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Research Article

ProtonMart - AI Driven E-Commerce Platform For Electronic Goods Using Collaberative Filtering Algorithm

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Abstract: This research paper investigates the development of a Django-based e-commerce platform specializing in the sale of electronic goods, augmented with a user-based collaborative filtering algorithm for personalized product recommendations. In the competitive landscape of online retail, providing tailored recommendations to users is crucial for improving user engagement and driving sales. Leveraging Django framework, SQLite3 database, AJAX technology, and PayPal integration , this study explores the integration of collaborative filtering into the e-commerce framework to enhance user experience and boost sales. key features of this platform includes a search bar, brand and category filters, an administrative interface, shopping cart functionality, and integration with PayPal payment gateway. Subsequently, the research details the incorporation of a user-based collaborative filtering algorithm for product recommendations.

Keywords: E-commerce, Django, SQLite3, Ajax, PayPal, Collaborative Filtering, Electronics.

1. Introduction

The rise of e-commerce platforms in recent years has changed how customers interact with companies, especially when it comes to technological items. The creation of effective and user-friendly e-commerce websites has become a major focus for both businesses and researchers due to the increasing demand for online purchasing. In this regard, our project, ProtonMart, shows itself as a complete solution designed to satisfy the demands of customers looking for electronics and accessories.

Built with Django, a high-level Python web framework renowned for its ease of use and scalability, ProtonMart is an e-commerce website. By utilizing Django's capabilities, ProtonMart provides customers with a simple and intuitive browsing experience that guarantees rapid product discovery and seamless navigation.

ProtonMart stands out due in part to the use of a collaborative filtering suggestion system. ProtonMart uses user-based collaborative filtering algorithms to make dynamic product recommendations to users based on their preferences and previous interactions. By providing customized recommendations, this personalized recommendation system improves the user experience and helps consumers make better informed purchases. ProtonMart also uses a variety of technologies to improve security and operation. While the integration of Ajax allows for asynchronous data transmission and produces a more responsive interface, the database management system, SQLite3, guarantees data integrity and effective storage. PayPal's integration as the payment gateway further improves consumer ease and transaction security.

This study tries to give a thorough overview of ProtonMart's architecture, features, and performance while highlighting its design, development, and implementation. With this research, we hope to add to the expanding body of knowledge about recommendation systems and e-commerce platforms by providing an analysis of the technology advancements and design factors that support ProtonMart's success.

2. Related Work

S. Gupta et al. discovered that the accuracy of personalized product recommendations in e-commerce was greatly increased by combining deep learning approaches with collaborative filtering. In comparison to conventional collaborative filtering techniques, their study demonstrated how well deep neural networks can be used to identify intricate patterns in user preferences and behaviour, producing recommendations that are more correct[1].

J. Patel et al. found that improving the precision of tailored recommendations in e-commerce requires understanding dynamic customer preferences over time. They saw gains in recommendation quality when temporal information was added to collaborative filtering algorithms, especially when user preferences changed over time[2].

M. Sharma et al. highlighted how crucial it is to protect user privacy in e-commerce while offering tailored recommendations. Their work presented a framework for privacy-preserving collaborative filtering that protected sensitive user data using methods like homomorphic encryption, yet allowed efficient suggestion creation using collaborative filtering algorithms[3].

K. Mehta et al. concentrated on creating a real-time recommendation system with the goal of enhancing scalability and lowering suggestion latency for e-commerce 2 platforms. Utilizing technologies like collaborative filtering and Apache Spark, they showed that real-time tailored recommendation generation is feasible, improving ecommerce website user experience[4].

N. Gupta et. al proposed a context-aware collaborative filtering approach to personalized recommendations, taking into account variables including user location, time, and device. Their results demonstrated how crucial contextual information is to enhancing the accuracy of recommendations, especially in dynamic e-commerce settings where user preferences change depending on contextual circumstances[9].

A. Verma et. al addressed the vulnerability of personalized recommendation systems to adversarial attacks in ecommerce. They identified a number of attack techniques aimed at recommendation algorithms and suggested countermeasures to lessen the impact of these attacks. Their research demonstrated how crucial strong security controls are to preventing malicious exploitation of personalized recommendation systems[10].

