Sentiment Analysis for Recommendation System and Business Intelligence using Deep Learning

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ABSTRACT

Sentiment analysis (SA) is the study of analyzing the sentiments, impressions by people about entities, persons, topics and services. Sentimental analysis uses text analysis techniques from big data analytics. Nowadays most of the people are active on social media. They usually show their sentiments through different websites or platforms. These sentiments are most important for business streams. In today's world, sentimental analysis is becoming important for identifying hidden information in unstructured data formats that arise in the usage of various platforms for business sides. Deep learning plays an important for this business intelligence. The sentiment analysis by deep learning uses popular algorithms. So, in this document we will see how deep learning is important for recommendation system and business intelligence using sentimental analysis.

Keywords: Deep Learning, Neural Networks, Machine Learning, Business intelligence, Sentimental analysis.

1. INTRODUCTION

Sentiment analysis is basically machine learning tool which analyzes text by opinions from positive to negative aspects. It uses popular algorithms like Naïve Bayes. Business intelligence reviews can be effectively applied to sentiment analysis of recommendation system. Most of the business organizations identify these reviews as an important part of organizations decision making.

Genuinely identified reviews present a baseline of information for recommendation that indicates general levels and supports the business intelligence. It also supports in business decisions which would be one more advantage. This research paper neatly explains the necessary information to get preprocess the business reviews in order to get recommendation's and confirms the analysis whether it's useful or not.

2. ANALYSIS

2.1 Features:

Sentiments are not gathered with a single decision, it is based on factors such as polarities. Support Vector algorithms are used to access pessimistic or optimistic sentiments. Labels are classified using neural networks for sentimental analysis. There are various social media platforms from which data can be derived, for example twitter and facebook, the comments or sentences can be broken down into words [1]. Accuracy is also very important, because with the accurate data we can more effectively analyze the data, this would improve the overall

performance of algorithm [2].

2.2 Fields:

Fields in which Sentiment analysis can be used are customer feedback, monitoring social media, management

of customer support [3]. Artificial Intelligence use some techniques like parsing, tagging, tokenization and lemmatization to break the text and derive some meaning from text. In this way algorithm can classify unstructured data easily. There is automatic text analysis which is applied on text to sort various responses and chats, posts from Twitter and Facebook, scan documents [4]. All these posts from various social media platforms help companies to take decisions which are based on insights that are derived from them [5].

2.3 Techniques:

In sentimental analysis technique the main inputs include polar words, parts of sentences which can be classified as collection of words, the insights in the sentences are also important aspect for sentimental analysis [6]. There are variety of Machine Learning algorithms which help in sentimental analysis such as Naïve Bayes, Support Vector Machine for accurate output. Lexicon based technique uses text to extract sentiment from it, the (SO-CAL) Semantic Orientation Calculator uses dictionaries from words which are annotated with semantic orientation which is combination of polarity and strength, and it includes negation and intensification, text is assigned negative or positive label based on the text's opinion [7]. K-Nearest Neighbors (k-NN) is used to construct decision tree, Single Dimensional Classification, and Sequential Minimal Optimization all these algorithms are used for sentimental classification [8].

There are three approach in Machine Learning: Supervised Machine Learning, Semi-Supervised Machine Learning, Unsupervised Machine Learning [9]. One of the best approach for sentiment analysis is capability to handle big data. To achieve better results and improve accuracy in sentiment analysis various Deep learning

