CSE4077- Recommender Systems

J Component – Project Report

Content-Based Movie Recommendation System

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MTech CSE with Specialization

Submitted to

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BONAFIDE CERTIFICATE

Certified that this project report entitled "Content-Based Movie Recommendation System" is a bonafide work of PBSS Jaswanth 19MIA1039, Vamsidhar S 19MIA1074, Mansoor khan lodi 19MIA1094, Shashank R 19MIA1105

who carried out the J-component under my supervision and guidance. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified

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ABSTRACT

The rapid growth of data collection has led to a new era of information. Data is being used to create more efficient systems and this is where Recommendation Systems come into play. Recommendation systems are becoming increasingly important in today's hectic world. People are always in the lookout for products/services that are best suited for them. Therefore, the recommendation systems are important as they help them make the right choices, without having to expend their cognitive resources. Recommendation Systems are a type of information filtering systems as they improve the quality of search results and provides items that are more relevant to the search item or are related to the search history of the user. They are used to predict the rating or preference that a user would give to an item. Almost every major tech company has applied them in some form or the other: Amazon uses it to suggest products to customers, YouTube uses it to decide which video to play next on autoplay, and Facebook uses it to recommend pages to like and people to follow. Moreover, companies like Netflix and Spotify depend highly on the effectiveness of their recommendation engines for their business and success.

For our project, we will be using **Content Based Filtering for Movie Recommendation System-** They suggest similar items based on a particular item. This system uses item metadata, such as genre, director, description, actors, etc. for movies, to make these recommendations. The general idea behind these recommender systems is that if a person liked a particular item, he or she will also like an item that is similar to it. In this recommender system the content of the movie (overview, cast, crew, keyword, tagline etc) is used to find its similarity with other movies using Cosine similarity. Then the movies that are most likely to be similar are recommended.

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Component	J – Component	
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Team Members(s) Contributions – Tentatively planned for implementation:

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Model building & results interpretation	PBSS Jaswanth & Shashank R
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1. Introduction

In the current post COVID-19 pandemic world, with major OTT (Over The Top) platforms such as Amazon Prime Video, Netflix etc., being a part and parcel of the lives of people, it is a must for the OTT platforms to have good recommendation algorithms. There can be an increase in churn rate due to poor recommendation algorithms as they fail to recommend things that matches the expectations of the target audience thus dissolving the positive opinions they have on the platforms. So, recommendation algorithms are the backbone of OTT platforms. Not only that, even they support other entities such as e-commerce sites, food delivery applications etc.

We might have observed that whenever we watch a movie of a particular genre, other movies of similar genre get recommended to us in OTTs. Recommendation algorithms are the main reason behind this behavior. These recommendation algorithms of OTT platforms had thus provoked our interest into taking up this topic for our project i.e., Movie recommendation system.

Objectives:

Regarding this project, our main goal is to implement a content-based movie recommendation system. To achieve this goal, we will be going through the following steps:

1) Performing text vectorization using 2 algorithms namely – CountVectorizer and TF-IDF and then taking the help of the cosine similarity measure for generating raw recommendations.

2) GUI implementation to represent our recommender system in a more interactive way.

Challenges:

The main challenges to our project are:

1) The ability to provide more accurate recommendations i.e., the overall accuracy of the model.

2) Complexity of the dataset.

2. Literature Survey

SL no	Title	Author / Journal name / Year	Technique	Result
1	Movie Recommendation Algorithm Based on Sentiment Analysis and LDA	YilinZhang, LinglingZhang Procedia Computer Science, 2022	Sentiment Analysis, LDA	Obtained 25 high-frequency evaluation topic categories.
2	Movie recommendation and sentiment analysis using machine learning	N Pavithaa, Vithika Pungliyaa, Ankur Raut, Roshita Bhonsle, Atharva Purohit, Aayushi Patel, R Shashidhar Global Transitions Proceedings, 2022	Naïve Bayes, Sentiment analysis, Support vector machine	SVM showed the maximum accuracy more than 98%.
3	Fully content-based movie recommender system with feature extraction using neural network	Hung-Wei Chen, Yi-Leh Wu, Maw-Kae Hor, Cheng-Yuan Tang 2017 International Conference on Machine Learning	Neural Networks Word2Vec CBOW	The DAGY_S_M is the best combination proposed with the best performance in all experiments.

