ISSN: 0974-5823 Vol. 7 (Special Issue 2, Jan.-Feb. 2022)

International Journal of Mechanical Engineering

Comparative and Performance analysis of FS- Feature Selection Optimization Techniques for Promotional Marketing Strategy to Predict and Forecast Product Demand (PMSPF) on Dissimilar Datasets Using Deep Learning Techniques

Midhu Bala G[1]

Research Scholar

Department of Computer Science

Madurai Kamaraj University, Madurai

Dr.K.Chitra[2]

Assistant Professor

Department of Computer Science

Govt., Arts College, Melur, Madurai

Abstract- In the competitive Business world marketing and prediction from customer feedback becomes a huge issue. Relevant, real time information analysed so that the issue can be rectified. Analysis of customer feedback to predict product demand is defined by the exploration of comment, reviews and star rating. The purpose of this paper is to investigate if online reviews, promotional strategies and sentiments from user reviews can predict product sales. In this paper the author deployed Node. js agents for scraping the Amazon.com, university site page, commercial site and banking sector pages. The data sets were then pre-processed for feature extraction and significant feature selection optimizers such as PSO, Eagle and proposed PMSPF-FS (Promotional Marketing Strategy Product Forecasting Feature Selection using Region search with Evolution Strategy) for deep learning analysis. The hybrid approach of deep learning techniques such as CNN fused with LSTM were employed to examine which considerable feature in the study are act as an important predictors of online product sales in more accurate manner. This study found some variables are more important predictors than others, the relationship effects of these features become more important features than the individual feature themselves. For example, online volume and valance interactions with discounts are more important than the individual predictors. This study designed big data architecture, in combination with sentimental and neural network analysis that can facilitate future business research for predicting product sales in an online environment.

Index- Product Demands, Online Reviews, Promotional Marketing Strategy, Big Data

I.INTRODUCTION

Data is growing more, the development of the internet and computing technology becomes smart, e-commerce, online business is now increasingly used [1][2]. Sales and purchase of products, goods changed from offline to online using the internet is known as e-business, e-commerce. The e-commerce platforms that are currently developing include Amazon, Flipcart, Tokopedia, Bukalapak and so on increase online shopping with various marketing strategies. Through this e-commerce platform, shoppers and buyers can make buying and selling transactions easily with saving their time.

The product promotions offered through e-commerce platforms is an important matter that needs to be considered because it makes a greater impact on the user's decision in buying a product. The goal of this study is to develop a product recommendation system and product promotion strategy on e-commerce. There are several methods that can be used to produce certain recommendations, including Content-based Filtering and Collaborative Filtering [5]. Content-based filtering provides recommendations by discovering product descriptions, customer name, purchase date and factors such as reviews, ratings and feedback of customers that can influence user decisions in buying a product.

The use of data analytics to better understand business processes is not new. Many Companies used various sales, pricing, economic and demographic data to understand customer behaviours and product demands and online sale promotion. Big Data technologies and the Internet however, provide companies with enhanced abilities to obtain and analyse data from multiple fields, resulting in opportunities for discovering untapped business information.

To achieve the sales goal of their products in the shortest time possible, both manufacturers and sellers have developed and implemented a series of promotional Strategies such as discounts, coupons, virtual gold coins, money-back guarantees, and free shipping insurance. Customers are often influenced by these promotional actions when making purchasing decisions. This approach used by manufacturers and sellers is becoming increasingly visible in new products, especially those related to the automobile and electronics sector [3], [4]. The timely and accurate collection of market information and the control of various factors affecting sales can assist manufacturers and sellers in maintaining reasonable inventory and improving competitiveness.

Factors that affecting the sales of online products is multifaceted. Some researchers had achieved certain research results, especially those related to online reviews, review online promotional strategies, and some seller guarantees. However, that research has some limitations and challenges. So that this study suggests the PMSPF-FS with CNN-LSTM model to analyze the factors that influence product sales based on four aspects, online reviews, online promotions and sentimental texts on customer's feedback for better understand customer demand, which in turn contributes to enterprise performance.

This study aims to improve accuracy of prediction of online sale by customer's feedback. To achieve this, our proposed system provided a approaches to overcome the challenges. First, the impact of the overall features of online reviews on online product sales is highlighted. Second, in addition to customers' rating of this system explores the influence of the number of sentiment words in the review content on product sales. In addition to that the online promotion strategy impacts are also considered. The fused CNN-LSTM model is constructed with a weighted matrix of PMSPF-FS optimizer which is used to analyze the factors affecting the online product sales. The model has a stronger data processing ability and it is compared with other prediction models of online sales prediction such as linear regression, support vector machine (SVM) and random forest (RF).

The algorithms use input from different sites, extract by web scrapping and pre-process data in real time from Amazon.com. The categories used for this study are both electronic devices and commercial data. These algorithms are also applied on other categories such as banking and university datasets called dissimilar data. Besides examining the influence of online promotional strategies and online reviews on product demand, this study also examines if their interaction effects (e.g. when both of them are being offered concurrently online to users) can improve the demand of products by weighting methods. Our proposed approach will allow a better understanding of customer demand through the use of online marketplace information, which in turn reduces the risks. One of the reasons why our approach reduces bullwhip effect risk is that new and real-time data can be extracted and feed into our architecture, and predictions and decisions can be made instantly instead of having the delays of compiling data from various sources which we may find in many legacy systems.

