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Algorithm Based on Deep Learning to Improve the Logistics Management of a Company That Distributes Reading Material

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Abstract. Companies in the field of sales and distribution of reading material, which have the problem of great variability in the demand for their products, which causes higher costs and customer dissatisfaction. Deep Learning, which is a branch of Machine Learning which is responsible for training a computer to learn on its own, works by recognizing patterns using many processing layers and learns through repetition in its training. Using the KDD methodology, we have implemented a deep learning algorithm to improve the logistics management of a reading material distribution company through demand forecasting and other aspects of logistics. It was shown that with the use of certain functions in the neural network of the algorithm it can be predicted with a low deviation and a minimum level of error, giving us results for 85% of improvement in demand prediction, also an 80% of improvement in material devolution, increasing the precision of the company on buying material aiming to get the exact amount of material to distribute. However, we can improve the results for a more accurate prediction by adapting the algorithm to the situation. Also, we share our challenges, and other opportunities for future research. This paper can help other investigators being a guide for beginners in deep learning application in logistics management.

Keywords. Deep learning, machine learning, value chain

1. Introduction

Despite the ravages of the pandemic due to covid-19, Latin American companies showed an 8.5% growth in the technology market during 2021 and new trends have arrived like IoT, big data and artificial intelligence with the digitalization on the 4.0 industry [1].

Authors Zhou, Yang and Fu's article [2] talks about pricing and ordering, which they say is very important, as benchmark prices have a significant impact on customer buying behaviors and companies' operational strategies. Therefore, we believe that this aspect will help the logistics management of book distribution companies.

Authors Kun and Hongliang [3] mention in their paper that smart purchase prediction is about predicting when a consumer may buy a new product or service based on their purchase history. This type of prediction has been applied in online advertising, search engines, recommendation systems and inventory control.

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Therefore, intelligent prediction helps distribution companies to reduce the rate of customer abandonment, determine the deficiency in business plans and in the processes of operation and logistics [4]. Likewise, in the article by Yiwey, Lin & Bo [5] it is said that accurately forecasting sales is a major challenge faced by almost all companies.

Overestimation can directly affect inventory, cash flow, the company's business reputation, and profits. Therefore, in the business world the predictive algorithm has attracted a lot of attention, which are mainly based on autoregressive models.

2. Methodology

According to Kanwal, Lau, Ng, Sim and Chandrasekaran [6] for the purpose of the algorithm which will be the prediction is considered complex by various market factors adding incomplete and sometimes confusing information, so a precise prediction model must be made using different input variables as it ensures [7].

All methodologies seek to convert data into information through organized work together with stakeholders (people affected or involved by the project), to turn it into resources that facilitate decision-making in the company [8].

The KDD is an interactive process that involves a series of steps, usually, we can find that this is divided into 6 steps: Mastery of the Study and Establishment of Objectives, Collection or obtaining of data, Cleaning and processing of data, Data mining, Interpretation of patterns, Use of the acquired knowledge.

For the domain of study, it is sought to take prior knowledge of the context in which we manage ourselves, to have a deep mastery of the subject understanding the problem to be solved and the objectives that we must achieve [8].

Subsequently, one of the categories was taken that will serve as test data for use in the development of the model. This data was arranged in a ".csv" file to make its manipulation by the software in which the algorithm will be developed more convenient.

Multilayer perceptron:

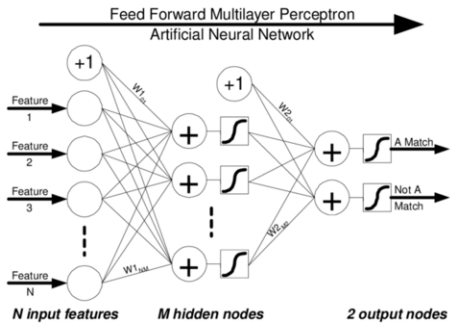

Figure 1. Feed forward multilayer perceptron artificial neural network.