models are used such as Convolution Neural Networks (CNN), Recurrent Neural Networks (RNN), Deep Belief Networks (DBN), and Deep Neural Networks (DNN) [10].
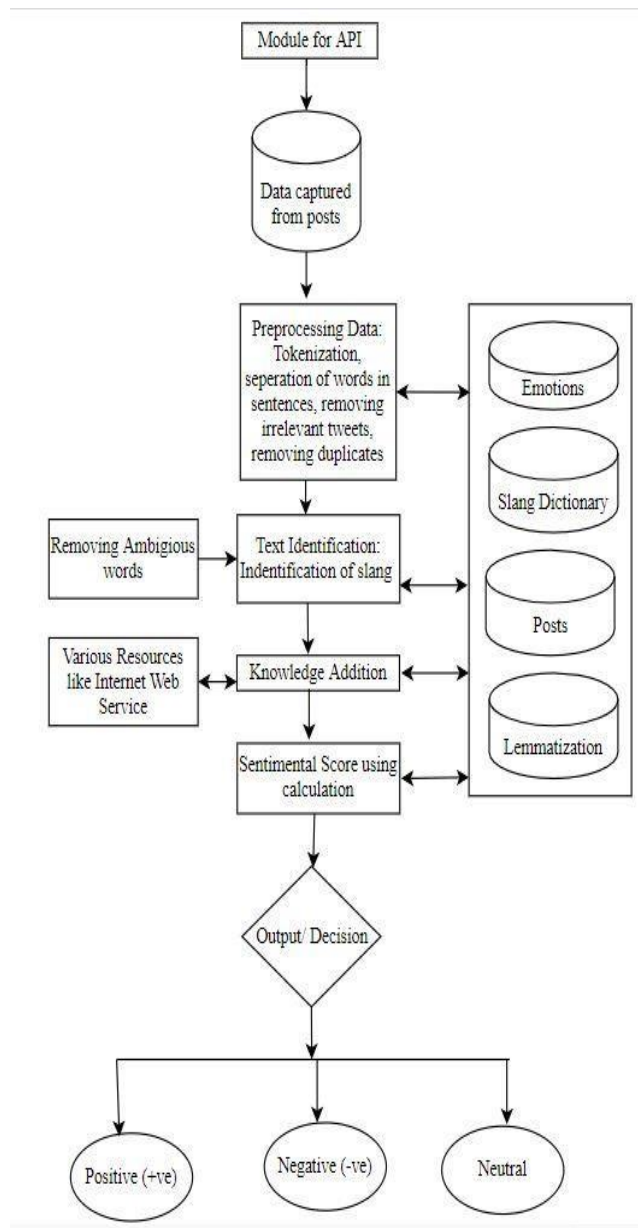

Fig. 1 Lexicon based technique System Framework

3. Deep Learning for Recommendation System

A recommender system is mainly used to analyze people and their interests, behavior, and preferences when selecting a particular product or item, this data is gathered from various resources such as previous history, products purchased by user previously [11]. Later on this data is used to predict whether the specific user can buy the same product or same variety of product in future. Filtering technology is used for this purpose to develop much better algorithm which can be used for information gathering [12].

There are variety of E-Commerce websites which are related to purchase of products and items, usually when a user purchase a product a ranking is assigned to the products that are purchased, using the ranking and the user list

analysis is made for processing the data [13]. Even in some algorithms weights are assigned to the products, then the products which are ranked highest or having more weight are then picked up from the list and recommended to the user [14]. User item Similarity Matrix is very important technique which is used in Collaborative Filtering Process. There are many techniques such as Collaborative Filtering, Cross-Domain, Group Basically, Content-Based Filtering and Constraint Based Filtering which are used for Recommender Systems [15].
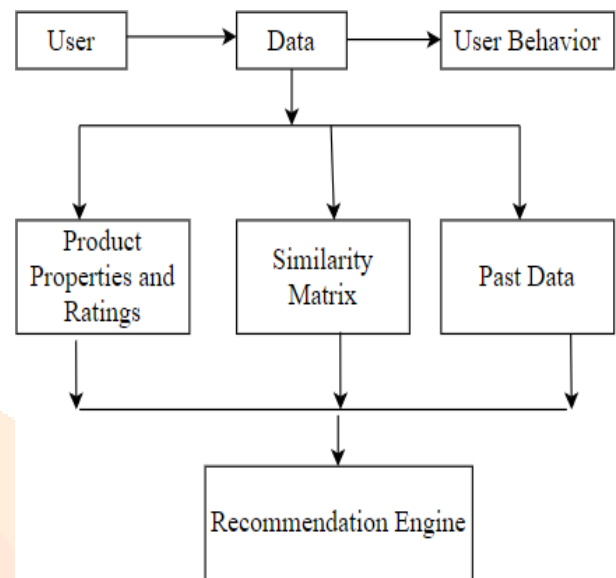

Fig. 2 Recommendation Process

Collaborative Filtering

Recommender system use Collaborative Filtering (CF) technique. Collaborative filtering makes predictions based on interests of customer by gathering preference or information from previous history or products purchased by customer [16]. In more detailed definition we can say that collaborative filtering is a technique for analyzing information and patterns using features like viewpoints, sources of input data. For process of Collaborative Filtering large datasets are used. Collaborative filtering have been applied for different fields such as multiple sensors, environmental sensing, and mineral exploration and financial service companies where the primary focus is on data gathered from user [17].