The rest of the paper can be organized as follows; section 2 depicts the related works of this research, the problem on product recommendation is recognized and pointed on section 3, the proposed methodology on product recommendations is optimized, developed and implemented in section 4, section 5 designates the result and evaluation of the suggested methodology performance of various datasets and as a final point section 6 concludes the paper.

II.RELATED WORKS

In modest business world product life cycles are shorter today, specifically in the online shopping sector, manufacturers, retailers are under burden to trade their products in a shorter period of time. Consumers now have more possibilities to know about the product than in the past because of the increased availability of product information. Consumers may now easily identify best product by comparing product pricing, rating and feedback online, nowadays companies are spending an ample amount to market and advertise their products online as a result of these commercial demands. Price reductions and discount are a common promotional marketing tactic used by businesses, because they can increase product sales in a short period of time [5]. According to transaction utility theory, customers' demand for a product increases when there are more discounts because they think they are getting a good deal [6]. The customer feedback given as comment, discount ratio compared with the actual price of a product was utilised as a predictor for the recommender system in this proposed study. The recommendation system is used in various fields to help someone to decide something, for example in providing restaurant recommendations that suit certain preferences [2], social network [5], books recommendation [6], and of course product recommendation in e-commerce systems [1][7][8].

Reviews of customers give a great impact on the sales. Positive reviews increase the sales. Negative reviews have been shown to impact a customer's purchase choice more than good evaluations in previous studies [9]. Negative feedback is also said to spread far more quickly than good feedback [11]. A good customer comment indicates a product's value and reputation, whereas a bad remark reveals users' lack of trust of the product, which might lead to worse product sales. Thus, consumer purchase decisions might be affected due to product ratings, and in addition with the percentage of positive and negative reviews. We added the proportion of negative reviews as predictors of customer product demand for electrical, dress and bank dataset meanwhile bad reviews might have a big impact on sales. Also, we have included the proportion of good reviews so as to compare and observe if negative reviews do really play a greater influence in determining product sales than positive reviews.

Although internet reviews can help customers make better purchase decisions, as the availability of online reviews grows, buyers are more likely to be impacted by how they are evaluated and used [12]. The online marketplace uses helpfulness to determine how customers rate a review. DL was firstly proposed in 2006 by the study of Geof Hinton who reported a significant invention in the feature extraction [13]. After then, DL researchers generated many new application areas in different fields [14]. Other types of DL methods can be found in [13, 15, 16].

III.PROBLEM STATEMENT

Recent approaches use machine learning and deep learning techniques for predicting product and to promote marketing strategies even more efficiently, but evenly the online reviews of customers is still increasing. This occurs because of the huge number of features leads to poor performance of analysis. Therefore, an efficient classification, optimization system is required to solve the current problems.

IV.METHODOLOGY

The following Figure 1 shows the proposed architecture for online sales promotion prediction through customer reviews.

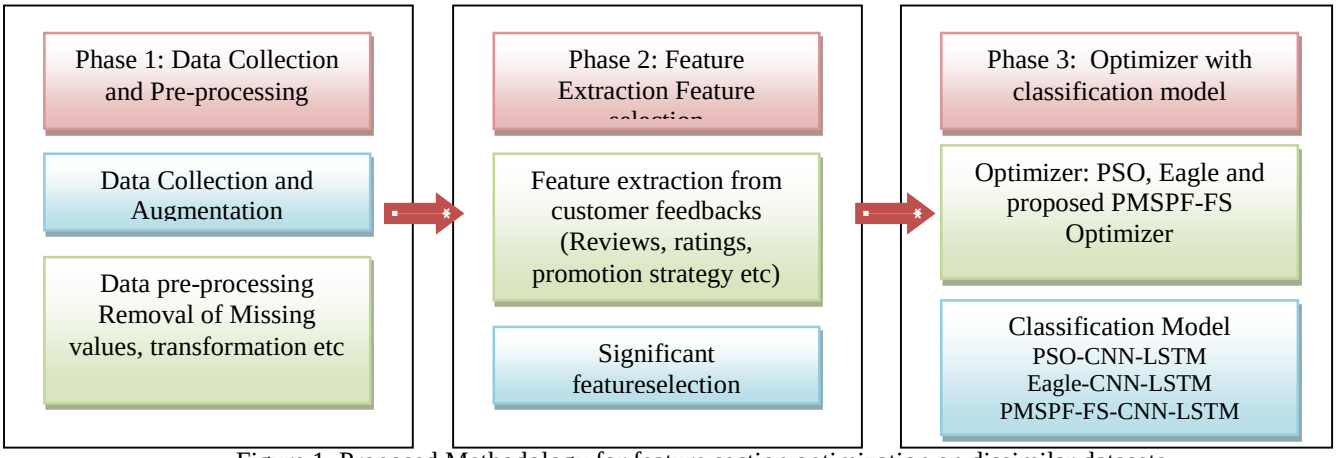


Figure 1. Proposed Methodology for feature section optimization on dissimilar datasets

