|  |
| --- |
|  |

|  |
| --- |
| TECHNICAL REPORT  Electrical & Computer Engineering & Computer Science (ECECS) |

|  |  |
| --- | --- |
| SPRING 2024 |  |



Contents

[Project Name 2](#_Toc96341549)

[Executive Summary 2](#_Toc96341550)

[Technical Report 3](#_Toc96341551)

[Highlights of Project 3](file:///C:\Users\ardia\Desktop\TEACHING\SPRING%2022\DSCI6002%20Data%20Science\Projects\Technical%20report%20Template.docx#_Toc96341552)

[Submitted on: 3](file:///C:\Users\ardia\Desktop\TEACHING\SPRING%2022\DSCI6002%20Data%20Science\Projects\Technical%20report%20Template.docx#_Toc96341553)

[Abstract 4](#_Toc96341554)

[Methodology 5](#_Toc96341555)

[Results Section 5](#_Toc96341556)

[Discussion 6](#_Toc96341557)

[Conclusion 6](#_Toc96341558)

[Contributions/References 7](#_Toc96341559)

|  |
| --- |
| Product Recommendation System |

|  |
| --- |
| Executive Summary Amazon is a multinational technology company based in Seattle, Washington, that specializes in cloud computing, digital streaming, artificial intelligence, e-commerce, and more. Among its products is the well-known e-commerce website Amazon.com. One way that Amazon maintains client attention is through their system of product recommendations. The system that makes recommendations for products considers the purchases made by customers who have made similar things in the past as well as their own. The algorithm makes recommendations for products that the user would like based on these two actions. Collaborative filtering enables users to view products from several categories, while content-based filtering only displays products exclusive to a domain.     Recommendations from collaborative filtering are different from those from content-based filtering, which only makes recommendations for goods that are specifically connected to a given subject.  1. The first method suggests items that other users find enjoyable to the individual user based on the user's rating of a certain product. Essentially, it finds the top products that other customers liked out of all those who gave a product a rating that is comparable to that of the individual customer.   2. The second method predicts what a person could appreciate based on past rating history and rating histories of other users. This method isn't restricted to the rating of a specific product, unlike the previous one.    3. The third method predicts items that are similar to a specific product by locating its nearest neighbors. This strategy is advantageous for clients who might like to purchase items in sets.  We evaluate our methods by:   * Testing the recommendation systems to see what products they return. * Understanding matrix factorization and how it effects collaborative filtering systems. * Selecting and tuning various recommendation algorithms to find the best performing algorithm. * Understanding estimated ratings vs. true ratings.   <https://github.com/UNH-Fall2022-DistributedSystems-G6/UNH-DS-Fall22> |
| person at a table writing in a notebook with people around  **Questions?**  **Team Members: Contact:**  Vignan Pallemeedi [vpall6@unh.newhaven.edu](mailto:vpall6@unh.newhaven.edu)  Roshan Reddy Mummadi rmumm2[@unh.newhaven.edu](mailto:lthal1@unh.newhaven.edu)  Teja Subbanna tsubb1@unh.newhaven.edu  Varshitha Edla vedla2@unh.newhaven.edu |