Collaborative Filtering mainly focuses on clustering algorithms rather than analyzing document or developing a language [18]. Collaborative Filtering is mainly evaluating the products using the opinions of user and their behavior patterns. It creates Item profile and a User profile, User profile are created by User rating for the products which arerated by user, Item profile contains the actual content of the Items purchased by user. The filtering techniques establish relationships between User profile, Item profile and similarity models. Collaborative Filtering also uses past historical data products purchased by group of users or single user [19].

There are mainly two types of filtering 1) Model Based 2)Memory Based. In Model Based Approach Models are being developed using different techniques such as

machine learning algorithms, and data mining techniques[20]. These techniques are used for prediction of unrated items and user's rating. Different model based collaborative filtering algorithms are latent semantic analysis, Bayesian networks, probabilistic latent semantic analysis and singular value decomposition [21].

In memory based technique rating of users are used to establish similarity in items and users. The example for this technique are item based or user based top-N recommendations and neighbourhood based collaborative filtering. In user based technique ratings the 'u' user gives 'i' item is calculated as an aggregation of similar 'u' user rating the 'I' item [22].

Collaborative Filtering is used to build recommendation on websites. Collaborative Filtering recommendation can help in making decisions faster [23]. It will help largely to E-commerce, Businesses and companies to close the business agreement or deal faster. Collaborative Filtering helps to understand user preference, tastes and find product according to their choice [24].
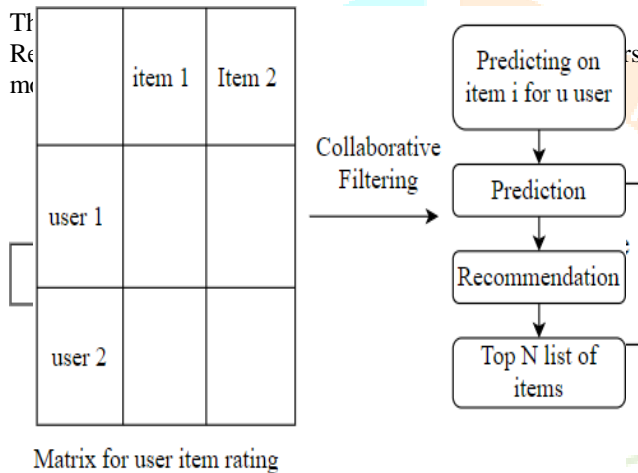

Fig 3. Matrix for Recommendation

Similarity is used in recommender system to identify the similarity in users or items with a system. There is PCC formula: $\sum (\bar{\ })(\bar{\ }) \sqrt{\sum (\bar{\ })} \sqrt{\sum (\bar{\ })}$ here U presents the set of common rating by user i and j. Similarity can be used in Item-Item and User-User collaborative filtering for recommendations [25].

PCC Formula:

$$PCC_{i,j} = \frac{\sum u \epsilon U (r_{i,u} - \bar{r}_i)(r_{j,u} - \bar{r}_j)}{\sqrt{\sum u \epsilon U (r_{i,u} - \bar{r}_i)^2} \cdot \sqrt{\sum u \epsilon U (r_{j,u} - \bar{r}_j)^2}} \quad (1)$$

U presents the set of common rating by user i and j. $\bar{\ }$ is the average rating. Predicted rating value of user i and j respectively, symbolizes the rating which is actual rating of item u by user i and j [26].

