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RNN Based Recommendation Engine: A Paradigm Shift towards Deep Learning

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ABSTRACT: With the explosive growth of Internet over last few years it is seen that there is a tremendous increase in the e-commerce business. The popularity of online shopping has increased the number of user on the web. With the increase in users over the web it becomes very critical for the e-commerce businesses to recommend products depending on the user requirements. These e-commerce companies allow user to give their opinion on the products these opinions can be viewed by other user and decide whether or not to buy it. This has given rise to the advent of Recommender systems. A recommender system recommends the best possible product to the user depending on user interest. Deep learning on the other hand is used to continuously train and improve the accuracy of the system by using the training data so that the user always gets the best possible recommendations. In this paper a framework for creating a recommender system is proposed. This framework is based on Deep Learning Recurrent Neural Network Model which reduces dimensions and thereby improves scalability and accuracy.

KEYWORDS: *Deep Learning, Recommender System, Recurrent Neural Network.*

I. INTRODUCTION

Nowadays E-commerce Website on the Internet has the wide range of billions of products, and these products are purchased and browsed by the users. Finding the best product from the collection of products on the e commerce website is hard, and it takes lots of time. Artificial Intelligence Methods or approaches are very good for retrieving the information and filtering the information. Recommender Systems are one of the artificial intelligence's approach used in the Ecommerce domain because Recommender Systems recommends the best suited product for user which they might like. Recommendation system used by e commerce websites for increasing the sales of products. Recommendation system can be categorized in mainly two ways Content based recommendation and collaborative based recommendation. Collaborative filtering can be done using the mutual choices of the users, Collaborative filtering can be classified into Memory based filtering technique and model based filtering technique and its performance is very effective if the data is sufficient, whereas content based filtering does analysis of the item's content and it is depended on the features which are extracted from items or the products. In Content based filtering recommendation technique it is not possible to predict the fully different types of products or items which user never showed interest in it, also the content based filtering overcomes the problems of cold start, cold start is a problem which occurs in personalized recommendations, where there is requirement of the past history to make recommendation, it becomes very difficult if there is very less history for recommendation, and Data sparsity problems and it recommends items easily for those users which has unique taste in choice of items.

In Collaborative based filtering recommendation technique cold start problem occurs for new users, also sparse ratings problem on the same particular items. It is not easy to recommend items to those users who have different choices for items. These problems can be solved by reducing dimensionality using singular value decomposition (SVD) by identifying and finding the similar users as well as items in the cluster of item and users, as implemented in [2] Dimensions reduction can also be done to make improvement in the clustering techniques, Dimension reduction can be done by combining Principal Component analysis and K means clustering technique, as shown in [4].Collaborative filtering techniques are very popular for business as well as for research purpose.

Deep Learning provides better recommendations than the traditional recommendation systems, Deep Learning techniques are able to understand the previous interaction between users as well as items, and also it identifies the demands of the users.

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Some of the techniques which are used for recommendation are as follows:

1. **Multilayer Perceptron:** It is a type of neural network which uses feed forward algorithm, consisting of multiple hidden layers between the input and output layer, in which the perceptron can apply the activation function without representing the binary classifier.

2. **Auto Encoder:** is a neural network model which is unsupervised and it attempts to construct the input data into the output layer .In this model the middle layer represents the features of data which is given as input.

3. **Convolutional Neural Network:** It is also a type of neural network which uses feed forward algorithm, it has some operations which does pooling as well as this neural network is able to extracting global as well as local features. It also increases the accuracy of recommendation. Convolutional neural network is very good in data processing.

4. **Recurrent Neural Network:** It uses information in cycles using the loops, Whenever Recurrent neural network makes decisions, it always considers the input which is currently given as well as the it will learn from the inputs which were formerly provided. It performs well if the data which is provided is sequential and it models the data which is sequenced. In this neural network, it consists of loops as well as memories which are used for remembering the previous computations. Long Short Term Memory and Gated Recurrent Unit, these networks are used for overcoming the vanishing gradient problem.

5. **Deep Semantic Similarity Model:** It is a neural network used for learning of representation of entities which are present in a continuous semantic space and it measures the similarities between them.

6. **Restricted Boltzmann Machine:** It is a neural network which consists of two layers, these two layers are named as variable layer and hidden layer. This neural network does not allow the intra layer communication which may occur in hidden layer as well as visible layer.

7. **Generative Adversarial Network:** It is a type of neural network which consist of a generator as well as discriminator. It is able to fuse the generative model with discriminative model.

8. **Neural Autoregressive Distribution Estimation:** It is a neural network which is categorized into unsupervised neural network which builds a model which is autoregressive which is feed forward neural network, it is a good estimator for data modeling densities and distributions.

II. LITERATURE SURVEY

The table below investigates the Gaps in the different Recommender System Approaches:

Table 2.1.

Reference	Technology used	Gap Analysis
[1]	Recurrent Neural Network, Word Embedding and padding, Genetic Algorithm	Categorization Accuracy is less.
[2]	Singular Value Decomposition , Collaborative Filtering	There is a scalability issue of CF and Evaluation using additional matrices such as Diversity and novelty is required.