E. Gupta et al. presented a multi-modal collaborative filtering technique Using graph neural networks ,to improve personalized suggestions in e-commerce. They noticed gains in suggestion quality by incorporating various user behaviors, like browsing history and social connections, especially in situations when standard collaborative filtering algorithms do not have enough information to make reliable predictions[13].

B. Kumar et al. concentrated on federated learning as a privacy-preserving method for individualized recommendations in decentralized e-commerce settings. They suggested an architecture that preserved user data privacy and decentralization while enabling numerous parties to work together to jointly train recommendation algorithms. According to their research, federated learning can be used to enhance suggestion quality while safeguarding user privacy[14].

R. Gupta et. al proposed a hybrid recommendation approach combining collaborative filtering and content-based filtering techniques. Their research showed that combining many recommendation systems could result in more varied and accurate individualized recommendations for e-commerce. They found that by utilizing item features as well as user item interactions, suggestion coverage and relevancy improved[15].

D. Sharma et al. concentrated on sequential collaborative filtering for individualized e-commerce recommendations using recurrent neural networks. They discovered that the accuracy of suggestions was enhanced when sequential patterns in user behaviour were captured, especially in situations where user preferences change over time. Their study demonstrated how well deep learning approaches represent intricate user dynamics for tailored recommendations[16].

3. Proposed Design

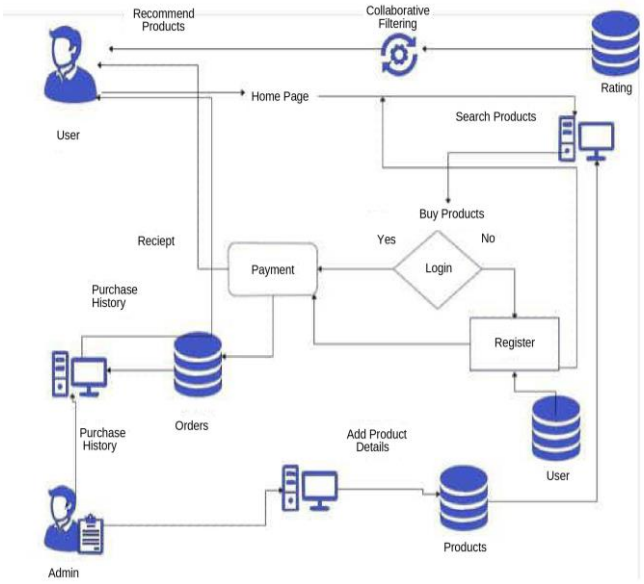

Figure 1. Architecture Diagram

The home page will be displayed when a user visits the website for the first time. The user can view the many products on the home page.

Additionally, the user can filter the products according to various brands and categories. The user is also provided with search capabilities, enabling them to look up products using keywords. Additionally, the user can view the specific product along with all of its details and other users' ratings.

It is necessary to log in or establish a new user account in order to purchase the product. Following the authentication process, the user can examine product details and add items to their cart. The user can check out and pay for the merchandise from their basket by integrating PayPal. will be sent an email with the order invoice, and the consumer can print it directly from the dashboard.

Users are able to rate and review products after making a purchase. Additionally, the user will be able to view the order's status. By employing a collaborative filtering technique, we are also able to suggest new products to the user based on their ratings for past products.

The admin is in charge of managing the database on the admin site, and they have complete control over making changes to the database.

There are numerous database tables on the ProtonMart website, including those for products, categories, brands, reviews, and orders. The administrator oversees the user and has the authority to designate them as super users, granting them access to the database. The administrator can add new brands, items, and categories to the current database. The order database allows the administrator to view every order. Able to modify the order status to Shipped, Delivered, or In Process.