5. Convolutional Neural Network for SentimentalAnalysis:

If two or more feed-forward networks are combined it forms a (CNN) Convolutional Neural Network. It contains Two Dimensional structure of the input data and it gives output in speech and image applications so it is useful for Two Dimensional audio data. Convolutional Neural Network has very few parameters so it is very to train [27]. The gathered data is filtered using window, on different sentences, the outputs are collected by pooling layer, and these results can be collaborated with softmax layer to produce prediction probabilities. Training phase is used to solve the overfitting issues, Convolutional Neural Network is used to produce high accuracy by reducing overfitting issues [28]. The major building blocks used in convolutional neural network are convolutional layers. A convolution is a application to filter the input and this helps for activation. If same filter is repeatedly applied on an input it produces map of activations which is called feature map, it indicates the strength and locations of a detected feature of an input like image [29].

The output that is produced from the multiplied filters with input array one time is termed as single value. When filter is applied repeatedly to multiple time on input, the output is 2-dimensional array of output which presents a filtering of the input array [30]. The two-dimensional output produced from this process is called as feature map. After the feature map is produced, we can append each value in the feature map through a non-linearity, like ReLU, it is done for output of a fully connected layer [31].

Fig 4. Filter on Two-Dimensional Array which produces Feature Map

6. Dense Neural Network

A dense layer is a deeply connected neural network layer. It is most important layer. It contains input data, kernel weighted data, dot which is numpy dot product of allinput and it's associated weights, bias which presents biased value to optimize machine learning model, activation is used to present the activation function. The result obtained from previous layer is passed as an input to the next layer. The resultant shape of the Dense Layer will be affected by units or number of neuron specified in DenseLayer. For Example the input array is [8,] and the number of neuron or unit is [16,] the output will be [16,]. The layer will have batch size as first dimension so input shape will be [None, 8] and the output shape will be [None, 16]. The batch size is set at the training time [32].

Reviews or Comments which are in original form, unstructured cannot be analysed by Machine Learning Algorithms. Machine Learning requires input in the form ofnumbers for regression, classification etc. Data is largely

available in text form, which is required for extracting the knowledge for building different applications [33]. Reviewsby Amazon are used for sentimental analysis which help to determine which products need to be improved and which user or group of users prefers which product, how to improve the business and develop efficient products which meets user needs, is done using reviews obtained from users[34].

Some other applications include the clustering and classification by Google which include reviews in form of text. The text can be converted into word embeddings. word2vec Model is used by deep learning, it considers single word instead of bag of words approach. Hence the performance of this Model is very low. Due to so many parameters it produces in adequate presentation of data. Therefore, various neural network platforms are being usedfor sentimental analysis [35].
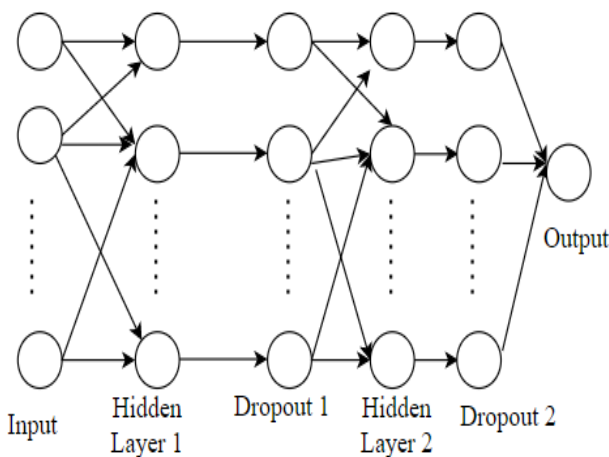
Neural Network with 2 Dropout and 2 HiddenLayers