|  |  |
| --- | --- |
| The Amazon website offers a wide range of product categories, such as digital products, hardware items, sports, cars, and more. Customers can purchase almost anything on Amazon.com and take use of the suggestion system.  TECHNICAL REPORT  Though they frequently have too narrow of a focus, recommendation algorithms are excellent at directing users toward similar products and prevent them from stepping outside of their comfort zones or discovering things they might not have known they wanted. When a consumer watches a video on YouTube, for instance, their browser will be inundated with numerous copies of the same video and insufficient variety. Our goal at Amazon is to develop a recommendation engine that provides users with a range of content or product recommendations at the right time. |  |
| Data have grown up uncontrollably due to which  ABSTRACT  there are large number of products that are listed on e-commerce  website today. In a way through which users can quickly find a  favorite item from big resources, the user requires such technology  by which it can be automated so recommendation systems were  introduced. Recommendation systems are mainly used by  companies like e-commerce to help the user discover items they  have to found out by them and increase the sales of the company.  A recommender engine can recommend user interest products. In  this paper the discussion various different recommendation system,  evaluation techniques and also the challenges and problem in the  system are discussed. Also using Amazon electronics data building  of popularity-based recommender engine and recommender engine  using collaborative filtering that is based on singular value  decomposition is discussed. The goal of the model is to  recommend users 5 top products to the user and performance of  each model is evaluated  Data have grown up uncontrollably due to which  there are large number of products that are listed on e-commerce  website today. In a way through which users can quickly find a  favorite item from big resources, the user requires such technology  by which it can be automated so recommendation systems were  introduced. Recommendation systems are mainly used by  companies like e-commerce to help the user discover items they  have to found out by them and increase the sales of the company.  A recommender engine can recommend user interest products. In  this paper the discussion various different recommendation system,  evaluation techniques and also the challenges and problem in the  system are discussed. Also using Amazon electronics data building  of popularity-based recommender engine and recommender engine  using collaborative filtering that is based on singular value  decomposition is discussed. The goal of the model is to  recommend users 5 top products to the user and performance of  each model is evaluated  Since data has grown out of control, a lot of things are currently promoted on e-commerce websites. Recommendation systems were created to help consumers quickly select their preferred products from a wide range of possibilities. However, users need technology that can automate this process. E-commerce companies are the main ones that utilize recommendation algorithms to help customers pick things they should know about and boost sales.  A recommender engine can be used to suggest products that draw in customers. Numerous recommendation systems, evaluation techniques, and system challenges and issues are included in this study. Furthermore, popularity-based recommender engines constructed with data from Amazon electronics and collaborative filtering based on single value decomposition are addressed in recommender engines. The model's effectiveness is evaluated, and its goal is to give consumers a list of the top five products. |

Introductory Section

Recommendation systems had changed the way of

interaction between user and websites and are increasingly

important today. Recommender system enhance accesses

and take charge to recommend appropriate items to users by

in view of the users raised choices and objective behaviors.

Being an online advertisement or e-commerce websites,

recommender system cannot be avoided today. Every other

company is trying to use the power of recommendation

system. These systems have huge application in different

sectors that are education, economy and researches, like

much other work[1]–[5]. The rate of digital information is

increasing rapidly due to rapid growth of information

technology. The recommendation system has attained great

results solving the problem of data overloaded. There is a

very large number of products that are listed today on e-

commerce websites like Flipkart, Amazon. Recommender

system helps user when they face huge amount of choices[6].

There are almost more than 30 million products present on

Flipkart today. Due to which it has become tough for

customers to choose their desired choice. The recommender

system deals with many data present by filtering the most

Recommendation engines, which are also becoming increasingly significant, have transformed user-website interactions. Recommender systems improve user experience and manage the process of providing customers with relevant product recommendations based on their stated preferences and objective actions. These days, recommender systems, like online advertisements or e-commerce websites, are unquestionable. Every other business is attempting to use the possibilities of recommendation systems. These systems are very beneficial in a variety of fields, including education, research, and economics.

The exponential rise of information technology is driving up the rate of digital information. The overload of data problem has been considerably mitigated by the recommendation approach. These days, one may find a wide variety of things on internet merchants such as Amazon and Flipkart. The usage of a recommender system can be advantageous to customers when they are presented with a multitude of options. Almost 30 million products are being offered on Flipkart. Customers are currently having difficulty deciding what they want to accomplish. To handle enormous amounts of data, the recommender system selects the most pertinent information from the user's past data while taking their interests and preferences into account. The potential of a recommender system. Determine if a certain user would prefer a particular item based on their profile. It can predict a user's inclination toward a product based on historical data. Recommender systems have advantages for both service providers and users. The decision-making and quality-assurance processes have also been enhanced by these kinds of technologies.

.

Recommender systems result in mainly things stated below:

* Helps clients find products that pique their interest.
* Help item vendors deliver their goods to the right customer.
* Ascertain which products are absolutely essential to the user.
* Customized content and a useful website boost user interaction.

## Methodology

**Data Collection and Preprocessing**:

Gathering and preparing data is the initial stage in developing a recommendation system. The Amazon product reviews dataset, which includes user ratings and reviews for a variety of products sold on Amazon, will be used in this scenario. The CSV version of the dataset can be found on the Amazon website.

Before being downloaded, the dataset must be preprocessed so that our recommendation engine can use it. First, we will go over the dataset and eliminate any redundant data and unnecessary columns. The average rating for each product will then be determined and entered in a different column. This will assist us in determining which goods, based on average rating, are most popular.  
  