		and Cybernetics (ICMLC), 2017		
4	Movie Recommendation System Using Genome Tags and Content-Based Filtering	Syed M. Ali, Gopal K. Nayak, Rakesh K. Lenka & Rabindra K. Barik Advances in Data and Information Sciences, 2018	Principal component analysis, Pearson correlation techniques	The system takes movieId as an input and recommends top five similar movies based on it.
5	A Content-Based Recommendation System Using Neuro-Fuzzy Approach	Tomasz Rutkowski, Jakub Romanowski, Piotr Woldan; Paweł Staszewski, Radosław Nielek, Leszek Rutkowski 2018 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), 2018	Neuro-fuzzy approach, deep learning techniques.	The recommender based on neuro-fuzzy approach generates interpretable fuzzy rules, and it has very good effectiveness, in most cases above 97%.
6	Movie recommendation system using enhanced content-based filtering algorithm based on user demographic data	G. Sunandana; M. Reshma, Y. Pratyusha, Madhuri Kommineni, Subbarao Gogulamudi 2021 6th International Conference on Communication and Electronics Systems (ICCES), 2021	Cosine similarity method, TF-IDF Vectorizer	The top 6 movie names recommended are Minions, Interstellar, Deadpool, Guardians of the Galaxy, Mad Max: Fury Road, Jurrasic World

3. Dataset and Tool to be used (Details)

The dataset we have chosen for our project is extracted from The Movie Database (TMDB) and contains the details of 5000 movies. The whole dataset comprises of two sub datasets i.e., credits and movies.

The credits' part consists of the following features: -

- movie_id - A unique identifier for each movie.
- cast - The name of lead and supporting actors.
- crew - The name of Director, Editor, Composer, Writer etc.

The movies dataset has the following features: -

- budget - The budget in which the movie was made.
- genre - The genre of the movie, Action, Comedy, Thriller etc.
- homepage - A link to the homepage of the movie.
- id - This is in fact the movie_id as in the first dataset.
- keywords - The keywords or tags related to the movie.
- original_language - The language in which the movie was made.
- original_title - The title of the movie before translation or adaptation.
- overview - A brief description of the movie.
- popularity - A numeric quantity specifying the movie popularity.
- production_companies - The production house of the movie.
- production_countries - The country in which it was produced.
- release_date - The date on which it was released.
- revenue - The worldwide revenue generated by the movie.
- runtime - The running time of the movie in minutes.
- status - "Released" or "Rumored".
- tagline - Movie's tagline.
- title - Title of the movie.

- vote_average - average ratings the movie recieved.
- vote_count - the count of votes recieved.

These two sub datasets will be merged in our project on title basis to generate the final dataset on which we will be making recommendations on.

- Here's the G-Drive dataset link: https://drive.google.com/drive/folders/1PuxYjzyaHZ0FjpUWvIeusmsoEhsTK1Gl?usp=sharing

Tools:

1) Jupyter Notebook or Google Colab for IDE

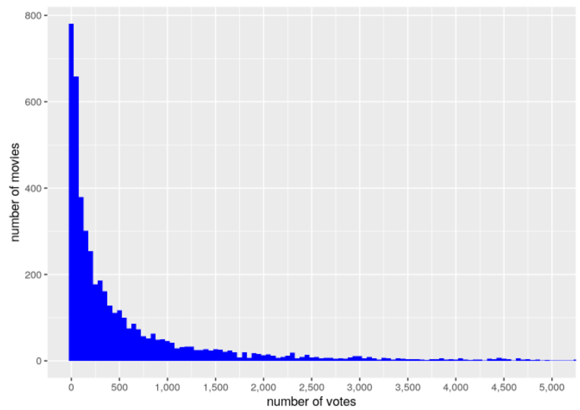
2) Python being the programming language

3) Python libraries like scikit-learn, pickle etc. for creating the recommendation system as well as the GUI.

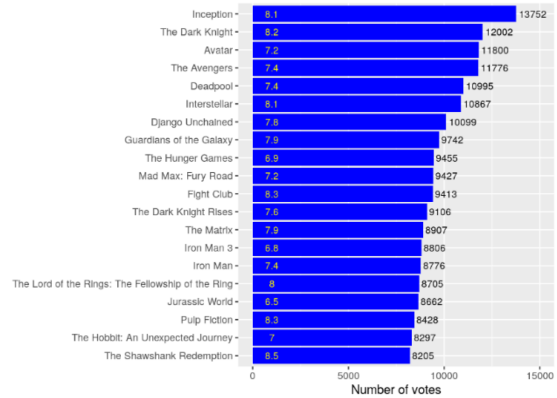
4) Using ‘Streamlit’ which is an open-source python-based framework and Pycharm platform for the GUI implementation.

