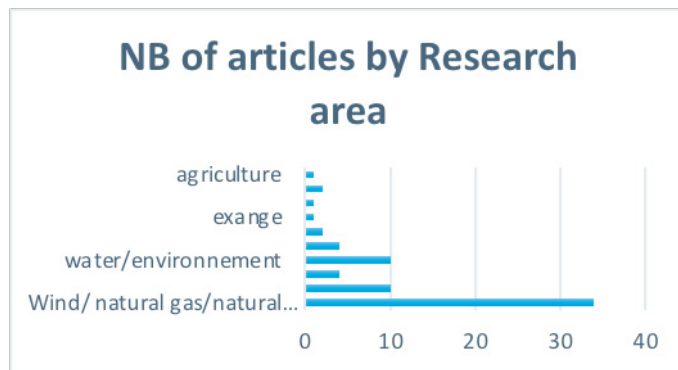


Fig.2 .NB of articles by research area

- The most used AI methods for hybridization

According to the analysis, we find that among all the AI methods, almost five methods dominate with a percentage of 80% of the models examined. From the figure bellow, we can see the Neural Network NN, Fuzzy logics, Genetic algorithm GA, Autoregressive models (AR, ARIMA or ARMA), support vector machine SVM are the most used for hybridization. The neural network is the most used in the majority of works.

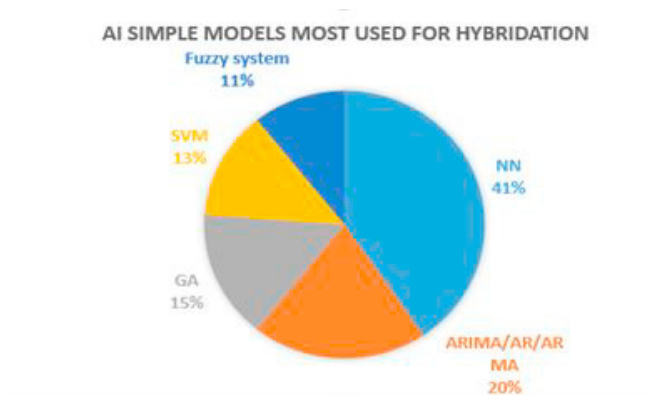


Fig. 3. AI hybrid models most used for hybridization

1.4. Discussion and conclusion

From the results of our analysis, it is clear that the interest of AI methods hybridization is increasing. It is one of the current trends in the use AI methods for forecasting. Combining two or more methods at the same time or sequentially could benefit from the predictive power of each method and fill in the gaps ones.

The field of renewable energy/energy, the supply chain and water consumption have attracted the attention of the authors according to our results. Energy demand trends have been developed using relatively simple methods of anticipating demand according to the short, medium or long term to avoid over-dimensioning their infrastructure and the resulting costs.

For the AI methods, in our work, neural network is the dominant method in hybridization. The power of neural network is that it has a different way to handle both linearly and non-linearly data. This study further recommends some research propositions to be explored in future research such a recommended method/s for each research area and new hybrid models could improve forecasting accuracy according to each research area.

References

- [1] Abolghasemi, M., Beh, E., Tarr, G., Gerlach, R., 2020. Demand forecasting in supply chain: The impact of demand volatility in the presence of promotion. *Computers & Industrial Engineering* 142, 106380. <https://doi.org/10.1016/j.cie.2020.106380>
- [2] Merkuryeva, G., Valberga, A., Smirnov, A., 2019. Demand forecasting in pharmaceutical supply chains: A case study. *Procedia Computer Science* 149, 3–10. <https://doi.org/10.1016/j.procs.2019.01.100>
- [3] Torkul, O., Yilmaz, R., Selvi, İ.H., Cesur, M.R., 2016. A real-time inventory model to manage variance of demand for decreasing inventory holding cost. *Computers & Industrial Engineering* 102, 435–439. <https://doi.org/10.1016/j.cie.2016.04.020>
- [4] Wu, D., Song, H., Shen, S., 2017. New Developments in Tourism and Hotel Demand Modeling and Forecasting. *International Journal of Contemporary Hospitality Management* 29, 507–529. <https://doi.org/10.1108/IJCHM-05-2015-0249>

Appendix A.

List of selected articles for analysis:

Articles	year
Prediction of electrical energy demand by hybridization of Particle Swarm Optimization and Noise filtering	2010
A Hybrid Deep Learning Model with Evolutionary Algorithm for Short-Term Load Forecasting	2019
A hybrid forecasting framework with neural network and time-series method for intermittent demand in semiconductor supply chain	2018
A hybrid load forecasting model based on support vector machine with intelligent methods for feature selection and parameter optimization	2020
A hybrid method for time series prediction using EMD and SVR	2014
A hybrid modern and classical algorithm for Indonesian electricity demand forecasting	2016
A hybrid neural network model for power demand forecasting	2019
A hybrid prediction model based on pattern sequence-based matching method and extreme gradient boosting for holiday load forecasting	2021
A hybrid statistical genetic-based demand forecasting expert system	2009
A method for short term load forecasting using support vector regression model and hybrid evolutionary algorithm	2012
A new approach for water demand forecasting based on empirical mode decomposition	2014

