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Book Recommendation Platform using Deep Learning

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Abstract - *The data available online, helps users to get information about anything of his/her interest. But since the data is huge and complex it is difficult to get useful information from it. Recommender System are effective software techniques to overcome this problem. Based on the user's and item's information available, these techniques provides recommendations to users in their area of interest. Recommender systems have wide applications like providing suggestive list of items to customers for online shopping, recommending articles or books for online reading, movie or music recommendations, news recommendation etc. In this paper, a subject-based books recommendation platform is proposed which uses Convolutional Neural Network (CNN) for recommending books. The proposed recommender system will give its user's the ability to view and search books and using Convolutional Neural Network (CNN), it will list the highly purchased and top rated books based on the subject name given as the input.*

Key Words: **Recommender Systems, Convolutional Neural Networks (CNN), Deep learning.**

1. INTRODUCTION

In simple words, a recommendation system is any system that automatically suggests content for website readers and users. These systems were evolved as intelligent algorithms, which can generate results in the form of recommendations to users. [1]They require a large dataset and a fast computing system that can perform analytics on same within fraction of seconds. [2] A variety of techniques have been proposed till today for performing recommendations.

Deep learning has been improvising the recommendation systems, also it brings more possibilities to improve performance of recommendation system. [3]Deep learning methods employ multiple processing layers to learn hierarchical representations of data. Recently, a variety of model deigns and methods have blossomed in the context of natural language processing (NLP).

1.1 Problem Statement

Students find it difficult searching for books based on subjects, especially when it comes to answering entrance level exams and also during their academic exams. Searching through various sites onto the internet and determining which book is appropriate for buying or referring to, is a tedious job for students. This paper provides solution to this problem by providing a subject-based books recommendation platform using deep learning algorithms.

2. LITERATURE SURVEY

2.1 Background

Recommender system has been so extensively used these days that it has become preferable choice for researchers. First paper on recommender system was published in year 1998. Since then a significant number of papers had been published. Different types of criteria have been explained in order to increase the flexibility and reliability of recommender system. Also, in the industry, recommender architectures are critical equipment to enhance user experience and also to promote sales/services for different online websites and mobile applications. For example, 80 per cent of movies watched on Netflix came from recommendations, 60 per cent of video clicks came from home page recommendation in YouTube.

Covington et al presented a deep neural network based recommendation algorithm for video recommendation on YouTube. *Cheng et al*. proposed a recommender system as an App for Google Play Store with a wide deep learning model. *Shumpei et al.* presented a news recommender system using RNN for Yahoo News. All of these models have stood the online testing and shown significant improvement over traditional models. Thus, we can see that deep learning has driven a remarkable revolution in industrial recommender applications. The success of deep learning algorithms for recommendation systems in industry and in academic area requires a broad review and also a summary for successive researchers and developers in order to better understand the strength and weakness, and also application scenarios of these deep learning models.

2.2 Related Work in the Area

In this article [5], the paper reviews state of art in recommender systems algorithms and techniques which is necessary to identify the gaps and improvement areas. In addition to that, they provide possible solutions to overcome shortages and known issues of recommender systems as well as discussing about recommender systems evaluation methods and metrics in details. In this paper, two types of

recommender systems are widely adapted which are collaborative filtering and content-based filtering respectively. In collaborative filtering, that is also referred as social filtering items are selected based on the correlation between the current user and other users of the system. However, in content-based filtering items are recommended based on the correlation between items and the user preferences. The user interests are firstly analyzed and the result of the user profile analysis compared with available items on the system to provide recommendations to the user.

They have further categorized each of systems into categories. Collaborative filtering could be implemented in the forms of memory-based or model-based. In memory-based approach the entire user database is kept in memory and the entire database is traversed in each operation, also recommendations are more accurate but when system database is very large, this approach is almost impractical due to existed limitation in primary memory for keeping the database. In model- based method, instead of keeping the entire database in memory just specific collection of data which are already trained using machine learning methods are kept in memory and this approach is more efficient and feasible to implement in real world scenarios. This paper also focuses on hybrid approach, which is made by combining both content-based and collaborative methods. In this article [5], the paper concludes by providing a broad overview of available recommender systems techniques with their pros and cons. In addition to that shortcomings of each technique have been discussed and some suggestions have been made which can be leveraged to improve quality of recommendations. Finally, methods to evaluate recommender systems have been discussed. Recommender systems are closely related to information filtering with the idea of having personalized decision guides for users.