5. Data Visualization

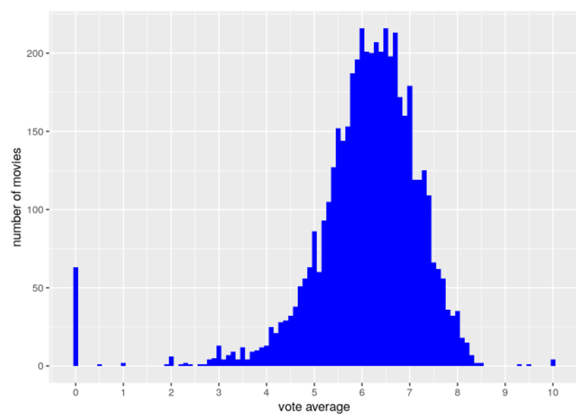
Number of votes



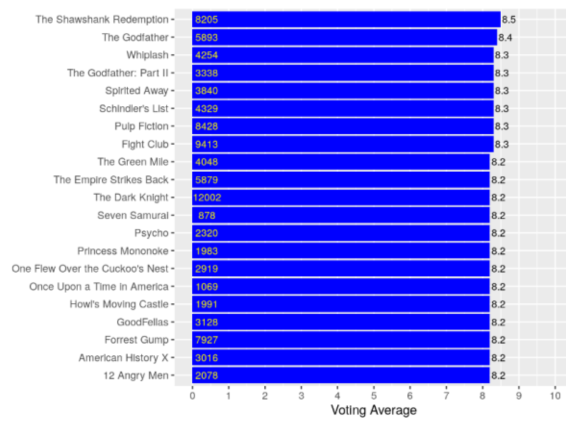
Movies with highest no. of votes



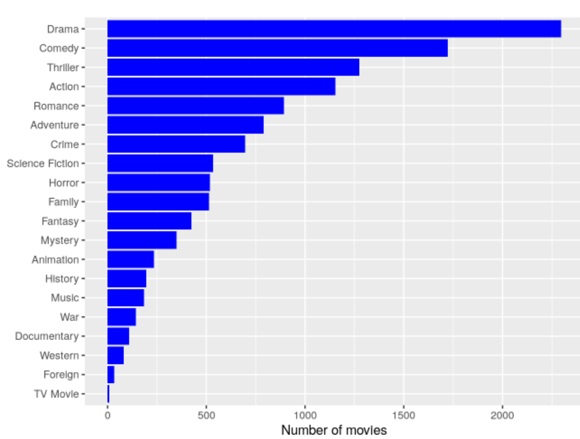
Vote average vs No. of votes



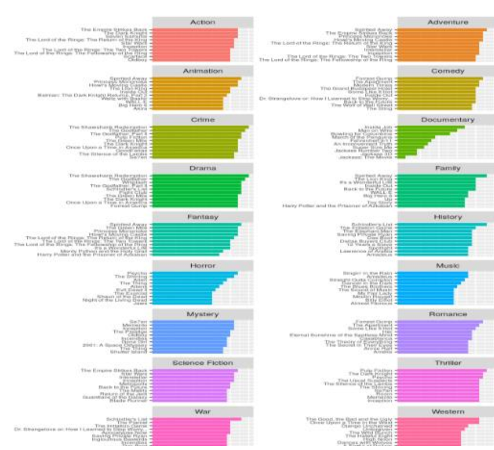
Movies with highest vote average



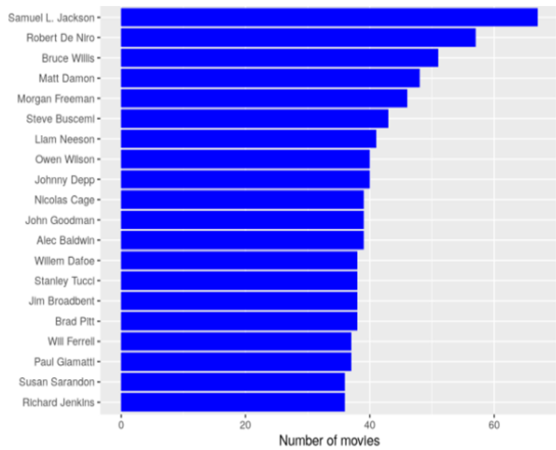
No. of movies by genre



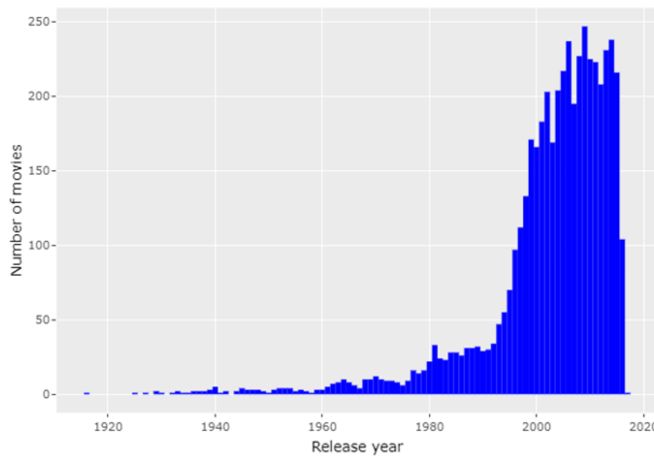
Highest rated movie by genre



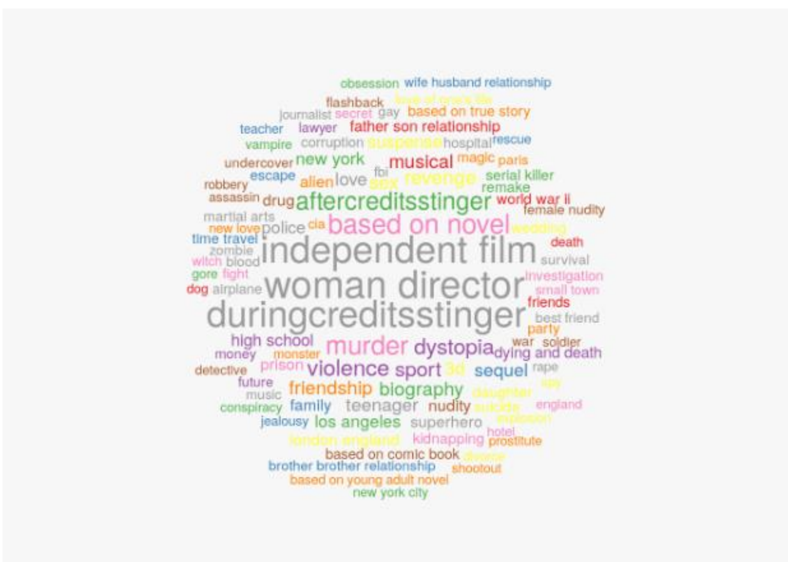
Most actor and director appearances



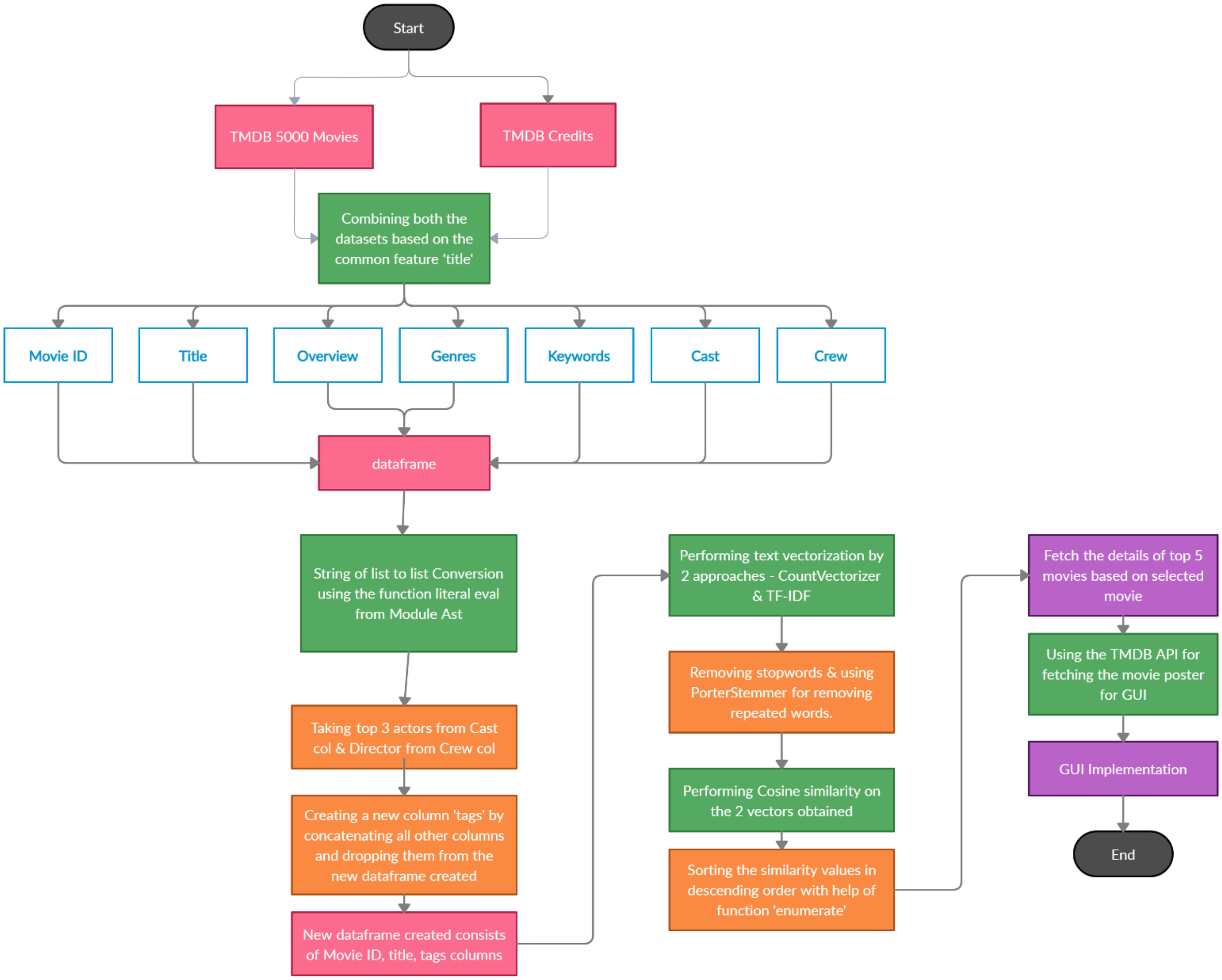
No. of movies vs Release year



Most used keywords



4. Proposed Methodology



- We have taken the dataset from The Movie Database (TMDB) which consists of 2 parts namely – ‘TMDB 5000 movies’ and ‘TMDB credits’
- We will combine these 2 datasets based on a common feature between them – ‘Title’
- For our recommender system, we will create a dataframe in which we only take the columns which adds value to our prediction system which includes ‘movie_id’, ‘title’, ‘overview’, ‘genres’, ‘keywords’, 'cast', ‘crew’ and remove all the unnecessary columns.
- We will create a helper function to convert the String of List to List using the function ‘**Literal eval’** from module ‘Ast’.

