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DESIGN AND IMPLEMENTATION OF E-COMMERCE WEB APPLICATION USING MERN STACK AND DATA SCIENCE

Preeti Manchekar, Aakash Patil, Ashutosh Patil, Shruti Pawar
Student,
Pillai College of Engineering, New Panvel

Sulochana Madachane
Professor,
Pillai College of Engineering, New Panvel

Abstract: **Social media has been influencing e-commerce in multiple ways by being a platform of marketing for e-commerce businesses over the years. This project boosts the idea of social commerce by providing a platform for small businesses to grow and reach the world. At the same time it provides a platform for the internet community to explore various products. A web application where users can register themselves in two ways, as a seller or as a customer. Sellers can post their products and will get insights on how their business is growing in the e-market. A detailed analysis will be provided based on the orders, no. of visitors, likes, etc. On the other hand, the customers can view the products as well as the posts just like on any other social media platform. These users can follow other users and see the posts of other users as well as they can search for a particular product in two ways, text and visual. Results will contain the products and the posts. Also, recommendations will be shown to the user. Users can follow, like and buy products from sellers. Features such as personalized recommendation, product classification, post engagement help the small businesses to create a brand. Being a fusion of social media and e-commerce, this web app provides a single platform for small businesses and social influencers.**

Keywords: **e-commerce, recommender system, collaborative filtering, sales forecasting, ARIMA**

I. INTRODUCTION

Factors like pandemic, women empowerment, unemployment boosted the idea of having small businesses in different ways. This project boosts the idea of providing an e-commerce platform for small businesses to grow and reach the world. At the same time, it provides a platform for the internet community to explore various products. A web application where there are two types of users, a customer, and a seller. Sellers post products and customers can buy them. Customers can support their favorite small businesses in multiple ways. Customers will have the features like personalized recommendations, smooth browsing experience, easy search facility Where as sellers will get insights of their future sale based on the past sales history this feature helps seller for inventory management, to create strategy for profits.

This project is built over MERN stack to give it seamless experience that is provided to the customers and sellers to interact with the website effectively. Recommendation System based on collaborative filtering technique is built to provide accurate results. ARIMA is algorithm used to predict the sales of next few months. Python APIs are called to fetch data from database to provide the recommendation and sales result.

II. RELATED WORK

[1] This project is a web-based purchasing platform for an existing company. The project's objective is to port an Android shopping app to the market. Online shopping is the act of customers making real-time, direct purchases from merchants over the Internet without the assistance of a middleman. It's a particular form of electronic trade. This project attempts to make online shopping accessible to clients of physical stores. It enables customers to use an Android device and the internet to purchase goods from a shop from any location in the world. This will enable the customer to shop online and have his products delivered to his home from his favorite retailer. Recommender systems use a technique called collaborative filtering (CF). There are two definitions of collaborative filtering: a narrow definition and a broad definition. Collaborative filtering is a method for obtaining preferences or taste information from numerous customers in a newer, tighter sense in order to make programmed assumptions about a client's interests. In a larger sense, collaborative filtering refers to the process of searching for information or patterns using techniques that need cooperation between many different players, points of view, data sources, etc.