In this article [1], the paper presents book recommendation system based on combined features of content filtering, collaborative filtering and association rule mining. In the paper, the proposed recommendation system explains association rule mining. Association rule retrieves the pattern from the database based on the two measures minimum support and the minimum confidence. Support is the rule (A B) holds in transaction set D with support s, where s is the percentage of the transactions in D containing A B. The rule (A B) has confidence c in the transaction set D, in which c is the percentage of transactions in D which contains A that also containing B than or equal to the user defined minimum confidence.In the article [1], purpose of the book recommendation system is to recommend books to the buyer that suits their interest. This recommendation engine works in the absence of internet i.e. offline and also stores recommendations in the buyer's web profile. Its working consists of few steps i.e. first it records the books which user's has bought earlier. Next it finds out category of book from users buying history, then it performs content based filtering i.e. it finds all the books according to the category that is found above. On getting the result from above procedure, it performs item based collaborative filtering and finds out the list of books in the descending order of ratings. Then, in the system it actually evaluates the quality of the recommending books based on the rating given to those books by the other buyers. From the book transaction database it finds all those transactions whose category is same as found in the above step and then applies association rule on those transactions and finds out the books which are frequently bought. Next it finds out the intersection of the result of above two steps and then arranges the intersection result in the descending order of ratings as given by the step above. Finally outcome of the above step is the final recommendations for the buyer.

All the above working steps are performed when the buyer is online and the results are stored in the buyer's web profile. Thus, whenever the buyer comes online next time, the recommender system will generate recommendations automatically. In the article [1], to conclude the proposed recommender system has considered many parameters like content of the book and quality of the book by doing collaborative filtering of ratings by the other buyers. This recommender engine also uses associative model to give relative and stronger recommendations. This system also has an advantage that it does not have performance problem since it built the recommendations online.

In this article [3], the paper presents different deep learning based recommender systems. It focuses on deep learning as it is able to effectively capture the non-linear and non-trivial user-item relationships, and enable the coordination of more complex abstractions as data representations in the higher layers. Furthermore, it captures the subtle relationships within the data itself, from various accessible data sources such as contextual, textual and visual information. This paper also presents a survey which begins with an introduction to the basic terminology and concepts regarding recommender architectures and deep learning methods. The typical meaning of deep learning is that it learns deep representations, i.e., learning multiple levels of representations and abstractions from data.

The survey conducted in the article [3], is categorized based on different deep learning techniques likewise. The techniques include

i. **Multilayer Perceptron (MLP)** is a feed-forward neural network with multiple (one or more) hidden layers between the input layer and output layer.

ii. **Autoencoder (AE)** is an unsupervised model attempting to reconstruct its input data in the output layer.
iii. **Convolutional Neural Network (CNN)**is a special kind of feed forward neural network with convolution layers and pooling operations.
iv. **Recurrent Neural Network (RNN)**is suitable for modelling sequential data.
v. **Restricted Boltzmann Machine (RBM)**is a two layer neural network consisting of a visible layer and a hidden layer.
vi. **Adversarial Networks (AN)**is a generative neural network which consists of a discriminator and a generator.

In this article [3], to conclude, the paper has provided an extensive review of the most notable works to date on deep learning based recommender systems. They proposed a classification scheme for organizing and clustering existing publications, and highlighted a bunch of influential research prototypes.

In the paper [6], the paper focuses on a Comparison of Semantic Similarity Methods for Maximum Human Interpretability. This paper explains about Text similarity which has been one of the most important applications of Natural Language Processing. Two texts are said to be similar if they infer an equivalent meaning and have similar words or have surface closeness. Semantic similarity measures the degree of semantic equivalence between two linguistic items, be they concepts, sentences, and/or documents. The basic idea to compute text similarities is by determining feature vectors of the documents and then calculating the distance between these features. A small distance between these features means a high degree of similarity, whereas a large distance means a low degree of similarity. Euclidean distance, Cosine distance, Jensen Shannon Distance, Word Mover distance are some of the distance metrics used in the computation of text similarity.