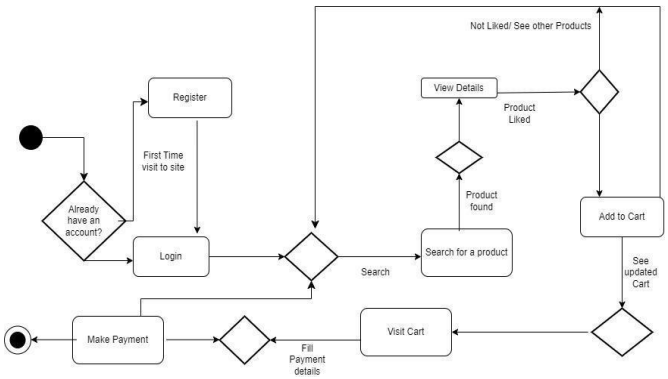

Figure 2. State Transition Diagram

The state transition diagram shows important user activities and system responses. Homepage is the initial state. Users move to states of product browsing, order confirmation, checkout, authentication, and cart management. Navigation, user actions (like adding products to the cart), and system responses (like order confirmation) are the three ways that transitions happen. The system's dynamic flow, which includes PayPal connectivity for payments and collaborative filtering for product recommendations, is shown in the diagram. It offers a succinct visual depiction of the user experience and system behaviour, which facilitates comprehension and maximizes the performance of the ecommerce platform.

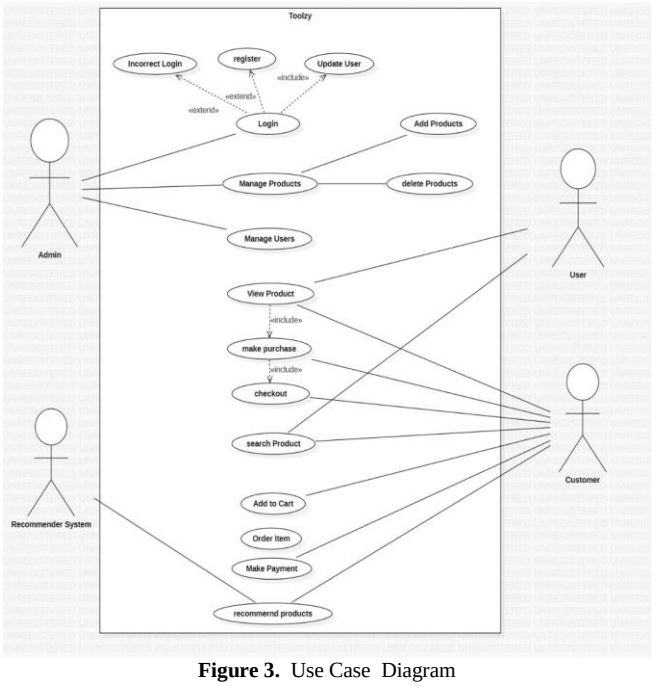

Figure 3. Use Case Diagram

The use case diagram illustrates how customers explore, purchase electronics, and get suggestions from the system. It involves activities like viewing products, completing Payment transactions, and receiving recommendations tailored to their tastes. This flowchart provides a brief synopsis of how users and administrators interact with the website.

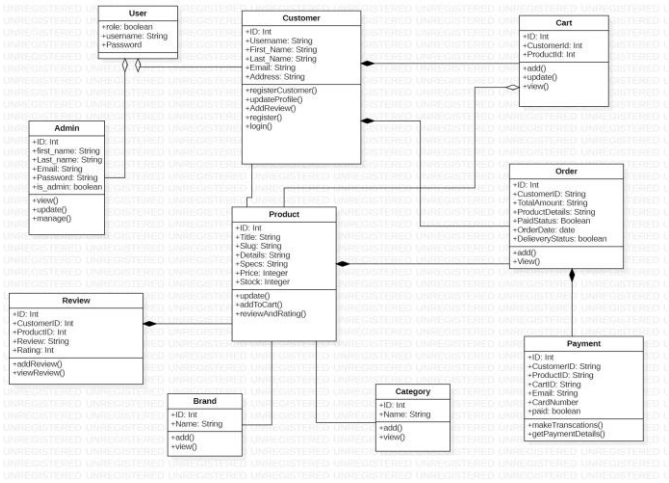

Figure 4. Class Diagram

The relationships between various classes in a user management system are depicted in the class diagram. User, Customer, Product, Payment, Order, Category, Brand, Review, and Cart are among the classes. The relationships are represented by a solid line for association, a diamond symbol for aggregation, and a triangle for inheritance.