7. Recurrent neural network

Recurrent Neural Network is very useful model which learns highly complex relationships from a given sequence of data. Recurrent Neural Network maintains a vector of activation units for each and every time stamp in the given sequence of data.[36] The Recurrent Neural Network structures. In this ,we study well known implementations such as Multi-stacked bi-directional Gated Recurrent Unit (GRU) and Long Short-Term Memory (LSTM) as well as novel implementation of attention-based Recurrent Neural Network structure. The attention-based structures which plays very important role are not only among the best models in terms of prediction accuracy, but they also assignan attention weight to each sentiments in the review by plotting the sentiment of each word we gain additional insight into the underlying mechanisms involved in the business intelligence process.
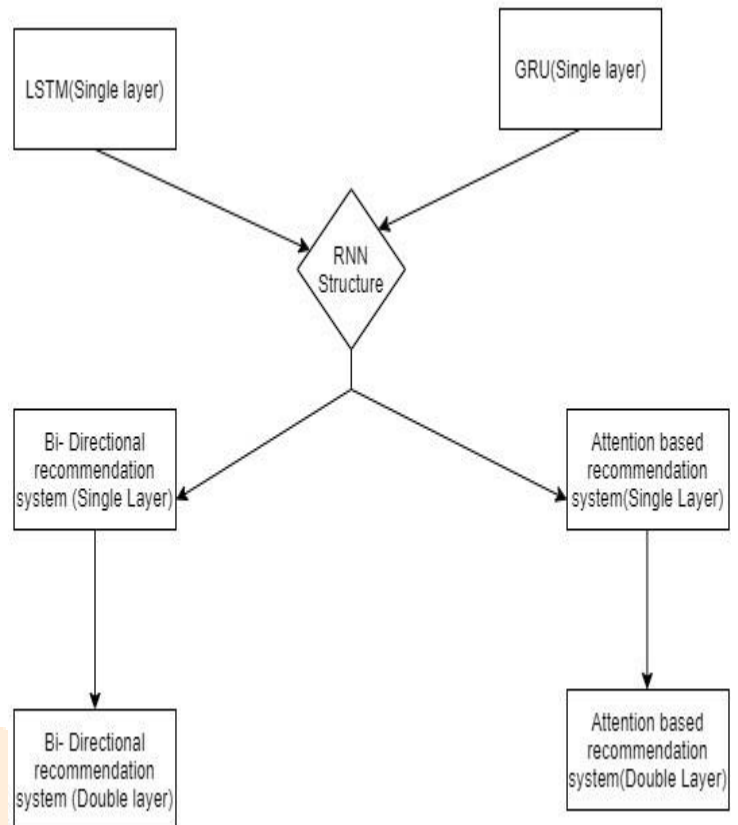

6. Recurrent neural network for sentimental analysisbased recommendation system.

8. Recursive neural network

Nowadays, business intelligence is expanding day by day. The results indicate that, compared with recommendation system models, the model in this paper is capable of providing the necessary evidence business intelligence and control due to its excellent performance in extracting the deep learning feature of sentiment analysis series, which can enhance the accuracy by 16.298% on average.[37]

Noticeably, for a more accurate and efficient identification on the sentiment analysis, as well as the more perfect and intelligent sentiment analysis system, the difficulties and key points stand on the prediction of the sentiment flow, of which the core study point in turn lies on how to predict recommendation system.
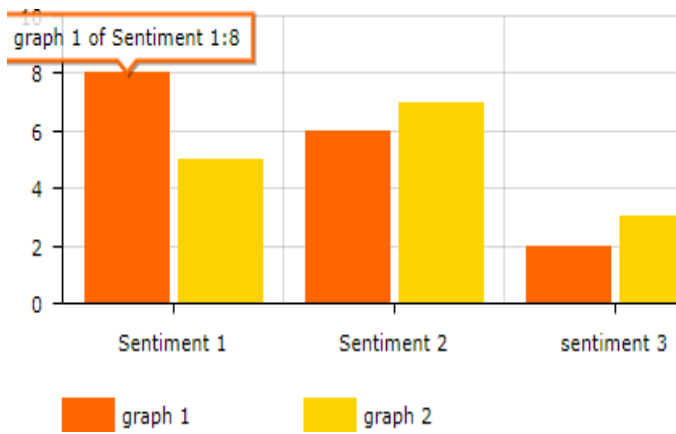
ive neural network for prediction of sentimentalanalysis

9. Context based recommender system and hybrid recommender system

As mentioned earlier, we are using collaborative filtering and content-based hybrid recommendation systems.[38] Collaborative filtering and content-based system can try to overcome shortcomings of each other, thus ensuring the accuracy and stability of the recommendation system based on business intelligence. On the one hand, collaborative filtering can make up for the lack of personalization of content-based method which we are using but on the other hand, content-based method can make up for the some of collaborative filtering method whose scalability is relatively weak. In general, the hybrid recommendation method is first executed based on user sentiments data to achieve a preliminary recommendation list based upon the businessrecommendation .