1) Data Extraction and Expansion

Web scraping will be done using a web crawler. Wrapper program would be used to detect templates in source. Required real time data is gathered and copied from the web and stored in a file for process.

i) Approach

The approach followed by the proposed framework is described in Fig. 1. Initially, the experimental data is collected from an e-commerce website Amazon.com. Each data set is in the Comma Separated Values (CSV) file format. In the next step, data are pre-processed to remove stop words, punctuation marks, whitespaces, digits and special symbols. In the next step, proposed feature selection is performed to extract relevant features from the data set with sentiment orientation of the reviews is determined. The selected features in the dataset to corresponding to each review to conduct supervised learning. The next step involves training and testing the classified data using CNN-LSTM hybrid model is fused with proposed optimizer PMSPF-FS.

ii) Datasets

Various Dissimilar datasets are collected from different resources. Reviews, feedback about the university, bank dataset is collected from Kaggle.com, Dress dataset from Amazon website and represented in Figure 2a, 2b, 2c.

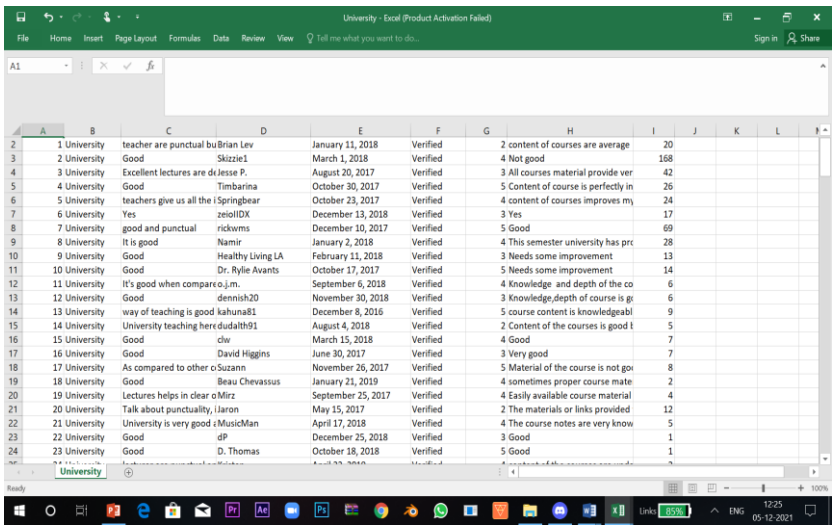
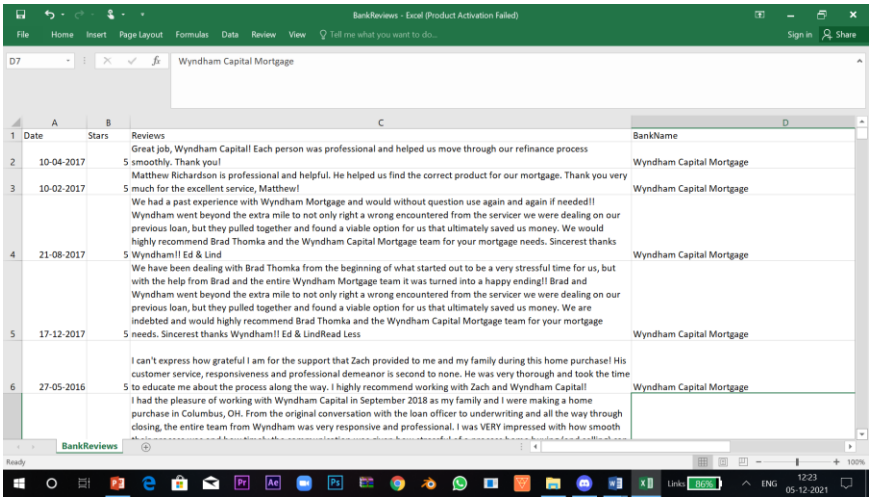