It explains about Similarity measures: Similarity function or measure is a real-valued function that quantifies the similarity between two objects. Types of similarity measures: cosine similarity and soft cosine similarity.

i. Cosine Similarity: It is a similarity measure which measures the cosine of the angle between two vectors projected in a multi-dimensional plane. It is the judgment based on orientation rather than magnitude.

Soft Cosine Similarity: A soft cosine or soft similarity between two vectors generalizes the concept of cosine similarity and considers similarities between pairs of features.The traditional cosine similarity considers the Vector Space Model (VSM) features as independent or completely different, while soft cosine measure considers thesimilarity of features in VSM as well. The similarity between a pair of features can be calculated by computing Levenshtein distance, WordNet similarity or other similarity measures. For example, words like “cook“ and “food“ are different words and are mapped to different points in VSM. But, semantically they are related to each other.

The article [7], the paper presents Deep Learning approcahes for image classification. This paper focuses on Deep architectures that are mainly neural networks (recurrent, convolutional, deep belief) and can be summarized as the composition of three elements:

1) Input layer - raw sensory inputs (e.g. words, Red-Green-Blue values of pixels in an image).

2) Hidden layers - these layers learn more abstract non-obvious representations/features.

3) Output layer - predicting the target.

It also explains about Convolutional Neural Network (CNN) which is a powerful machine learning technique from the field of deep learning. CNNs are mainly trained using large collections of diverse images. Convolutional neural network’s capacity are often controlled by varying their depth and breadth, and that they also end in making strong and mostly correct assumptions about the character of images (example: stationarity of statistics and locality of pixel dependencies). When CNNs are compared to plain feedforward neural networks with similarly-sized layers, CNNs have much fewer connections and parameters and since of this reason they are easier for training, but their theoretically-best performance is probably going to be only slightly worse.

In this paper [8], it explains about Judging a Book by its Cover. “Don’t judge a book by its cover” commonly used idiom in English language which means that "not to judge something by its outward appearance". Books come with a wide variety of book covers and styles, including nondescript and misleading covers. The concept of neural networks and neural coding is to use interconnected nodes to figure together to capture information. Early neural network-like models like multilayer perception learning were invented within the 1970s but fell out of favor. More recently, artificial neural networks have been a focus of state-of-theart research because of their successes in pattern recognition and machine learning. Their successes are partially thanks to the rise in data availability, increase in processing power, and introduction of GPUs.

CNN utilize learned convolutional kernels, or filters, as a method of feature extraction. The general idea is to use learned features rather than pre-designed features as the feature representation for image recognition. Recent deep CNNs combine multiple convolutional layers along with fully-connected layers. By increasing the depth of the network, higher level features are often learned and discriminative parts of the pictures are exaggerated. These deep CNNs have had successes in many fields including digitrecognition and large-scale image recognition.

Finally taking into account the study made on different research papers, we propose a book recommendation system. The project is divided into two segments such that one segment takes subject name as input from the user and processes it. After processing, we use cosine similarity measure to find the similar books related to the subject from sites like Amazon and Flipkart. We take the datasets from these sites and convert the datasets into trained data and use these for finding the similarities. In the second segment we create a recommendation system using Convolutional Neural Networks, where we list the books based on the book covers given as the input. The book cover dataset is obtained through Kaggle site. Once the user clicks on the required book, the system recommends the books similar to the book covers. In this recommendation system, we do not use content based or collaborative filtering techniques.

3. PROPOSED MODEL

In this project, we propose a book recommendation system. The project is divided into two segments such that one segment takes subject name as input from the user and processes it. After processing, we use cosine similarity measure to find the similar books related to the subject from sites like Amazon and Flipkart. We take the datasets from these sites and convert the datasets into trained data and use these for finding the similarities. In the second segment we create a recommendation system using Convolutional Neural Networks (CNN), where we list the books based on the book covers given as the input. The book cover dataset is obtained through Kaggle site. Once the user clicks on the required book, the system recommends the books similar to the book covers. In this recommendation system, we do not use content based or collaborative filtering techniques.