Then sentiment analyses is implemented to optimize the preliminary list and get the final recommendation list business intelligence. Hence , on the basis of the hybrid recommendation framework, this paper fully considers the efficiency of the recommendation system based on intelligence unit**.**
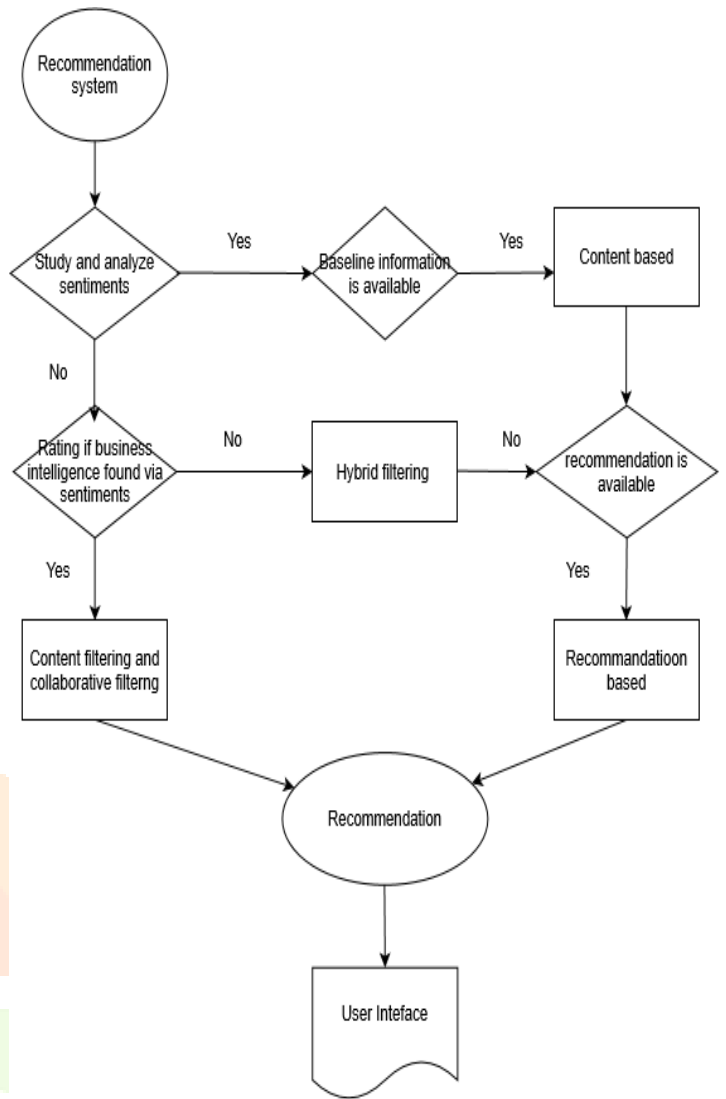

Fig 8. Hybrid and context based recommendation system

Conclusion:

By exploring the different algorithms we have found that Recurrent Neural Network is built on the sentence with tree presentation and it is accurate to analyze the relationships between sentence and words. (CNN) Convolutional neural network has low accuracy compared to Recurrent Neural Network because it considers labels from phrase level at the time of training data. This overfitting can be reduced by using the pre-trained word2vec vectors, this will boost the over performance of the Convolutional neural network. Recommender Systems for applications can be implemented using Naïve Bayes Algorithm. Hybrid Recommendation System which can be used to analyze the data which is obtained from various resources such as posts and reviews, hybrid recommendation system will make prediction based on the interest of the customer for particular purchase. The best feature of Hybrid Recommendation System is it doesn't require human intervention for prediction. By using all these algorithms for Sentimental Analysis the Business can improve their sales and delegate companies to identify positive and negative sentiments regarding their product and service with accuracy, this will help organization, business and companies to plan and address their issues and overcome the issues with necessary steps and action.