User is the foundation class for both registered and unregistered customers in terms of inheritance. Accordingly, the User class provides methods and attributes that are inherited by both Registered and Unregistered Customers.

Association: There are several connections among different classes. For instance, a single customer may be the owner of multiple orders. A product may have multiple reviews, and reviews may be associated with a single product. Products may be added by the user to their cart, which may hold several Products.

4. Requirements Analysis

For the development of Project following software tools and hardwares are used as mentioned in below table.

Table 1. Project Requirements

Hardware	Intel i5 Processor
Speed	2.80 GHz
RAM	8 GB
Hard Disk	256 GB
Operating System	Windows 11
IDE	VS Code
Programming Language	Python
Framework	Django, Bootstrap
Frontend	HTML, CSS, Javascript, Ajax
Database	Sqlite3

5. Results and Discussion

5.1 User Interface

From the time a new user lands on the website, ProtonMart stresses user engagement and simplicity of navigation. The site has an eye-catching user interface that is visually appealing and carefully crafted to capture attention. A modern and eye-catching navigation bar, embellished with a range of symbols signifying various features and areas of the website, commands prominent space at the top of the page.

The site features a carefully chosen assortment of products beneath the navigation bar, which is structured to draw visitors in and encourage them to explore deeper. This first product display piques customers' interest and encourages them to explore more of ProtonMart by providing a visual overview of the wide range of options available.

Users are offered easy ways to browse products according to their preferences on the left side of the navigation bar. The two categories of these options are exploration by brand and 4 exploration by category. ProtonMart makes its products easier to find by allowing customers to explore based on their favorite brands or product categories. This makes it easier for consumers to find products that suit their requirements and interests.

Through the integration of these design components into the homepage layout, ProtonMart hopes to give users an engaging and easy-to-use browsing experience. The goal of the platform's appealing aesthetics, simple navigation, and well-placed product placement is to draw users in, stimulate their curiosity, and eventually increase their level of engagement and platform satisfaction.

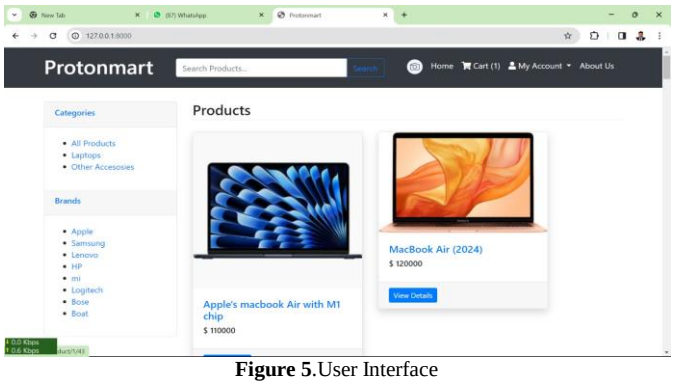

Figure 5.User Interface

5.2 Search Bar

ProtonMart has an extensive search feature that allows consumers to quickly find things they want from its wide selection. Easily and quickly find products with the help of the search box, which is placed prominently in the UI. Users can enter keywords, brands, or specs and get real-time search results that are dynamically generated using Ajax technology by utilizing Django's robust querying capabilities. This improved search experience adds to the overall usability and efficacy of the ProtonMart platform by improving user happiness and simplicity of navigation.

5.3 Shopping Cart

ProtonMart has a shopping cart function that is easy to use, making the process of choosing products and checking out quick and easy. Users can quickly add preferred items to their carts for subsequent purchasing after finding them. By utilizing Django's session management, customers may observe their pending purchases in a transparent manner as the cart dynamically refreshes to reflect the things they have chosen. Furthermore, without requiring page refreshes, Ajax technology allows fluid cart interactions like adding, removing, or altering quantities. For ProtonMart customers, this user-friendly cart feature improves the overall purchasing experience and promotes efficiency and convenience.