- From ‘Cast’ column – we will take the top 3 actors from the list.
- From ‘Crew’ column – we will extract only the names of the ‘Director’.
- Then we will remove the spaces in each single entity from all the columns.
- Next, we will create a new column called ‘tags’ which is made by concatenating all the other columns which includes ‘movie_id’, ‘title’, ‘overview’, ‘genres’, ‘keywords’, ‘cast’, ‘crew’ and drop these columns from the new dataframe created.
- Creating a new dataframe which consists of Movie id, title, and tags.
- We will perform text Vectorization using 2 algorithms namely **Count Vectorizer** and **TF-IDF** and remove stopwords from the movies data.
- We will use ‘**PorterStemmer**’ from ‘nltk’ library which is a process for removing the commoner morphological and inflexional endings from words in English.
- Then, we will perform **Cosine Similarity** on the final vectors achieved through the 2 algorithms.
- Next, we will sort the movies in descending order w.r.t the distance, in order to have the movies with highest cosine similarity at the top: but in this process we lose the index value of the movie to avoid we will use the function '**enumerate**' which converts a data collection object into an enumerate object. Enumerate returns an object that contains a counter as a key for each value within an object, making items within the collection easier to access.
- We will fetch the index position of the movie to be searched.
- Finally, we will get the details of the top 5 movies based on our selected movie.
- API stands for “Application Programming Interface.” An API is a messenger that delivers your request to the provider that you are requesting it from and then delivers the response back to you. In our case the provider is TMDB. TMDB has a huge collection of

movies data, from which the system can fetch the information that it needs. To use TMDB API, an API key has to be generated after creating an account on TMDB.

- For our recommender system, we will fetch the movie poster based on the selected movie ID from the dataset using the **TMDB API**.
- For **GUI** implementation, we will dump both movies.pkl and similarity.pkl in write binary mode from our ipynb file, then load and open both movies.pkl and similarity.pkl in read binary mode in Pycharm and use Streamlit for GUI implementation.