REFERENCES

[1] Qurat Tul Ain_, Mubashir Ali_, Amna Riazy, Amna Noureenz, Muhammad Kamran, Babar Hayat_, and A. Rehman," Sentiment Analysis Using Deep Learning Techniques: A Review " International Journal of Advanced Computer Science and Applications, 2017

[2] Shuai Zhang, Lina Yao, Aixin Sun, "Deep Learningbased Recommender System: A Survey and New Perspectives," ACM J. Comput. Cult. Herit., 2017

[3] Mikolov, Tomas, et al. Distributed representations of words and phrases and their compositionality. Advances in neural information processing systems in 2013.

[4] Graves, Alex. Supervised sequence labeling with recurrent neural networks. Vol. 385. Heidelberg: Springer

[5] Socher, Richard, et al. Parsing natural scenes and natural language with recursive neural networks. Proceedings of the 28th international conference on machine learning (ICML-2011)

[6] Walaa Medhat, Ahmed Hassan, and Hoda Korashy. Sentiment analysis algorithms and applications: A survey. Ain Shams Engineering Journal, 5(4):1093– 1113, 2014

[7] Kumar Ravi and Vadlamani Ravi. A survey on opinion mining and sentiment analysis: tasks, approaches and applications. Knowledge-Based Systems, 89:14– 46, 2015.

[8] Fabian Abel, Qi Gao, Geert-Jan Houben, and Ke Tao. Analyzing user modeling on twitter for personalized news recommendations. In International Conference on User Modeling, Adaptation, and Personalization, pages 1–12. Springer, 2011

[9] Paolo Cremonesi, Yehuda Koren, and Roberto Turrin. Performance of recommender algorithms on top-n recommendation tasks. In Proceedings of the Fourth Conference on Recommender Systems, pages 39–46. ACM, 2010. ISBN 978-1- 60558-906-0

[10] Ehsan Aslanian, Mohammadreza Radmanesh, and Mahdi Jalili. Hybrid recommender systems based on contentfeature relationship. IEEE Transactions on Industrial Informatics, 2016

[11] Gediminas Adomavicius and Alexander Tuzhilin. Toward the next generation of recommender systems: A survey of the state-of-the-art and possible extensions. IEEE Transactions on Knowledge and Data Engineering, 17(6):734– 749, 2005.

[12] Basiliyos Tilahun Betru, Charles Awono Onana, Bernabe Batchakui, Deep Learning Methods on Recommender System: A Survey of State-of-the-art ",International Journal of Computer Applications,2017

[13] Gediminas Adomavicius and Alexander Tuzhilin, "Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions", IEEETKDE: IEEE Transactions on Knowledge and Data Engineering, 17, 2005

[14] Claypool, M., A. Gokhale, T. Miranda, P. Murnikov, D. Netes, and M. Sartin, "Combining content-based and collaborative filters in an online newspaper". In ACM SIGIR'99, Workshop on Recommender Systems: Algorithms and Evaluation, August 1999.

[15] Boddu Raja Sarath Kumarmaddali and Surendra Prasad Babuan:, "Implementation of Content Boosted Collaborative Filtering Algorithm", IJEST

[16] S. K. Zhuo Zhang, Paul Cuff, "Iterative Collaborative Filtering for Recommender Syatems with Sparse Data" Princeton University, Princeton , NJ 08544," IEEE Int., pp.1–6, 2012

[17] M. Santhini, M. Balamurugan, and M. Govindaraj, "Collaborative Filtering Approach for Big Data Applications Based on Clustering," Int. J. Recent Res. Math. Comput. Sci. Inf. Technol., vol. 2, no. 1, pp. 202–208, 2015

[18] B. Wang and R. Wang, "A Collaborative Filtering Algorithm Fusing User-based , Item-based and Social Networks," IEEE Int. Conf. Big Data (Big Data), pp. 2337–2343, 2015

[19]] T. Arsan, "Comparison of Collaborative Filtering Algorithms with Various Similarity Mesures for Movie Recommendation," Int. J. Comput. Sci. Eng. Appl., vol. 6,no. 3, pp. 1–20, 2016

[20] B. A. O. F.O. Isinkaye, Y.O. Folajimi, "Recommendation systems : Principles , methods and evaluation," Egypt. Informatics Journa, elsevier, pp. 261–273, 2015.