  
  
  
Model Training and Testing:

With the preprocessed data, we can now train our recommendation system model. Many techniques, such as matrix factorization, collaborative filtering, and content-based filtering, can be used to build a recommendation system. For this project, we used a crowdsourced filtering process.

**Collaborative filtering:**

A method called collaborative filtering makes product recommendations to a user based on the tastes of other users who share those same likes. The ratings that each user has given each product must first be compiled into a user-item matrix before we can implement this technique. After then, the dataset will be divided into training and testing sets, with the model being trained on the training set. Using the testing set, we will assess the model's performance once it has been trained.

Recommendation systems frequently employ the well-liked technique of collaborative filtering to offer clients recommendations for goods or services based on their preferences as well as those of similar users. The system finds commonalities between products to provide individualized suggestions.

Item-based and user-based collaborative filtering are the two primary varieties. Collaborative filtering based on user preferences finds users who share the target user's tastes and suggests items that these users have found interesting. Products that the targeted user has enjoyed are located and related products are recommended through collaborative filtering based on things.

Collaborative filtering is based on the idea that individuals who have made similar decisions in the past are probably going to make similar decisions in the future. This assumption, however, could not always be true because the sparsity of the data or the existence of irrelevant or noisy data could have an impact on how well collaborative filtering performs.  
  
To solve these problems, scientists have created more sophisticated methods like deep learning-based models and matrix factorization. By more successfully locating the underlying patterns in the data, these methods raise the effectiveness of recommendation systems.

**SVD (singular value decomposition):**

The singular value decomposition (SVD) algorithm is a popular technique for developing recommendation systems, and it is employed in Amazon's product suggestion system. The SVD algorithm, a matrix factorization technique, splits the user-item ratings matrix into three matrices: U, S, and V.

The matrix U, where a user is represented by each row and a latent characteristic by each column, is used to represent the user features. The item features are represented by the matrix V, where each row denotes an item and each column a latent feature. S is a diagonal matrix that represents each latent feature's strength.  
  
  
The SVD algorithm uses latent information from the user-item ratings matrix to predict the ratings for items that the user has not yet evaluated. Based on the anticipated outcomes, the user can thereafter receive personalized recommendations.

The user-item ratings matrix must be preprocessed to remove any anomalies or missing data before the SVD algorithm in Amazon's product recommendation system is applied. The matrix is then broken down using the SVD algorithm to get the U, S, and V matrices. After that, these matrices can be used to predict user ratings for items that haven't been rated yet.

The performance of the SVD algorithm can be evaluated using metrics such as the mean absolute error (MAE) and root mean square error (RMSE).

All things considered, the SVD algorithm is a powerful technique for building recommendation systems that has been applied successfully in a variety of fields, such as music, movies, and e-commerce. It can help Amazon's product recommendation engine provide precise and tailored suggestions to its users.

**Results Section**

We used the SVD technique to slice the data, plot the features to analyze the label and its frequency, visualize a subset of the features through a bar graph, and train the model. We also constructed a diagonal array and a pivot table in SVG to draw more conclusions.

A screenshot of a computer program

Description automatically generated

A screenshot of a computer program

Description automatically generated

## 

## A screenshot of a computer Description automatically generated

Chart, bar chart

Description automatically generated

## Discussion

We used several factors, such as "user Id," "product Id," "ratings," "timestamp," and others, to determine the top "n" product recommendations. We cleansed the data by replacing "Nan" values with 0 in order to obtain the appropriate accuracy. During the project's execution, we omitted a few columns that had no effect on the accuracy of the predictions.

## Conclusion

Collaborative filtering suggestion systems enable users to find similar things and leap (or switch) to other product categories based on similarities with other users and products, unlike content-based filtering, which only suggests related products or domain-specific products.

This approach makes product recommendations to a person based on other users' evaluations of a certain product. In essence, it identifies the best products that other consumers enjoyed from among all those who rated a product similarly to the individual client. With the use of a basic recommender that was created from scratch without the use of any real model training or prediction techniques, this method served as an introduction to recommendation systems.

## Contributions/References

* <https://www.researchgate.net/publication/3419552_Linden_G_Smith_B_and_York_J_'Amazoncom_recommendations_item-to-item_collaborative_filtering'_Internet_Comput_IEEE_7>
* <https://www.semanticscholar.org/paper/A-Survey-on-Recommendation-System-Das-Sahoo/5e90a13c6b159dbc85772309f5301dc9f308f9d9>
* <https://en.wikipedia.org/wiki/Recommender_system>