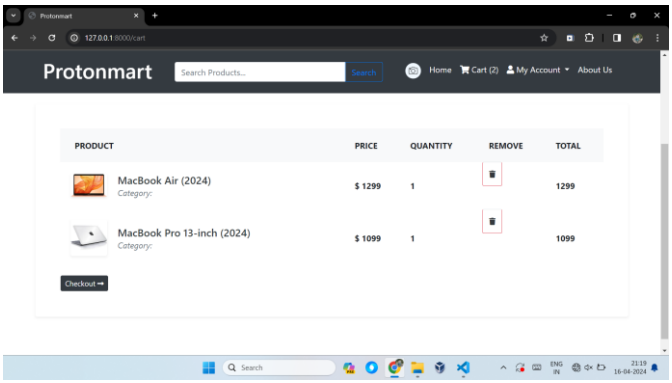

Figure 6. Shopping Cart

5.4 Admin Interface

The Admin Page of ProtonMart serves as a powerful and intuitive interface designed exclusively for administrative users, providing them with comprehensive control and oversight over various aspects of the e-commerce platform. As the backbone of ProtonMart's backend management system, the Admin Page empowers administrators to efficiently manage products, users, and activities, ensuring smooth operations and optimal performance.

One of the primary functionalities of the Admin Page is product management. Administrators have the authority to add new products to the platform, removing outdated or discontinued items, and modifying product attributes such as price, description, and availability. This granular control over product data allows administrators to keep the product catalog updated and reflective of current market trends and user demands. In addition to product management, the Admin Page enables administrators to oversee user management tasks. This includes the ability to create, edit, or deactivate user accounts, as well as manage user roles and permissions. By maintaining a centralized hub for user management, administrators can ensure the security and integrity of the platform while providing users with a seamless experience. Furthermore, the Admin Page offers robust monitoring and tracking capabilities, allowing administrators to keep a close eye on recent activities and transactions within the platform.

As a convenience feature, the Admin Page includes an option to redirect administrators to the main website with a single click. This seamless transition between the backend

administrative tasks and frontend user experience streamlines workflow and enhances productivity, enabling administrators to quickly switch between different areas of the platform as needed. Overall, the Admin Page of ProtonMart serves as a centralized hub for administrative tasks, providing administrators with the tools and functionalities needed to effectively manage and optimize the e-commerce platform. From product management to user administration and activity tracking, the Admin Page empowers administrators to uphold the highest standards of 5 efficiency, security, and user satisfaction across the entire ProtonMart ecosystem.

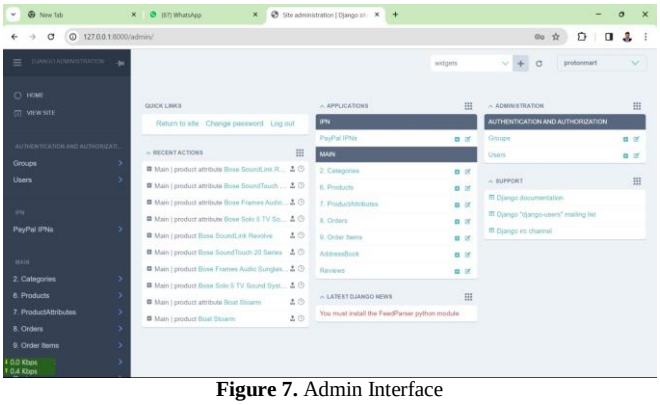

Figure 7. Admin Interface

5.5 User Account

The User Account have following components:

User Profile

The User Profile component encompasses essential details and settings associated with the user's account. It typically includes information such as the user's full name, email address, username, password, and any additional personal details provided during registration. Users can access and manage their profile information through this section, enabling them to update or modify their account settings as needed.

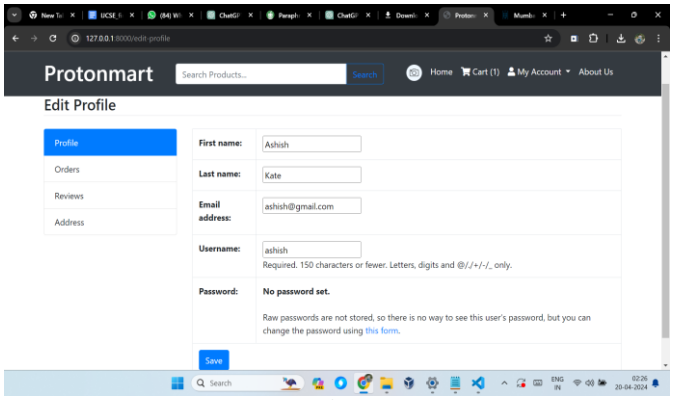

Figure 8. User Profile

Orders

The Orders section presents a summary of the user's past orders. It includes essential information such as the order number, order status, order timestamp, and total order amount. Users can easily track their previous purchases and monitor the status of their orders through this section.