5. Algorithms / Techniques description

A) Count vectorizer:

It is used to transform a given text into a vector on the basis of the frequency (count) of each word that occurs in the entire text.

Text data demands special preparation before employing it for predictive modeling. The text has to be parsed to pull out words, termed tokenization. Then the words require to be encoded as integers or floating-point values for applying as input to a machine learning process, named feature extraction or also vectorization. The CountVectorizer offers an uncomplicated technique to both build a vocabulary of known words and tokenize a series of text documents, however as well as to predetermine recent documents utilizing that vocabulary. CountVectorizer's fit.tranform method is applied to calculate the number of texts and will produce the converted matrix count_matrix into an array for more efficient insight. When the text input is introduced through the 'count vectorizer' function, it fetches a matrix of the number count of each word.

CountVectorizer is used as follows:

1. Construct an instance of the CountVectorizer object.

2. Request the fit() function so as to gather a vocabulary from one or more documents.

3. Call the transform() function on one or more documents as required to translate each as a vector. A converted vector is countered with a length of the complete vocabulary and an integer count for the number of times every word featured in the document

B) TF-IDF

Content based filtering approach filters the items based on the likings of the user. It gives result based on what the user has rated earlier. The method to model this approach is the Vector Space Model (VSM). It derives the similarity of the item from its description and introduces the concept of TF-IDF (Term Frequency-Inverse Document Frequency).

TFIDF is based on the logic that words that are too abundant in a corpus and words that are too rare are both not statistically important for finding a pattern. The Logarithmic factor in tfidf mathematically penalizes the words that are too abundant or too rare in the corpus by giving them low tfidf scores.

Tf(t)=frequency occurrence of term t in document / totalnumberoftermsindocumen$t$

If(t)= log10 (totalnumberofdocument / numberofdocumentscontainingtermt)

C) Cosine similarity:

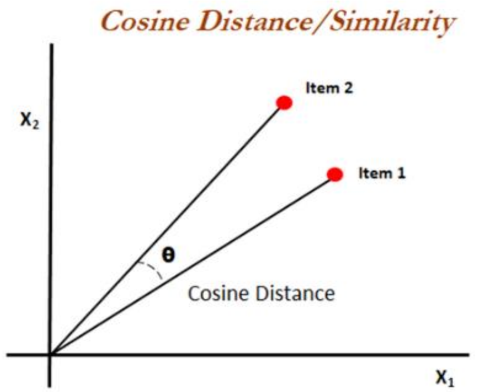
It is used to degree the similarity of vectors regardless of the scale. Cosine similarity is measured via way of means of utilizing the two non-zero vectors and acquiring the dot manufactured from the each and ultimately dividing it via way of means of the goods of Mathematically, it's miles in particular used for measuring the cosine of the perspective among non-0 vectors projected in a multidimensional space. The Cosine Similarity is better whilst the perspective is smaller and vice-versa. In Movie Recommendation System, Cosine similarity takes person evaluations on film as statistics and gives the result. Cosine(X1, X2) = X1. X2 / X1 * X2 where,

• X1.X2= product (dot) of the vectors ‘X1’ and ‘X2’.

• X1 and X2 = period of the 2 vectors ‘X1’ and ‘X2’.

• X1 * X2 = pass manufactured from the 2 vectors ‘X1’ and ‘X2’.

• The Cosine similarity of non-0 vectors is measured in ‘θ’.



$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A}\cdot\mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}},$$

• If $\theta = 0°$, the ‘X1’ and ‘X2’ vectors overlap, for this reason proving they're similar.

• If $\theta = 90°$, the ‘X1’ and ‘X2’ vectors are dissimilar.

• Consider an instance to locate the similarity among vectors – ‘X1’ and ‘X2’, the use of Cosine Similarity.

• The ‘x’ vector has values, X1 = {1,0,0,0}, The ‘y’ vector has values, X2 = {3,2,0,5}

• The components for calculating the cosine similarity are - Cosine (X1, X2) = X1. X2 / X1 * X2

• X1.X2= 1*3+ 0*2 + 0*0 + 0*5 = 3

• X1 = √ (1)^2 + (0)^2 + (0)^2 + (0)^2 = 1

• X2 = √ (3)^2 + (2)^2 + (0)^2 + (5)^2 = 6.16

• ∴ Cosine (X1, X2) = 3 / (1*6.16) = 0.49

• The dissimilarity among the 2 vectors ‘X1’ and ‘X2’ is given via way of means of

• ∴ Dis (X1, X2) = 1 - Cosine(X1, X2) = 1 - 0.49 = 0.51

Advantages:

• Two similar statistics gadgets that's a way aside via way of means of the Euclidean distance because of the scale have a smaller perspective among them.