[21] Hasan, M.; Roy, F. An Item–Item Collaborative Filtering Recommender System Using Trust and Genre toAddress the Cold-Start Problem. Big Data Cogn. Comput.2019, 3, 39.

[22] Lashkari, Y.; Metral, M.; Maes, P. Collaborative interface agents. In Proceedings of the 12th National Conference on Artificial Intelligence, AAAI, Seattle, WA, USA, 31 July–4 August 1994; pp. 111–116

[23] Pirasteh, P.; Jung, J.J.; Hwang, D. Item-based collaborative filtering with attribute correlation: A case study on movie recommendation. In Asian Conference onIntelligent Information and Database Systems; Springer: Berlin/Heidelberg, Germany, 2014; pp. 245–252.

[24] Herlocker, J.L.; Konstan, J.A.; Riedl, J. Explaining collaborative filtering recommendations. In Proceedings ofthe 2000 ACM Conference on Computer Supported Cooperative Work; Association for Computing Machinery:New York, NY, USA, 2000; pp. 241–250.

[25] Chantal Fry "A Comparison of Collaborative Filtering Algorithms for Job Recommendations Using Apache Mahout", Master thesis, Computer Science Department, Faculty of California State Polytechnic University, Pomona, 2016

[26] Pirasteh, P.; Jung, J.J.; Hwang, D. Item-based collaborative filtering with attribute correlation: A case

study on movie recommendation. In Asian Conference on Intelligent Information and Database Systems; Springer: Berlin/Heidelberg, Germany, 2014; pp. 245–252.

[27] Zhang, X.; Zhao, J.; LeCun, Y. Character-level convolutional networks for text classification. In Advances in Neural Information Processing Systems 28; Neural Information Processing Systems Foundation, Inc., Montreal,Quebec, Canada, 2015; pp. 649–657.

[28] Shen, Y.; Xiaodong, H.; Gao, J.; Deng, L.; Mensnil, G. Learning Semantic Representations Using Convolutional Neural Networks for Web Search. In Proceedings of the 23rd International Conference on World Wide Web, Seoul, Korea, 7–11 April 2014; pp. 373–374

[29] Alm, C.O.; Roth, D.; Sproat, R. Emotions from text: Machine learning for text-based emotion prediction. In Proceedings of the Conference on Human Language Technology and Empirical Methods in Natural Language Processing, Vancouver, BC, Canada, 6–8 October 2005; pp. 579–586

[30] Heraz, A.; Razaki, R.; Frasson, C. Using machine learning to predict learner emotional state from brainwaves.In Proceedings of the Seventh IEEE International Conference on Advanced Learning Technologies (ICALT 2007), Niigata, Japan, 18–20 July 2007; pp. 853–857.

[31] Kim, Y. Convolutional neural networks for sentence classification. arXiv 2014, arXiv:1408.5882

[32] Chen-Yu Lee, Saining Xie, Patrick W Gallagher, Zhengyou Zhang, and Zhuowen Tu. Deeplysupervised nets.In AISTATS, volume 2, pp. 5, 2015.

[33] Tsung-Yi Lin, Michael Maire, Serge Belongie, James Hays, Pietro Perona, Deva Ramanan, Piotr Dollar, and C Lawrence Zitnick. Microsoft coco: Common objects in context. In ́ECCV, pp. 740–755. Springer, 2014.

[34] Tolga Bolukbasi, Joseph Wang, Ofer Dekel, and Venkatesh Saligrama. Adaptive neural networks for fast test-time prediction. arXiv preprint arXiv:1702.07811, 2017.

[35] A. R. Zamir, T.-L. Wu, L. Sun, W. Shen, B. E. Shi, J. Malik, and S. Savarese. Feedback Networks. ArXiv e-prints, December 2016.

[36] A Recurrent Neural Network Based Recommendation System by David Zhan Liu Gurbir Singh Stanford University.

[37] A Traffic Flow Prediction Method Based on Road Crossing Vector Coding and a Bidirectional Recursive Neural Network by Shuanfeng Zhao Qingqing Zhao YunruiBai and Shijun Li.

[38] Deep Learning Sentiment Analysis ForRecommendations In Social Applications