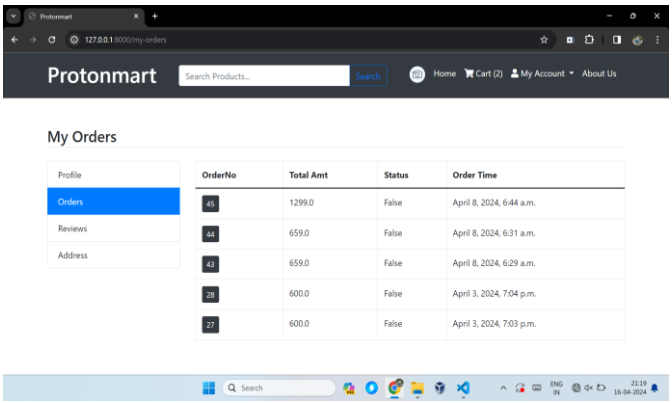

Figure 9. Orders

Reviews

Within the Reviews section, users can view and manage the product reviews they have submitted. This section displays attributes such as the Product Title, Product Image, price of products, text reviews provided by the customer, and review ratings in stars. It enables users to share their feedback on purchased products, contributing to the community's knowledge and trust in product quality.

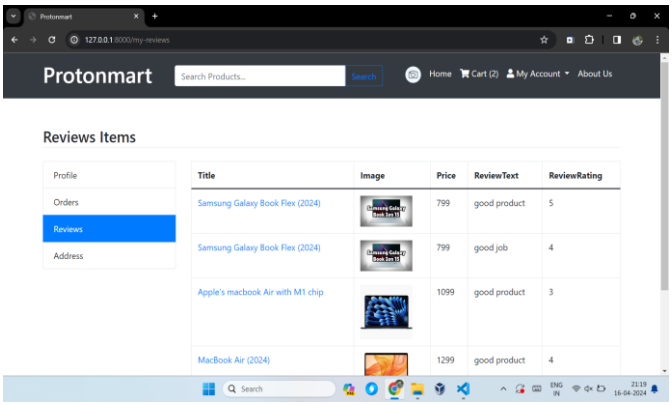

Figure 10. Reviews

Address

The Address component allows users to store and manage their preferred addresses for shipping and billing purposes. Users can save multiple addresses, such as home and office addresses, for added convenience during the checkout process. This section streamlines the shipping process for users, ensuring accurate and efficient delivery of their orders.

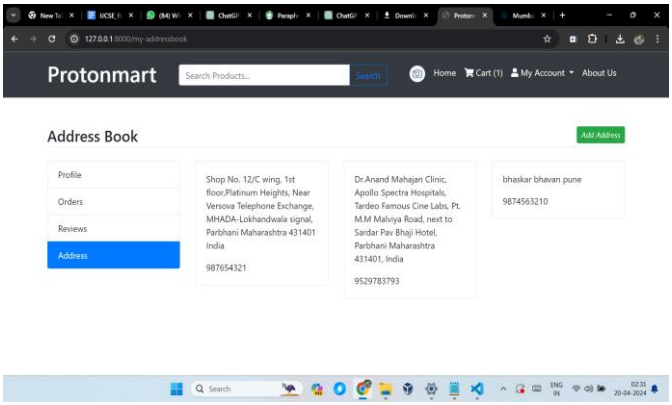

Figure 11. Address

5.6 Invoice

After the checkout process, an invoice is generated containing essential transaction details. The invoice includes an invoice number for identification purposes, along with a list of purchased items detailing each product's name, quantity, unit price, and total price. Additionally, the invoice displays the user's name and mobile number, providing contact information for reference. The date of the transaction is also included to indicate when the purchase occurred. This comprehensive invoice serves as a record of the transaction, facilitating transparency and accountability for both the buyer and the seller.