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[2] The recommendation system extracts from the mass of information resources that users may be interested in or require based on the interest characteristics of various users and makes recommendations. It is regarded as one of the most potent tools to address the information explosion because it is a BI platform built on massive data mining. In essence, the recommendation system analyses the user-selected resources to gauge the user's preferences for some products they have never used before and reports back to the user the products with the highest preferences among the anticipated results.
[3] Now days Recommendation system is playing a vital role in YouTube, Netflix, amazon prime, Instagram and Facebook etc., where the system recommends an item to the user based on the ratings or preferences given to an item, the system predicts the ratings or preferences given to an item and recommends an item to the user. This recommendation system helps by recommending the things that one likes when they search for something on the website. In this project, content-based filtering technique is used and the dataset is taken from TMDB movie dataset and streamlit for website development is used along with some python libraries such as pickle, sklearn, NumPy, pandas, requests, and AST. The main idea of this project is to build a model which helps the user in easy recommendation of movies by the system based on their behavior.
[4] The goals of this thesis were to clarify and understand the fundamental ideas and applications of each technology in the MERN stack, as well as their interoperability and benefits when used as a whole stack in the development of web applications. By utilizing these contemporary tools and putting a web application in place, the thesis was able to accomplish that objective. The author's parents' decision to launch a book retail store inspired the concept for this web application. By doing research, the author learned how e-commerce, a huge platform, has been growing at an extraordinary rate over the past few decades throughout the world and offering more benefits and conveniences than physical stores. E-commerce has fundamentally altered how companies and customers interact, enabling customers to connect with their preferred stores and brands whenever and wherever they choose. This also enables businesses to engage with customers more directly. With the advent of new technologies, it is predicted that e-commerce will grow at an unprecedented rate over the ensuing years. In response to this need, the author developed an online bookstore as an e-commerce web application to help the start-up establish its business plan.
[5] The core of e-commerce is now the recommender system (RS). Every e-commerce portal chooses to include RS as a crucial component of it in addition to the basic searching feature. More goods and services are made available for online purchase as the e-commerce market expands. By recommending products that they think the customer might like or want, online merchants have found a way to assist them in finding the right item. A recommendation scheme (RS) is the technical framework that enables the recommendation process. RS makes recommendations for the products it anticipates potential online customers will like. In contrast to search engines, which are used to find online goods, recommendation engines work to deliberately draw users' attention to the goods they might like. The main goal is to save users from tedious and explicit searching while also enhancing the online shopping experience. The sophistication of the algorithm used to recommend a product is a key factor in determining how successful an online business will be. Therefore, to remain competitive in the market in the era of digital marketing, it is essential for online stores to adopt intelligent recommendation techniques. RS is a key component of the business innovation and exploration of organizations like Flipkart, Amazon, eBay, Netflix, Movie Lens, IMDb, etc.
[6] The work presented in this article helps in modeling and forecasting food company demand using a time-series approach. Using historical demand information, we developed several autoregressive integrated moving average (ARIMA) models using the Box Jenkins time series method and selected a suitable model according to four performance criteria: Akaike criterion, Schwarz-Bayes criterion, maximum likelihood method, standard error. The selected model was ARIMA (1, 0.1). The results obtained demonstrate that this model can be used to model and predict future demand in this food production.

III. IMPLEMENTATION DETAILS

1.1 Recommendation System

In today's busy environment, recommendation systems are becoming more and more crucial. Individuals are constantly searching for goods and services that are best for them. As a result, the recommendation systems are crucial since they enable people to make the best decisions without using up their cognitive resources.

Three categories of recommendation systems can be used to classify them:

- Collaborative Filtering
- Content-Based Filtering
- Hybrid Recommendation System

Collaborative Filtering: This filtering technique typically relies on gathering and analyzing data regarding user behaviors, hobbies, or preferences in order to forecast what they will find appealing based on similarities with other users. Because collaborative filtering does not rely on content that can be automatically analyzed, it may accurately recommend complex objects like products without requiring an understanding of the item itself

Further, there are several types of collaborative filtering algorithms:

- User-User Collaborative Filtering: Strive to find clients who resemble them and present them with products based on their choices.

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- Item-Item Collaborative Filtering: It is pretty like the previous algorithm; except this time, we aim to find object lookalikes instead of customer lookalikes. We can quickly suggest similar things to a customer who has already purchased an item from the store once we have an item lookalike matrix.
- Other algorithms: There are further methods, such as market basket analysis, which looks for combinations of goods that regularly appear together in transactions.
- KNN Collaborative Filtering: Popular collaborative filtering technique used in recommendation systems is KNN Collaborative Filtering. A method called collaborative filtering uses historical user and item behavior to forecast how they will interact in the future. KNN Collaborative Filtering predicts a user's choice for an item based on the preferences of other comparable users using the k-nearest neighbor's algorithm.