The multilayer perceptron is one of the most used designs in the section of neural networks, unlike machine learning, the neural network does not need to be trained with individual features, but by training algorithms such as back-propagation the weight of each node in the layers is adjusted like in the fig. 1, in this way a more accurate precision is reached as Mentioned by Broussard and Kennell [9].

The indicators and metrics that we will use for this research are the following:

MAD (Mean Absolute Desviation): Represents the average deviation of the forecast in absolute values.

MSE (Mean Square Error): Average of the squares of the deviations of the estimate in the N periods.

RMSE (Root Mean Square Error): It is the root of the average of the squares of the differences of the estimate in the N periods.

MAE (Mean Absolute Error): The different errors are not weighted, but the scores increase linearly with the increase in errors. This is measured as the average of the absolute error values.

3. Results

For this section, the demand prediction was determined as a solution, for this we based on a sales and distribution dataset of the company, and we took it to the multilayer perceptron model with embeddings, we obtained the following results:

And in the metrics chosen for the prediction of demand we have the MSE, which shows us values that even reach 0.05 which indicates a very good result since there is no deviation in the prediction as shown in Fig. 2.

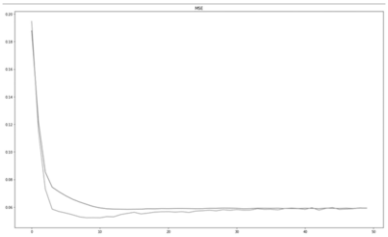

Figure 2. MSE Indicator.

And according to Fig. 3 in the case of MAD we have values close to 0.17 that indicate a good percentage for the absolute deviation of the predictions.

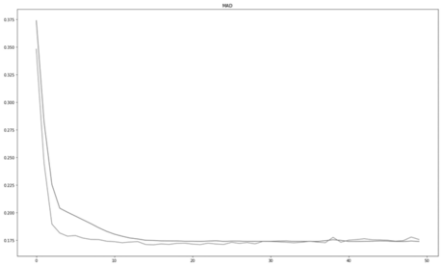

Figure 3. MAD Indicator

In the metrics chosen for the prediction of the withdrawal of merchandise we have the RMSE, which shows us that the values descend considerably fig. 4 to 0.20, which is a big improvement due to the low error rate per average root.

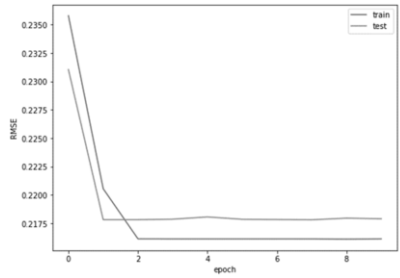

Figure 4: RMSE Indicator

And finally for the MAE we can see according to fig. 5 that the value of the absolute error drops to average values of 0.35

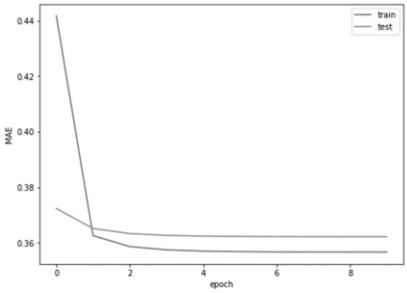

Figure 5: MAE Indicator

4. Discussion

In the present research work aimed at the development of a mobile application based on Deep Learning for the prediction of the demand for books per season of bookstores, in this way it will be possible to prevent what type of reading material will be a trend at each time of the year, so they will know what products they should distribute, consequently, this will give the administrative area of the company the opportunity to select the work with certain publishers based on the tastes of the end customer.

Likewise, the following question was asked: Will the development of a predictive algorithm carried out with Deep Learning help improve the logistics of supply in a company that distributes reading material?

Widely we can answer with a yes , since experimental/practical studies usually produce models, systems, frameworks, approaches, algorithms, methods or methodologies, and that logistics belongs to the experimental/practical type [10], so it demands an algorithm, which is our predictive algorithm which gives an accuracy of 80% to 85% for the continuous improvement of the end customer.