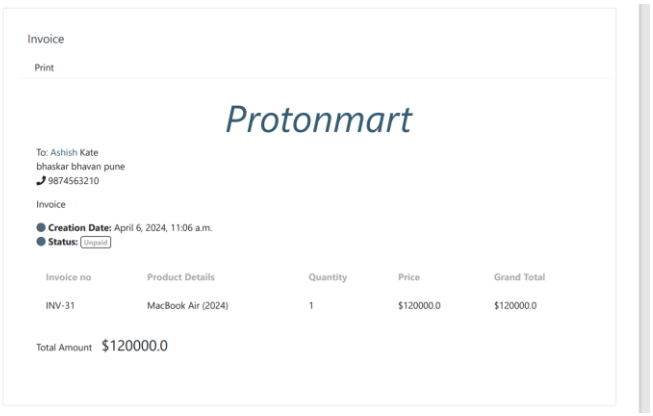

Figure 12. Receipt

5.7 PayPal Payment Gateway

ProtonMart seamlessly integrates the PayPal payment gateway, providing users with a secure and efficient transaction experience. This integration enables customers to make purchases using various payment methods supported by PayPal, ensuring convenience and trust in the ecommerce platform's payment processing system.

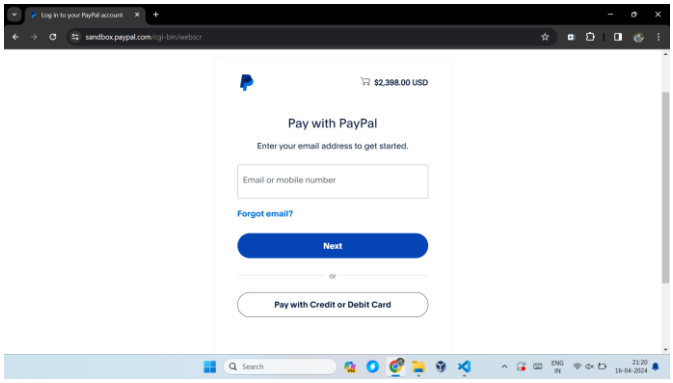

Figure 13. PayPal Payment Gateway

6. Algorithm & Related Maths

A recommendation system called collaborative filtering makes predictions about a user's interests or preferences by analysing the preferences or actions of other users who are similar to them[7-8]. It is predicated on the notion that users are likely to retain similar tastes or preferences in the future if they do so in the past[5–6].

There are two primary methods for implementing collaborative filtering[12]:

User-based Collaborative Filtering: This method aims to identify users who share similar interests and then suggest products that those users have either enjoyed or engaged with.

Item-based Collaborative Filtering: In this approach, the algorithm identifies similar items based on the preferences of users and recommends items that are similar to the ones the user has already liked or interacted with.

In this research paper we are using user based collaborative filtering where recommendations are based on the ratings given by the users.

User Based Collaborative Filtering Algorithm

User-based collaborative filtering is a recommendation algorithm that predicts a user's preferences for items by leveraging the preferences of similar users[11]. It operates on the principle that users who have exhibited similar behaviours or preferences in the past are likely to have similar tastes in the future. The algorithm identifies these similar users by calculating a similarity score based on their interactions with items. Then, it generates recommendations for the target user by aggregating the ratings or interactions of these similar users with items that the target user has not yet experienced. This approach is particularly effective in scenarios where explicit item characteristics are less important compared to user preferences and where users' behaviours and interactions with items are readily available for analysis.

Following are the steps for implementation of User Based collaborative filtering algorithm:

Data Representation: To begin with, a dataset including user-item interactions or preferences must be obtained. Usually, this dataset is shown as a matrix, with rows denoting users and columns denoting objects. Every cell within the matrix signifies a user's choice or rating for a particular item. For instance, if user ABC gives item XYZ a score of 3, you would see a cell value of 3 where user ABC's row and item XYZ's column overlap.

User-Item Matrix: Create a user-item matrix using the dataset. The preferences of users for various goods are represented by this matrix. Every column represents an item, and every row represents a user. Not every user rates every item in the matrix, which might lead to sparsity[12].