• Hence, Cosine similarity is beneficial.

• If the angle is smaller, the similarity will be higher.

6. Experimental Results

The formula used to measure how similar the movies are based on their similarities of different properties. Mathematically, it shows the cosine of the angle of two vectors projected in a multidimensional space. The cosine similarity is very beneficial since it helps in finding similar objects.

(I) Using **Count Vectorizer** for Text Vectorization, showing top 10 movie ID's and similarity values based on the cosine similarity values achieved in descending order w.r.t the first movie of index 0.

```
In [53]: sorted(list(enumerate(similarity[0])),reverse=True,key = lambda x: x[1])

Out[53]: [(0, 1.0),
          (539, 0.26089696604360174),
          (1194, 0.2581988897471611),
          (260, 0.25110592822973776),
          (1216, 0.24944382578492943),
          (507, 0.24846467329894412),
          (1444, 0.24397501823713333),
          (1920, 0.243599382882345),
          (582, 0.24147264420814754),
          (3730, 0.23904572186687872),
          (74, 0.22677868380553634),
```

The top 5 recommended movies are –

```
In [56]: recommend('Gandhi')

         Gandhi, My Father
         The Wind That Shakes the Barley
         A Passage to India
         Guiana 1838
         Ramanujan
```

(II) Using **TF-IDF** for Text Vectorization, showing top 10 movie ID's and similarity values based on the cosine similarity values achieved in descending order w.r.t the first movie of index 0.

```
In [59]: sorted(list(enumerate(similarity1[0])),reverse=True,key = lambda x: x[1])

Out[59]: [(0, 1.0000000000000002),
          (2409, 0.2519930130215996),
          (3730, 0.22559347561842458),
          (582, 0.19390717213891556),
          (1216, 0.18848538168904172),
          (3608, 0.17684322332408908),
          (47, 0.17304643775881712),
          (778, 0.16571834555284645),
          (1204, 0.16306831442162661),
          (539, 0.15630094071167544),
```

The top 5 recommended movies are –

```
In [61]: recommend1('Gandhi')

         Gandhi, My Father
         Dil Jo Bhi Kahey...
         Neal 'n' Nikki
         A Passage to India
         Guiana 1838
```

7. Discussion on Results

Based on the above results obtained through the two text vectorizations techniques namely Count Vectorizer and TF-IDF we can see that there is only a slight difference between the movies recommended by both these approaches. Since the Count Vectorizer focuses on the frequency of words while the TF-IDF not only focuses on the frequency of words present in the corpus but also provides the importance of the words.

8. Model Evaluation

The common way to assess the performance of a recommender system would be through standard metrics such as Accuracy, Precision or Recall. However, these metrics require ground truth knowledge about which recommendations are correct, which is hard to obtain at a large scale in our specific problem setting i.e., Content-based Recommender system.

9. Conclusion

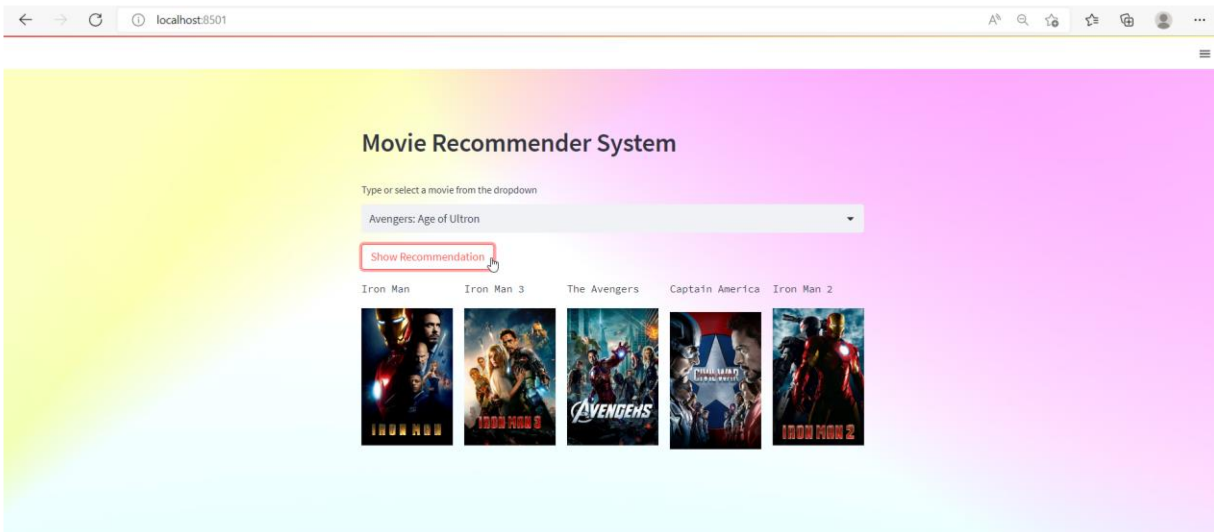
Recommendations systems have become the most essential fount of a relevant and reliable source of information in the world of internet. Simple ones consider one or a few parameters while the more complex ones make use of more parameters to filter the results and make it more user friendly.