Figure 2a – University Dataset



Date	Stars	Reviews	BankName
10-04-2017	5	Great job, Wyndham Capital! Each person was professional and helped us move through our refinance process smoothly. Thank you!	Wyndham Capital Mortgage
10-02-2017	5	Matthew Richardson is professional and helpful. He helped us find the correct product for our mortgage. Thank you very much for the excellent service, Matthew!	Wyndham Capital Mortgage
21-08-2017	5	We had a past experience with Wyndham Mortgage and would without question use again and again if needed!! Wyndham went beyond the extra mile to not only right a wrong encountered from the servicer we were dealing on our previous loan, but they pulled together and found a viable option for us that ultimately saved us money. We would highly recommend Brad Thomka and the Wyndham Capital Mortgage team for your mortgage needs. Sincerest thanks Wyndham!! Ed & Lind	Wyndham Capital Mortgage
17-12-2017	5	We have been dealing with Brad Thomka from the beginning of what started out to be a very stressful time for us, but with the help from Brad and the entire Wyndham Mortgage team it was turned into a happy ending!! Brad and Wyndham went beyond the extra mile to not only right a wrong encountered from the servicer we were dealing on our previous loan, but they pulled together and found a viable option for us that ultimately saved us money. We are indebted and would highly recommend Brad Thomka and the Wyndham Capital Mortgage team for your mortgage needs. Sincerest thanks Wyndham!! Ed & LindRead Less	Wyndham Capital Mortgage
27-05-2016	5	I can't express how grateful I am for the support that Zach provided to me and my family during this home purchase! His customer service, responsiveness and professional demeanor is second to none. He was very thorough and took the time to educate me about the process along the way. I highly recommend working with Zach and Wyndham Capital!	Wyndham Capital Mortgage
		I had the pleasure of working with Wyndham Capital in September 2018 as my family and I were making a home purchase in Columbus, OH. From the original conversation with the loan officer to underwriting and all the way through closing, the entire team from Wyndham was very responsive and professional. I was VERY impressed with how smooth	

Figure 2b – Bank Dataset

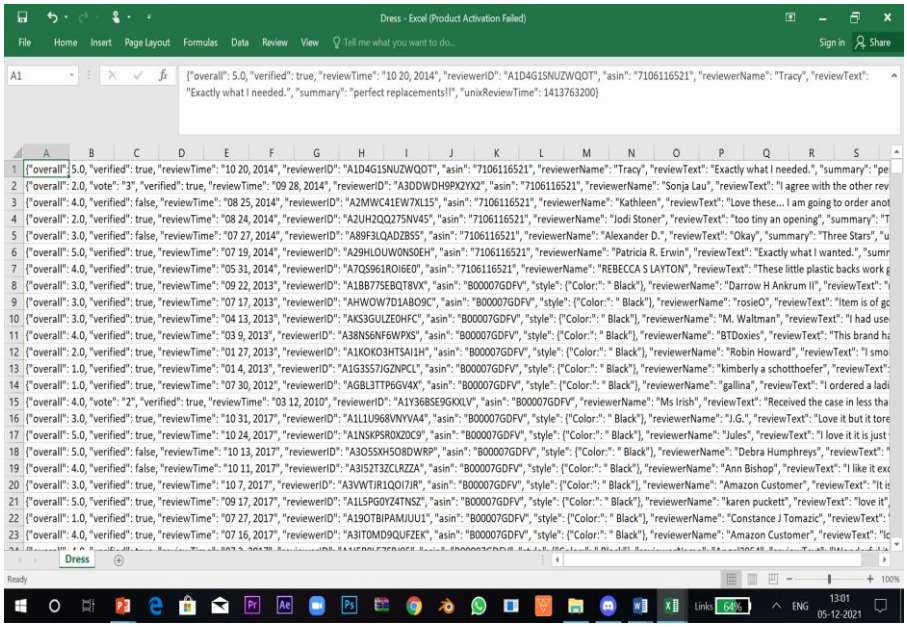


Figure 2c – Dress Dataset

2) Pre-processing

Asynchronous Input / Output calls were used to scrape the Amazon.com sites using Node.JS agents. After that, the data sets from Web crawling and scraping were stored into an excel format. The datasets are pre-processed by removing the null values, irrelevant information etc. the dataset size was reduced from 20GB to 10MB and then feature set were extracted into 12 types from the reviews.

3) Feature Extraction and Feature Selection

The following features are extracted from customer's feedbacks such as reviews, ratings, promotion strategies etc from three dissimilar datasets of banking, university and cloth. Sample features are shown in figure 2.

*feat - Notepad

File Edit Format View Help

```
Retrieved features from Xls
-----
Discount Rate (comments )
Customer Review Rating (Valence)  (stars)
Number of Customer Reviews (Volume) (comments )
Number of Answered Questions (comments )
Positive Reviews (comments )
Negative Reviews (comments )
Rating of the Most Helpful Review    (stars)
Number of people who found the most helpful review useful (n_helpful)
Total number of people that gave feedback to the most helpful review (title)
Volume × Discount Rate
Positive Review × Discount Rate
Valence × Discount Rate
```