Similarity Calculation: A similarity measure is needed to find people who are similar to one another. Cosine similarity is frequently utilized in user-based collaborative filtering because of its efficiency in calculating how similar two vectors are to one another. The formula for calculating it is the vectors' dot product divided by the product of their magnitudes.

The cosine similarity value is a number between -1 and 1, where a value of 1 denotes total dissimilarity and a value of 1 indicates perfect similarity. The following formula can be used to determine the cosine similarity between two users, u and v:

Cosine (u, v) = (u • v) / (||u|| * ||v||)
In this case, user vectors' dot product is represented by u • v, and their Euclidean norms are indicated by the symbols ||u|| and ||v||.

Nearest Neighbours: For a target user, you can determine the k nearest neighbours after calculating the similarity 7 between users. These neighbours are other users who share the target user's tastes. You can change the parameter k's value according to the desired degree of resemblance. Select the top K users to be your neighbours by sorting the individuals based on similarity score.

Rating Prediction: Based on the ratings of the closest neighbours who have evaluated the item, you can estimate how the target user will rate it. The weighted average of the ratings from the closest neighbours—whose weights represent the similarities between the target user and the neighbours—is used to compute the anticipated rating. Here's the formula to get the expected rating:

predicted_rating=sum(similarity(target_user, neighbour_user)*neighbour_user_rating)/ sum(similarity(target_user, neighbour_user))
The similarity between the target user and a neighbour is represented by the expression similarity (target_user, neighbour_user), while the neighbour's assessment of the item is indicated by neighbour_rating.

Top-N Recommendations: Lastly, using the anticipated ratings as a guide, you can create a list of the target user's top-N suggestions. Sort the items based on the user's anticipated ratings, then suggest the top-N items to them.

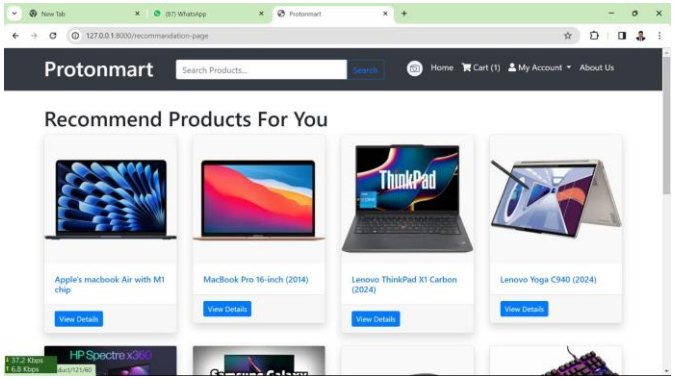

Figure 14. Recommendations

7. Conclusion and Future Scope

The development of an e-commerce website for electronic product recommendations using Django has been a comprehensive and enlightening project. This platform not only serves as a testament to the robust capabilities of Django as a web development framework but also highlights the importance of intuitive design and functionality in enhancing user experience. The research paper describes the developement of an electronics e-commerce website using Django, incorporating necessary functionalities like a product-displaying store page, a search bar, brand and category filters, a shopping cart, a safe payment gateway, and a recommendation system that suggests products based on user ratings.

The study highlights the potential for additional improvements and advancements in areas like user experience optimization, scalability for handling increased traffic and transactions, integration of advanced analytics such as customer sentiment analysis, dynamic pricing, for more accurate product recommendations, and adaptation to emerging technologies like customer churn analysis, chatbot, adding more filters for enhanced customer engagement and satisfaction. It also proves the viability and effectiveness of using Django for building robust e-commerce platforms.

Conflict of Interest
The authors of this review paper hereby declare that they have no known or potential conflicts of interest with any institutions, businesses, or people connected to the topic of this work. Regarding the subject matter of this review, we have not received any direct or indirect financial or non-financial support from any parties. Our evaluation of the available data and research, which is independent and impartial, serves as the exclusive foundation for our analysis and judgments.

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Authors' Contributions
Author-1 contributed in fronted design and development of machine learning algorithm. Author-2 contributed in designing Database and API development . Author-3 contributed in development of recommendation algorithms. Author-4 wrote Python Scripts for various modules and functions. Author-5 Supervised the research, provided overall guidance for the Project.

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