A new hybrid evolutionary based RBF networks method for forecasting time series: A case study of forecasting emergency supply demand time series	2014
A new hybrid model for request rate prediction in mobile cloud computing	2015
A new hybrid model for short-term electricity load forecasting	2019
A Novel Air-Conditioning Load Prediction Based on ARIMA and BPNN Model	2009
A novel fuzzy-based ensemble model for load forecasting using hybrid deep neural networks	2020
A novel hybrid algorithm for electricity price and load forecasting in smart grids with demand-side management	2016
A Novel Hybrid Model for Short-Term High-Speed Railway Passenger Demand Forecasting	2019
A Real-time Prediction Algorithm for Driver Torque Demand based on Vehicle-Vehicle Communication	2019
A review on applications of ANN and SVM for building electrical energy consumption forecasting	2014
A seasonal hybrid procedure for electricity demand forecasting in China	2011
Accuracy Assessment of Artificial Intelligence Based Hybrid Models for Spare Parts Demand Forecasting in Mining Industry	2020
Adaptive Forecasting Techniques Applied to Short Time Wind Speed Forecasting	2019
Agriculture irrigation water demand forecasting based on rough set theory and weighted LS-SVM	2010
An eco-environmental water demand based model for optimising water resources using hybrid genetic simulated annealing algorithms. Part I. Model development	2009
Artificial neural network and regression coupled genetic algorithm to optimize parameters for enhanced xylitol production by <i>Debaryomyces nepalensis</i> in bioreactor	2017
CEREF: A hybrid data-driven model for forecasting annual stream flow from a socio-hydrological system	2016
Comparison of neural network and hybrid genetic algorithm-neural network in forecasting of Philippine Peso-US Dollar exchange rate	2014
Day-ahead high-resolution forecasting of natural gas demand and supply in Germany with a hybrid model	2020
Developing a hybrid intelligent model for forecasting problems: Case study of tourism demand time series	2013
Easy, reliable method for mid-term demand forecasting based on the Bass model: A hybrid approach of NLS and OLS	2016
Electric Load Forecasting Using Hybrid Machine Learning Approach Incorporating Feature Selection.	2015
Forecasting aggregated wind power production of multiple wind farms using hybrid wavelet-PSO-NNs	2014
Forecasting copper prices using hybrid adaptive neuro-fuzzy inference system and genetic algorithms	2019
Forecasting Domestic Shipping Demand of Cement: Comparison of SARIMAX, ANN and Hybrid SARIMAX-ANN	2019
Forecasting electricity load demand using hybrid exponential smoothing-artificial neural network model	2016
Forecasting energy consumption in Taiwan using hybrid nonlinear models	2009
Forecasting of water quality using grey GM(1,1)-wavelet-GARCH hybrid method in Songhua River Basin	2016
Forecasting the demand of the aviation industry using hybrid time series SARIMA-SVR approach	2019
Hybrid forecasting approach based on GRNN neural network and SVR machine for electricity demand forecasting	2017
Hybrid LEAP modelling method for long-term energy demand forecasting of regions with limited statistical data	2019

Hybrid load forecasting method with analysis of temperature sensitivities	2006
Hybrid Model for Short-Term Water Demand Forecasting Based on Error Correction Using Chaotic Time Series	2020
Hybrid short term load forecasting using ARIMA-SVM	2017
Hybrid SSA-TSR-ARIMA for water demand forecasting	2018
Hybrid wavelet and local approximation method for urban water demand forecasting - chaotic approach	2018
Implementing Fuzzy Cognitive Maps with Neural Networks for Natural Gas Prediction	2018
Improved supply chain management based on hybrid demand forecasts	2007
Intelligence in tourism management: A hybrid FOA-BP method on daily tourism demand forecasting with web search data	2019
Inventory demand forecast based on grey correlation analysis and time series neural network hybrid model	2017
Inventory lot-sizing with supplier selection using hybrid intelligent algorithm	2008
Load forecasting using hybrid models	2010
Medical service demand forecasting using a hybrid model based on ARIMA and self-adaptive filtering method	2020
Modified genetic algorithm-based feature selection combined with pre-trained deep neural network for demand forecasting in outpatient department	2017
Multi-Objective Optimization of Hybrid Renewable Energy System with Load Forecasting	2017
Overview, comparative assessment and recommendations of forecasting models for short-term water demand prediction	2017
Short term load forecasting of anomalous load using hybrid soft computing methods	2016
Short term load forecasting using hybrid adaptive fuzzy neural system: The performance evaluation	2017
Short term wind power forecasting using hybrid variational mode decomposition and multi-kernel regularized pseudo inverse neural network	2018
Short-term forecasting of high-speed rail demand: A hybrid approach combining ensemble empirical mode decomposition and grey support vector machine with real-world applications in China	2014
Short-term hourly price forward curve prediction using neural network and hybrid ARIMA-NN model	2015
Short-term load forecasting for microgrid energy management system using hybrid HHO-FNN model with best-basis stationary wavelet packet transform	2020
Short-term water demand forecasting using hybrid supervised and unsupervised machine learning model	2020
Short-term wind power forecasting using hybrid method based on enhanced boosting algorithm	2017
Short-term wind speed and wind power prediction using hybrid empirical mode decomposition and kernel ridge regression	2018
Solar power forecasting using a hybrid EMD-ELM method	2017
Spring onion seed demand forecasting using a hybrid Holt-Winters and support vector machine model	2019
SVR with hybrid chaotic genetic algorithms for tourism demand forecasting	2011
Tourism demand forecasting using novel hybrid system	2014