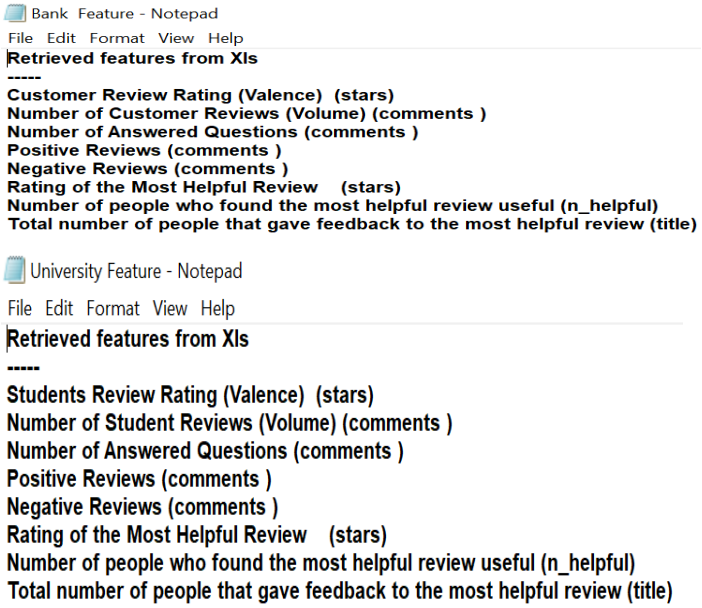


Figure 2. Sample Feature Extraction from Commercial, Bank & University datasets

The 12 feature list which are considered for the product promotional strategy. From the dataset, by considering reviews of the customers, these 12 features were extracted from the excel sheet data.

4) Feature Selection Optimization techniques

The optimization of these features is done using PSO, Eagle and proposed PMSPF-FS optimization with evolution algorithms. The working of these three algorithms is stated below:

PSO based optimization

The features that are passed to deep network with Particle swarm optimization (PSO for training and testing the data. 70% of the information is trained. 30% of the information is then tested. The adjustment of the hyper-parameters and finding the optimal network architecture of convolution neural networks represents an important challenge. This algorithm iteratively trying to improve or obtain the solution. Even though it improves the number of iterations, it cannot be reach the feasible region to search. It has no assumption to locate feasible region.

Eagle based optimization

Eagle strategy is a two-stage method, and so a global search randomization method and an intensive local search are combined and ES can explore the global search space more effectively. if any probable solution is found, an intensive local optimizer is put to use for local search such as differential evolution, particle swarm optimization algorithm. This algorithm used to find the target space by increasing search speed in a feasible region with shortest time. It exploits global optimization problem for a various resources of datasets.

PMSPF-FS optimization

The aim of developing this proposed meta-heuristic algorithm is to increase/improve the capability of carrying out global search and to increase the accessibility of the global optimality. It is one of such algorithms for dealing with stochastic optimization. This search algorithm, based on the nature inspired algorithm with global search and is inspired by bald eagle search behavior during the hunting process. In the selecting phase, it selects a space based on previous search. The parameter α for control the changes in position can be formulated. It use an adaptive reduction of population size, that is, the population size is linearly reduces depending on the current number of function evaluations. Initially for population size p_i, a search space S having minimum and maximum bound.

$$P_i=S_{min}+[S_{max}-S_{min}] \text{ x } S \quad (1)$$

$$P_{new}=p_b + \alpha \text{ x } fr\ (p_m - p_i) \quad (2)$$

This parameter αaffects the position and enhances the searching and utilization a where this parameter takes values from 5 to 10 and fr value takes from 0 to 1.5.P_{new} denotes new population and P_m denotes mean value of consequent movement of next position to search.

$$p_{i,\,new} = p_i + y(i) \times (p_i - p_{i+1})p_{best} + x(i) \times r(p_i - p_{mean}) \quad (3)$$

Consequently, from the local search to global search, fitness value is changed from the worst to the best, so as a generation can not only find a good search but also switch to new search area in the search space. Further it can be noted that the two consecutive generations select the same X, the initial point taken for the interior point method of the latter generation is the Y of the former generation. This PMSPF-FS effectively update the population. Evolution strategy is hybrid with FRG that is used to find most promising areas and provide best solution in group and then it optimized by evolution methods. The best solution obtained by the proposed optimization in which it is again updated byevolution based optimization which is set as bet NP for individual population. The following depicts the PMSPF-FS algorithm.

Algorithm: PMSPF-FS

1. Generate initial population Pi, set decision variables
2. Determine fitness function for initial population
3. Set the count c variable for maximum iteration C_{max}
4. Calculate the surplus group distance from active member in group
5. If C < Cmax continue to get best value for initial, otherwise initial population will be updated
6. Get every initial node for best solution
7. Select the significant area for best solution using equation 1
8. Evaluate the fitness function for getting best space for search
9. Select the space for search using equation. 3
10. Deploy new search space toward target.
11. Repeat until criteria reached and update best solution
12. Optimize the initial population using evolution strategy
13. Update best solution
14. Finally, optimal population is set as the best NP individuals in population.
15. End

Algorithm 1: Algorithmic representation of Proposed PMSPF-FS optimization

5) Deep Learning models

Proposed hybridization of CNN-LSTM model

Combining the advantages of convolution neural networks (CNN) that can extract effective features from the data, and long short-term memory (LSTM) which can not only find the interdependence of data in time series data, but also automatically detect the best mode suitable for relevant data, this method can effectively improve the accuracy of online sale promotion through customer feedback.

This CNN–LSTM hybrid model utilizes generated semantic representation to classify the helpfulness of the reviews. This study has built a review helpfulness classification model using the combined CNN and LSTM that demonstrates excellent performance in the Natural Language Processing (NLP) study. We confirm the advantages of the combined CNN–LSTM hybrid model in semantic representation extraction through various experiments. The following model includes the method of classification with various optimizers.