The project is divided into two approaches:

1. Recommendation using text processing and similarity measures.
2. Recommendation using image classification.

3.1 Working

3.1.1 Recommendation using text processing and similarity measures:

I) Input

In this segment, we first take the input as the subject name and process it accordingly. The input can be of two types:

1. *Name of the subject* (As specified normally) – The output from this module directly goes to the classification module without any further processing.
2. *Input can be long terms and reference links* – In this case, is undergoes text preprocessing for identifying only the useful and meaningful terms.

II) Datasets

The required datasets are web scrapped from websites like Amazon and Flipkart. The datasets contains the book name, author, ratings, customers rated and the price. The datasets of amazon and flipkart are processed separately and converted to csv files. Depending on the user input the books are searched with similarity measures in the particular dataset of Amazon or Flipkart.

III) Working

The input as subject name is concatenated with the dataset of user preference and based on the category selected by the user. The concatenated data is stored as (input, book dataset). Then the pairs of input and books in dataset are formed as (input, $book_i$). The book names in the dataset are retrieved and normalization of data is performed. Normalization of data includes tokenization, stopword elimination, stemming and POS tagging. This normalized data is fitted into TFidfvectorizer and a feature matrix is created. The pairs formed are mapped with the index of the pairs and feature matrix of the document. Then the cosine similarity of the pairs is calculated.

IV) Output

The output of the cosine similarity function is the similarity scores between the pairs. The pairs having the highest similarity scores are listed and the books corresponding to the index pairs are retrieved and displayed.

3.1.2 Recommendation using image classification

I) Dataset

The input to the recommendation segment is the book cover dataset. There are 987 book covers images in the dataset web scraped from Amazon.

II) Working

The images are then loaded from the dataset and converted into vectors. The dataset is then trained using CNN

(ResNet50). After training the model is loaded and the embeddings are saved.

III) Output

Then the distance similarity matrix is calculated between the input book cover and the book covers in the dataset. The output book covers are recommended.

3.2 Design

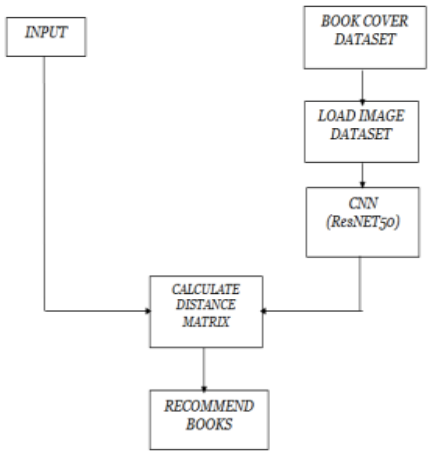

Fig-1: Recommendation Segment

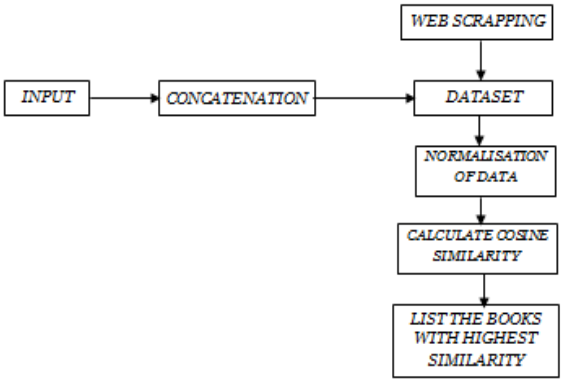

Fig -2: Similarity Segment

3.3 Algorithms

3.3.1 Convolutional Neural Networks (CNN) Algorithm:

Convolutional Neural Network (CNN) may be a special quite feed forward neural network with convolution layers and pooling operations. They can capture the worldwide and native features and significantly enhancing the efficiency and accuracy. They performs well in processing data with grid-like topology.

CNNs for Image Feature Extraction[2]: The influences of visual features to Point of Interest (POI) recommendation, and proposed a visible content enhanced POI recommender system (VPOI). VPOI adopts CNNs to extract image features. The advice model is made on PMF by exploring the interactions between:

- visual content and latent user factor;
- visual content and latent location factor.