We have based on 3 dimensions which are Supply, Return and Withdrawal of merchandise. For each one, different neural network models were applied based on the multilayer perceptron and varying properties of the same model such as batch size, learning rate, loss functions, activation functions and Epochs. We even use embeddings for supply prediction, from which we get a loss of 17%, which indicates a low deviation in our predictions in contrast to real values.

For the prediction of the withdrawal of merchandise it was identified that we have a low percentage of deviation since we reached success values of 70%.

5. Conclusion

On what has been investigated based on the methodology and results of the experiments carried out, we can conclude that through the use of neural network models, predictions of different dimensions of the logistics of a book distribution company can be reached, resulting in an 85% improvement in the prediction of demand, also an 80% improvement in the return of material, increasing the accuracy of the company in the purchase of material with the aim of obtaining the exact amount of material to be distributed.

In addition, the KDD methodology helped us to propose the study from an application panorama, following the steps of research and elaboration of the algorithm to reach the results obtained.

In turn, the use of the algorithm sought to improve the prediction of demand to obtain accuracy in purchases and improve the total cost of acquiring new reading material for the company.

6. Limitations and implications

On the present work we can observe that we had limitations to be explicit in the details of the research, such as the state of the art, the elaboration of the algorithm and its comparison with others.

Due to the few works on the field of the distribution of reading material, we have decided to explain in an integral way the operation of the algorithm and its results in practice, to demonstrate that it has use in the field and is of help to the client.

In addition, our research has some implications in the aspect of the use of the algorithm, since its effectiveness depends on its characteristics and properties, which must be modified if they are used for different data sets.

7. Future research

Although deep learning in the reading material companies sector is new, all prediction algorithms share with each other the use of different learning models and neural network design, just as we use the multilayer perceptron and back-propagation.

To improve the results and reduce the scientific vacuum, other machine learning and deep learning models could be integrated, such as Random Forest, recognition and classification patterns or other models applied in prediction with images, in order to solve problems in integration of the distribution of the reading material.

References

[1] C. Ovalle, «Predictive model based on Machine Learning for the Supply Chain and its influence on the logistics management of car sales company. » 2022
[2] Zhou, Q., Yang, Y., & Fu, S. (2022). Deep reinforcement learning approach for solving joint pricing and inventory problem with reference price effects. Expert Systems with Applications, 195.
[3] X. Kun, F. Hongliang , H. Jianguang , W. Hanyu, R. Junxue , J. Qin y W. Dafang , «An Intelligent Self-Service Vending System for Smart Retail,» Sensors , vol. 21, nº 10, p. 3560, 2021.
[4] M. Torrens and S. Parra, "Artificial Intelligence. The Road to Ultraintelligence," RBA Collectibles, 2017.
[5] Y. Liu, L. Feng y J. Bo, «Future-Aware Trend Alignment for Sales Predictions» MDPI, vol. 11, nº 558, 2020.
[6] A. H. Moghaddam, M. H. Moghaddam y M. Esfandyari, «Stock market index prediction using artificial neural network, » Journal of Economics, Finance and Administrative Science, vol. 21, nº 41, pp. 89-93, 2016.
[7] R. H. Ballou, Logistics: Supply Chain Management, Pearson Education, 2004.
[8] J. S. Burgos Vargas and K. L. González Cubero, "Implementation of a Management System Based on Methodology," Guayaquil, 2020.
[9] R. P. Broussard y L. R. Kennell, «An artificial neural network based matching metric for iris identification, » Proceedings of SPIE - The International Society for Optical Engineering, vol. 6812, nº 1, 2008.
[10] Toorajipour, R., Sohrabpour, V., Nazarpour, A., Oghazi, P., & Fischl, M. Artificial intelligence in supply chain management: A systematic literature review. Journal of Business Research, 122, 502-517. (2021).