PSO-CNN-LSTM

Network performance and achieving efficient learning models for a particular problem depends on setting hyper-parameter values and this implies exploring a huge and complex search space. The use of heuristic-based searches supports these types of problems; therefore, the contribution of this research work is to apply the PSO algorithm to find the optimal parameters of the convolution neural networks which include the number of convolution layers, the filter size used in the convolution process, the number of convolution filters, and the batch size. This work describes two optimization approaches; the first, the parameters obtained by PSO are kept under the same conditions in each convolution layer, and the objective function evaluated by PSO is given by the classification rate; in the second, the PSO generates different parameters per layer, and the objective function is composed of the recognition rate in conjunction with the Akaike information criterion, the latter helps to find the best network performance but with the minimum parameters. PSO repeatedly searches and optimizes the complex hyper parameter space of the CNN-LSTM. Our PSO-based CNN-LSTM neural networks produces good accuracy than other heuristic based optimizer.

Eagle-CNN-LSTM

In terms of product-level demand forecasting, CNN-LSTMs have a few promising properties. For starters, they are perfectly suited to modeling time series. This is due to their ability to capture dependency in a sequential context and preserve previous information as they progress through subsequent time steps in a series. LSTMs also accept multivariate inputs. Thus, when predicting, not only historical demand data but also additional demand determinants such as price or promotion can be considered.

Finally, LSTMs can make predictions for multiple products at the same time. By doing so, the complementary and substitutive effects of the goods can be learned. The features are extracted efficiently by this algorithm when they are optimized along with both the Eagle optimization algorithm.

Proposed PMSPF-FS optimization with CNN-LSTM

The evolving CNN-LSTM models are subsequently devised using the proposed PMSPF-FS variant, where the network topology and learning hyper parameters are optimized for time series prediction and classification tasks. Evaluated using a number of benchmark problems, the proposed PMSPF-FS-optimized CNN-LSTM models produce statistically significant results over those from several classical search methods such as Particle Swarm Optimization variants and eagle optimization variant. Comparing with the baseline methods, the CNN-LSTM networks devised by the proposed PMSPF-FS variant offer better representational capacities.

Forecasting attributes for online product a sale promotion

Product design is also part of the product sales promotion. Product designers aim to find the most relevant product features that will suit the wants and needs of consumers throughout the early stages of product creation. Traditionally, multiple surveys must be conducted over the time between product creation and the launch of a new product in order to understand any changes in the value of product attributes. The procedure, however, is time-consuming and pricey. Online consumer reviews have recently been generated on a number of websites, and they can be used to analyse changes in the relevance of product attributes.

This work attempts to propose an empirical approach for identifying and predicting product design qualities that will be useful to consumers in the future using internet big data. We offer a model for estimating the future importance of product attributes based on online consumer reviews to achieve this goal. It has the ability to aid developers in developing approaches and processes for product designs that provide higher returns.

In the existing literature, the time series method has been used to forecast data on nonlinear problems. To forecast the initial future importance of product qualities, two and more factors are introduced. The factors are derived from data on online product sales that are deemed to be of high importance. The next stage is to calculate the weights of each online product attribute, as well as the weights of product attribute interactions. On numerous websites, a large number of online user reviews of items are available, providing corporations with useful sources for anticipating the future importance of new product qualities.

Future research will take into account implicit or hidden product qualities in online reviews to establish the value of product attributes. Online reviews do not directly mention latent traits or product aspects. Hidden features have the potential to identify inventive people from a vast pool of internet evaluations, which might be utilised to uncover key product aspects for producing new items.

V EXERIMENTAL RESULTS AND DISCUSSION

Experimental analysis is performed on three dissimilar dataset such as university, banking and dress and to assess its performance in this section. PSO (particle swam optimization), eagle optimization algorithm are the selected algorithms for the comparison with proposed PMSPF-FS optimization technique on three dissimilar dataset. The overall performance of the optimization algorithm for dress dataset is depicted in table 1. The proposed PMSPF-FS outperforms than existing optimization techniques followed by eagle optimization techniques.

Optimization Over All Performance of Dress Dataset						
Performance Metrics	Dataset Based			Feature Based		
	PSO	EAGLE	PMSPF-FS	PSO	EAGLE	PMSPF-FS
Accuracy	74.57	83.00	94.34	78.49	86.52	93.77
F-Score	76.42	84.78	96.56	60.42	88.41	94.76
Sensitivity	62.22	69.63	87.81	51.39	63.49	88.89

Table 1. Performance of optimization Techniques

The overall optimization performance for three Datasets and Feature-Based are calculated in order to find which optimization algorithm works better for these datasets for optimization and Feature-optimization. The results are tabulated in Table.1. From the results, it is inferred that PMSPF-FS optimization outperforms the PSO with high accuracy of 94.34% for dataset optimization and

93.77% for feature optimization. Similarly, It outperforms the PSO with high F-Score of 96.56% for dataset optimization and 94.76% for feature optimization along with sensitivity calculated. The dataset optimization has sensitivity of 87% and 88% for feature optimization. The overall performance for the datasets in terms of accuracy, sensitivity, specificity, F-Score is calculated and depicted in Figure 3.