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[3]	Pearson's correlation coefficient and FP-growth	Optimization and Accuracy in different Recommendation Environment or on different dataset is not implemented.
[4]	K-means Clustering, PCA, Collaborative Filtering	There should be Dimension reduction coupling with other clustering techniques for improvement of recommendation precisions.
[5]	k-means clustering algorithm, artificial bee colony (ABC) optimization technique, collaborative filtering	Performance should be evaluated on advance high-configuration machine by including other important characteristics of users, such as privacy and context with cross-domain data.
[6]	Sequential Collaborative mapping,	There is an issue of Semantic and CF similarity.
[7]	Latent Factor Models, Natural Language Processing, attention	No Utilization of sequence to sequence

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	based RNN.	(seq2seq) framework.
[8]	Research Summarization	There is no Meta-analysis of Deep Learning Models.
[9]	Character Level RNN's	Progressive sampling is slightly less in training Parameters.
[10]	Feed-forward neural network, Collaborative Filtering, Multi view Neural Network	Construction of an end-to-end neural networks on history view is required. Appending additional view of content into multi view neural networks.

III. PROPOSED SYSTEM

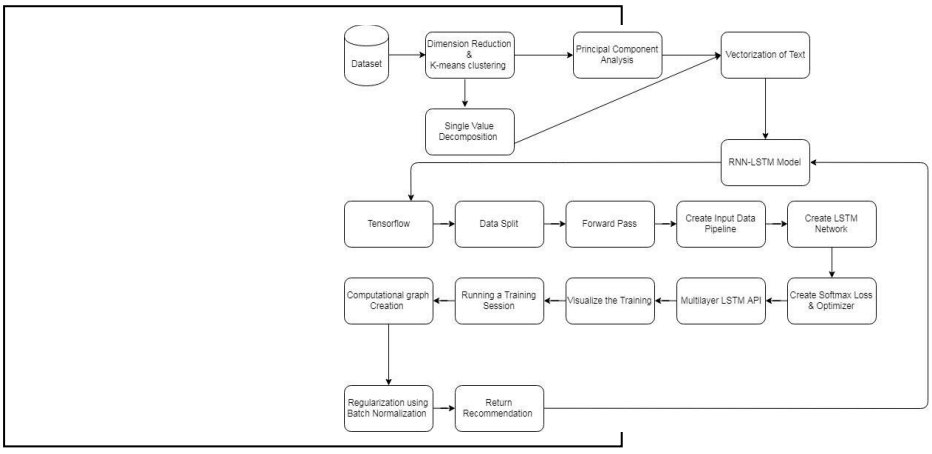

Fig 1.1-Proposed Model

The proposed framework consists of 2 parts. Complete model is shown in Fig 1.1.

2.1 Preparing Textual data

As popularity of e-commerce is increasing, the number of people buying products has also increased.to give best experience to the users all the e-commerce companies allow users to give reviews on their products which other users

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can view and depending on the review take decision whether to buy a particular item or not, as a result even a smallest product gets thousands of review. To read all these review is not possible for a user. This type of data is in textual format and in very large size. We cannot use deep learning algorithms on textual data as they require numeric input. Therefore, before using this type of data it is required to convert it into numerical data. To convert text to numeric we need to first extract the features from data and pre-process it.

This can be done in following ways:

2.1.1 Dimension reduction

When textual data is converted into numeric data it is represented in the form of vectors these numeric vectors are big in size.

Dimension reduction can be achieved in two ways:

1. Single Value Decomposition (SVD) This method is one of the most important matrix factorization methods usually used for dimension reduction. SVD Algorithm consist of following steps as mentioned in [2]:

1.1 Take input as user item matrix.

1.2 Generate user clusters using k-means.

1.3 For every cluster, to generate decomposition matrix.

1.4 For every matrix generated from the above step calculate the similarity.

2. Principal Component Analysis (PCA) The main feature of PCA is analysis of big data and to eliminate noise & finds pattern to reduce dimensions without loss of information.

PCA Algorithm consists of following steps:

2.1 Input Data set.

2.2 Normalize data.

2.3 Calculate covariance of matrix.

2.4 Calculate eigenvectors of covariance matrix.

2.5 From matrix multiplication translate the data to be in terms of principle components.

2.6 Output

2.1.2 Vectorization:

In this step the text gets represented into vectors. It tries to represent every word into specific integer. There are various API to achieve this like CountVectorizer, word2vec, etc.

2.2 RNN Model

A recurrent neural network, at its most fundamental level, is simple type of densely connected neural network. However, the key difference to normal feed forward networks is the introduction of time – in particular, the output of the hidden layer in a recurrent neural network is fed back into itself.

The RNN Model makes use of Tensorflow. It will split the data and pass it forward to the input data line here length of the data is calculated and is divided by batch size.

2.2.1 Create LSTM Network

Initial state of Tensorflow placeholder is set which loads initial state of LSTM cells for every training batch.

2.2.2 Creating the Softmax, Loss and Optimizer Operations:

In this stay, output is flattered so that it can be fed into softmax layer.

2.2.3 Multilayer LSTM API:

Multilayer-LSTM-API accepts the state as a tuple of LSTM Tuples therefore we need to unpack the state. Each layer in the state will have a LSTM Tuple stated.

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2.2.4 Visualize the Training:

There is a visualization function with which one can see what's going on in the network as we train. It will plot the loss over the time, show training input, training output and the current predictions by the network on different sample series in a training batch.

2.2.5 Running a Training session

Here the model is trained using the training data.

2.2.6 Computational graph Creation

Depending on the training data multiple graph can be plotted to visualize the results obtained.

2.2.7 Regularization Using Batch Normalization

We normalize the input layer by adjusting and scaling the activations, batch normalization reduces the amount by what the hidden unit values shift around and gives output as recommendation to the user. In this model, once a recommendation is made to user it keeps track of the recommendation that whether or not the user is buying what is recommended to it and if he is not buying then user will not get that type of recommendation in future.

III. CONCLUSION

The Proposed method is based on Deep Learning Recurrent Neural Network Model. The use of Recurrent Neural Network may help in the Recommender Engine to provide recommendations with improved scalability in relation to the Deep Learning approaches.

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