3.3.2 Cosine Similarity:

Cosine similarity may be a measure of similarity between two non-zero vectors of an scalar product space. It is defined to equal the cosine of the angle between them, which is additionally an equivalent because the scalar product of an equivalent vectors normalized to both have length 1.

Feature vectors: In machine learning, a feature vector is a n-dimensional vector of numerical features that represent some object or context. It holds an important place in computing semantic similarities between texts.

Tf-idf Vectors: TF-IDF is an abbreviation for Term Frequency-Inverse Document Frequency and is a very common algorithm to transform a text into a meaningful representation of numbers. Tf-idf weight is a statistical measure that evaluates the importance of a particular word to a document.

A tf-idf model was created using sklearn vectorizer model. This model was fitted using the documents and a set of tfidf vectors containing tf-idf weight of each words of the documents were created. Now, these tf-idf vectors were used as a feature vectors for measuring similarities between the input and the books in the datasets of Amazon and Flipkart.

3.4 Experiments Conducted

Experiments were conducted for the two approaches of the project. The first approach uses text processing and finding the similarity measures and the second approach of recommendation using book covers similarity.

3.4.1 Recommendation using text processing and categorical data in CNN

The first experiment was conducted for recommending books using books dataset which had categorical data. The input to the CNN was the embedded pair form of book name and book ratings together. The model was then trained and loaded. The output of the model was then evaluated and further steps with necessary changes were taken based on the analysis of the output from this experiment.

3.4.2 Recommendation using text processing and similarity measures

The experiment was conducted to list the similar books from Amazon and Flipkart. The input as subject name was concatenated with the dataset of user preference and based on the category selected by the user. The concatenated data was stored as (input, book dataset). Then the pairs of input and books in dataset were formed as (input, $book_i$). The book names in the dataset were retrieved and normalization of data is performed. Normalization of data includes tokenization, stopword elimination, stemming and POS tagging. This normalized data was fitted into TFidfvectorizer and a feature matrix was created. The pairs formed were mapped with the index of the pairs and feature matrix of the document. Then the cosine similarity of the pairs was calculated. It was performed for multiple input subject names and the output was quite accurate.

3.4.3 Recommendation using image classification with book covers dataset

Another part of the experiment was conducted where book cover dataset was used to recommend books. The images were loaded from the dataset and converted into vectors. The dataset was then trained using CNN(ResNet50). After training, the model was loaded and the embeddings were saved. The recommended books were then displayed.

4. CONCLUSIONS

To conclude about our project, we have made analysis of different research papers and algorithm implemented in it about recommendation systems. In our project we have improvised and modified the recommendation systems. This Book Recommendation System has considered many parameters like ratings, book name, book cover images, price etc. We successfully implemented and found the similar books from Amazon and Flipkart using cosine similarity. Also, the recommendation system was implemented using book covers dataset and CNN algorithm to display most similar book covers based on the input book cover.

4.1 Advantages of the Project

This Book Recommendation System upon its implementation, it can benefit tremendously from:

1) No Need for Feature Engineering: Feature engineering is the process of extracting features from raw data to better describe the underlying problem. It is a fundamental job in machine learning as it improves model accuracy. The process can sometimes require domain knowledge about a given problem.
2) Best Results with Unstructured Data: Deep learning algorithms can be trained using different data formats, and still derive insights that are relevant to the purpose of its training.
3) No Need for Labelling of Data: With deep learning, the need for well-labelled data is made obsolete as deep learning algorithms excel at learning without guidelines. Other forms of machine learning are not nearly as successful with this type of learning. In the example above, a deep learning algorithm would be able to detect physical anomalies of the human body, even at earlier stages than human doctors.
4) Efficient at Delivering High-quality Results: Humans need rest and fuel. They get tired or hungry and make careless mistakes. That is not the case for neural networks. Once trained correctly, a deep learning brain can perform thousands of repetitive, routine tasks within a shorter period of time than it would take a human being. The quality of its work never diminishes, unless the training data includes raw data that does not represent the problem you are trying to solve.
5) Fast access to the most purchased and highly rated books.
6) It allows smart search based on the recent ratings.

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