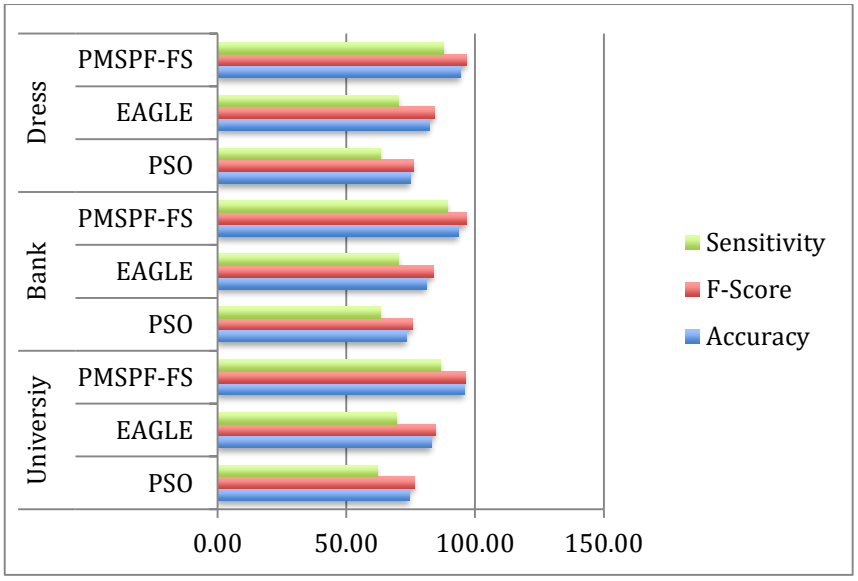


Figure 3. Overall performance of optimization techniques

The following Table 2 shows the overall performance of the deep learning model to predict the best feature to promote the product or institutional performance through their reviews that has given by customer or end users. From the experimental analysis the proposed deep learning model PMSPF-FS based CNN-LSTM outperforms than other deep earning modes with other meta heuristic optimization techniques.

Feature Based Algorithm wise Overall Classification Performance									
Performance Metrics	PSO			Eagle			PMSPF-FS		
	CNN	LSTM	Proposed	CNN	LSTM	Proposed	CNN	LSTM	Proposed
Accuracy	77.84	78.47	84.44	78.85	87.87	84.44	90.11	86.99	95.66
Sensitivity	74.75	84.89	74.44	78.78	84.48	84.78	88.56	86.37	95.23
Specificity	77.48	74.85	84.49	84.44	87.75	84.78	89.35	87.98	94.78
F-Score	77.75	74.74	77.44	74.49	88.75	84.84	93.45	85.76	97.93
Precision	84.87	78.45	84.74	88.88	84.44	84.44	94.25	86.97	96.88
Recall	74.75	84.89	74.44	78.78	84.48	84.78	96.66	86.90	96.95

Table 2. Overall performance of the proposed deep learning (CNN-LSTM) with optimization techniques.

The proposed deep learning algorithm is fused with three optimization algorithms performed on three dissimilar datasets. The following figure 4 shows the overall performance of the deep learning method for all datasets.

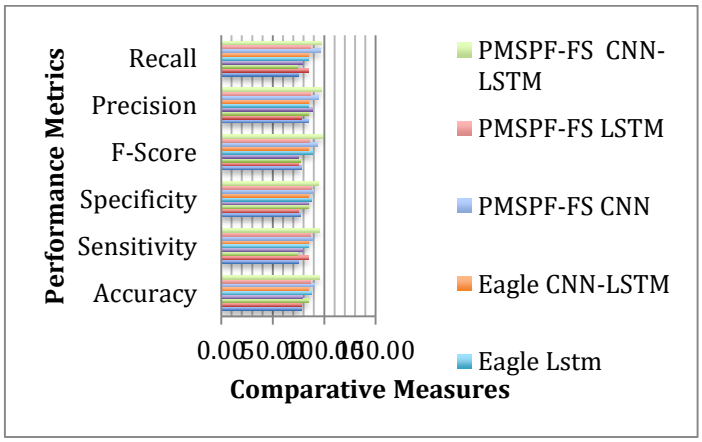


Figure 4. Overall performance of deep learning Techniques.

The following figure 5 shows the accuracy, f-score for the proposed deep learning techniques performed on three dissimilar datasets. The proposed methodology PMSPF-FS with CNN-LSTM outperforms than other existing methods.