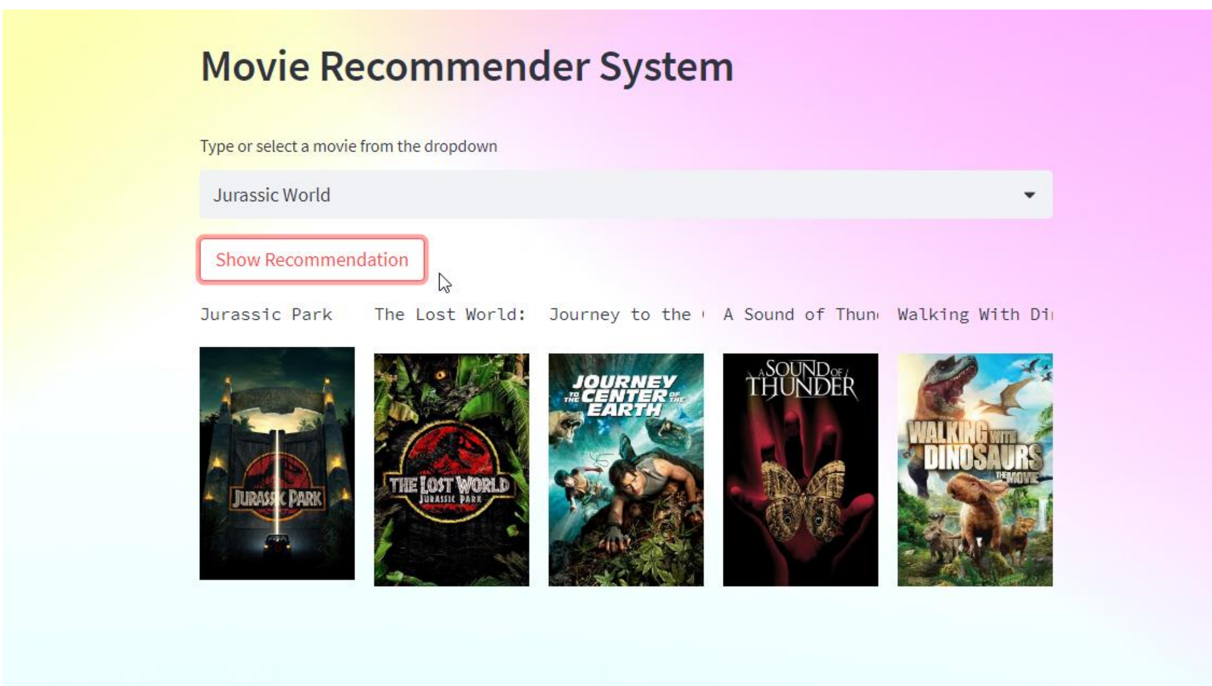
We have illustrated the modelling of a movie recommendation system by making the use of content-based filtering in the movie recommendation system. For text Vectorization, 2 algorithms are implemented in this model namely Count Vectorizer and TF-IDF along with the principle of cosine similarity distance measure as it gives more accuracy than the other distance metrics and the complexity is comparatively low too.

When a user wants a list of movies similar to a movie that they had previously watched. Then the user searches on our recommender system for the movie name that he/she has already watched, and our recommender system will recommend the top five movies that are most similar to the searched movie. This feature will save user's time which otherwise would have been wasted on finding a movie that he/she may or may not like. Every month several movies are released, the movies database only gets bigger and bigger. This would help the system to provide a more accurate recommendation to the user and in turn increase customer satisfaction.

10. Screenshots

GUI Implementation





11. Github Repository Link

https://github.com/Gojitha/Recommender-System-Project

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