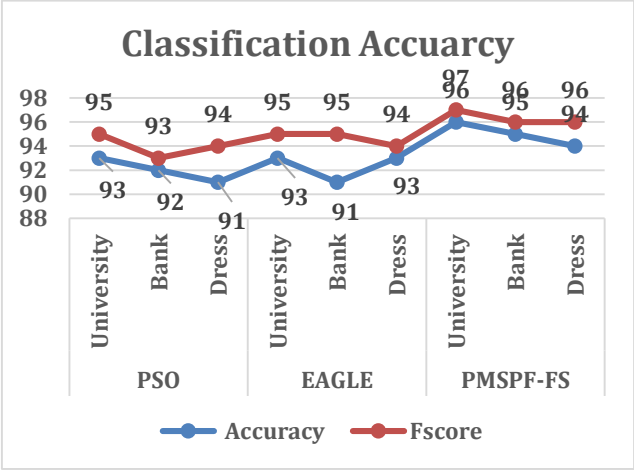


Figure 5. Overall classifications Accuracy for dissimilar Datasets

VI. CONCLUSION

This paper investigates the online demand for dress products in Amazon site, University and Banking site for customer or users feedback such as reviews and promotion strategies using Deep Learning algorithms with optimization algorithms. Results show that PMSPF-FS effectively solves the dissimilar datasets tests implemented in this work. This paper proposes a novel meta-heuristic and nature inspired global optimization techniques. The proposed PMSPF-FS algorithm mainly indicates that to find out feasible region search to predict significant parameter. The findings indicate that all of the variables used in the study are useful predictors of product sales, promote banking and educational sites. The findings also show that online review variables and online promotional strategy variables from previous studies can be used to develop a proposed model that predicts promotional strategies with dissimilar datasets. Our model also demonstrated that all predictors are important, as none were removed during the sensitivity analysis. From the experimental results, our proposed algorithm PMSPF-FS-CNN-LSTM has outperformed with high accuracy of 96%, 88% sensitivity, 90% specificity, 96% F-Score,98% Precision and 95% Recall. The PMSPF-FS-CNN-LSTM algorithm outperforms the other examined algorithms in terms of accuracy and precision, recall, F-Score in finding the optimal solution of the tested methods.

REFERENCES

[1] L. Yan, “Personalized recommendation method for E-commerce platform based on data mining technology,” *Proc. - 2017 Int. Conf. Smart Grid Electr. Autom. ICSGEA 2017*, vol. 2017-Janua, pp. 514–517, 2017.

[2] A. U. Martliong and N. M. S. Iswari, “Rancang Bangun Sistem Rekomendasi Restoran Menggunakan Metode AHP dan VIKOR pada Platform LINE,” *J. Ultim. Comput.*, vol. 10, no. 1, pp. 27–33, 2018.

[3] A. Y. L. Chong, B. Li, E. W. T. Ngai, E. Ch'ng, and F. Lee, "Predicting online product sales via online reviews, sentiments, andpromotion strategies A big data architecture and neural network approach," International Journal of Operations & Production Management, vol. 36, no. 4, pp. 358-383, 2016.

[4] 4.C. Lee, X. Xu, and C. -C. Lin, "Using Online User-Generated Reviews to Predict Offline Box-Office Sales and Online DVD Store Sales in the O2O Era," Journal of Theoretical and Applied Electronic Commerce Research, vol. 14, no. 1, pp. 68-83, 2019.

[5] Z. Wang, J. Liao, Q. Cao, H. Qi, and Z. Wang, “Friendbook: A semantic-basedfriend recommendation system for social networks,” IEEE Trans. Mob. Comput., vol. 14, no. 3, pp. 538–551, 2015.

[6] L. Cui, H. li, C. Wang, and B. Yang, “Personalized Book Recommendation Based on Ontology and Collaborative Filtering Algorithm,” *Open Cybern. Syst. J.*, vol. 8, no. 1, pp. 632–637, 2018.

[7] E. Guiyang, “E-commerce Personalized Recommendation Technology Based on Expert System,” no. 1, pp. 342–345.

[8] Sung-Shun Weng and Mei-Ju Liu, “Personalized product recommendation in e- commerce,” pp. 413–420, 2004.

[9] Cheung, Christy M. K., and Dimple R. Thadani. 2012. “The Impact of Electronic Word-of-Mouth Communication: A Literature Analysis and Integrative Model.” Decision Support Systems 54 (1): 461–470. doi:10.1016/j.dss.2012.06.008.

[10] Cui, Geng, Hon-KwongLui, and XiaoningGuo. 2012. “The Effect of Online Consumer Reviews on New Product Sales.” International Journal of Electronic Commerce 17 (1): 39–58

[11] Mudambi, Susan M., and David Schuff. 2010. "What Makes a Helpful Online Review? A Study of Customer Reviews on Amazon. Com." Management Information Systems Quarterly 34 (1): 185–200.

[12] G. E. Hinton, S. Osindero, and Y. Teh, "A fast learning algorithm for deep belief nets," Neural Computation, vol. 18, no. 7, pp. 1527– 1554, 2006.

[13] Y. Bengio, "Practical recommendations for gradient-based training of deep architectures," in Neural Networks: Tricks of the Trade, vol. 7700 of Lecture Notes in Computer Science, pp. 437– 478, Springer, Berlin, Germany, 2nd edition, 2012.

[14] Y. LeCun, Y. Bengio, and G. Hinton, "Deep learning Review," International Journal of Business and Social Science, vol. 3, 2015.

[15] S. Kim, Z. Yu, R. M. Kil, and M. Lee, "Deep learning of support vector machines with class probability output networks," Neural Networks, vol. 64, pp. 19–28, 2015.