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The initial step in the algorithm's operation is the creation of a user-item matrix, which represents each user's preferences for each system item.

Table 1. User Product Matrix

	Product1	Product2	Product3	Product4	Product5
U1		5	4	2	1
U2					
U3	1	4	4	5	3
U4	1		2	1	2
U5	1				
U6	1	3			

The ratings or scores that users have assigned to things can be represented as entries in this sparse matrix. A distance metric, such as cosine similarity or Euclidean distance, is then used to determine how similar two users are to one another. The developed model is given by equation (1)

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

The target user's k-nearest neighbors are then found using their similarity scores.

The algorithm uses a weighted average of the preferences of the k-nearest neighbors to predict the target user's preference for an item after identifying the closest neighbors. The weights are typically determined based on the neighbor's similarity scores, with closer neighbors having higher weights. The user is subsequently given a recommendation based on the expected choice.

KNN Collaborative filtering offers a number of benefits. Large and sparse datasets can be handled using this straightforward and efficient method. Also, it is simple to use and comprehend. It does, however, have significant drawbacks, such as the cold-start problem, which prevents the algorithm from making recommendations for brand-new customers or products with scant or no previous data. When there are a high number of users and items, it also has a scalability problem.

1.2 Sales Forecasting System

Sales forecasting also known as sales prediction is the complex process of finding future sales based on some data. It considers various factors such as past sales data, market trends, customer behavior, economic indicators, and competitive landscape. There are several methods that can be used for sales prediction, including time series analysis, regression analysis, machine learning algorithms, and deep learning models. One common approach is to use historical sales data to identify patterns and trends, and then use this information to make forecasts for future sales. Time series analysis techniques such as moving averages, exponential smoothing, and ARIMA (autoregressive integrated moving average) models are commonly used for this purpose.

Time Series Analysis: Time series analysis is a statistical method which is used to analyze and forecast data points that are collected over time. It involves analyzing and modeling time series data to identify patterns and trends that can be used to make predictions about future values. It involves some basic steps such as data collection, data cleaning, exploratory data analysis, time series modeling, model evaluation and forecasting.

ARIMA: ARIMA is a time series forecasting method that models the relationship between a time series and its past values, as well as the errors or residuals in its past values. ARIMA stands for Autoregressive Integrated Moving Average.

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ARIMA models have three main components:

- Auto regression (AR): This component models the relationship between a time series and its past values. It assumes that the value of a time series at any given point in time is dependent on its past values.
- Integration (I): This component models the non-stationarity of a time series. It assumes that a time series can be made stationary by taking the difference between consecutive values.
- Moving Average (MA): This component models the errors or residuals in a time series. It assumes that the errors in a time series are dependent on the errors in its past values.

ARIMA Parameters: There are three parameters in ARIMA with a standard notation. For ARIMA models, a standard notation would be ARIMA with p, d, and q, where integer values substitute for the parameters to indicate the type of ARIMA model used.

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The parameters can be defined as:

- p: It is the lag order i.e. the number of lag observations in the model
- d: the number of times the raw observations change; also known as the degree of differencing
- q: the moving average window's size, also known as the order of the moving average.

model = ARIMA (sales data, order= (3, 1, 0))
model fit = model.fit()

The sales prediction for next 12 months is done based on the historic data of previous years which contains two attributes, date and sales in that particular month i.e. number of products sold in that month. Using the ARIMA model in python, data is first visualized and then model is fitted on the data and finally the forecast for next 12 months is predicted.

IV. RESULT AND DISCUSSION

Python API for Recommendation System: The python flask-based API sends request to database of web application fetch the data from database it then applies collaborative filtering algorithm to create an output of recommended products which is sent as response to web application.

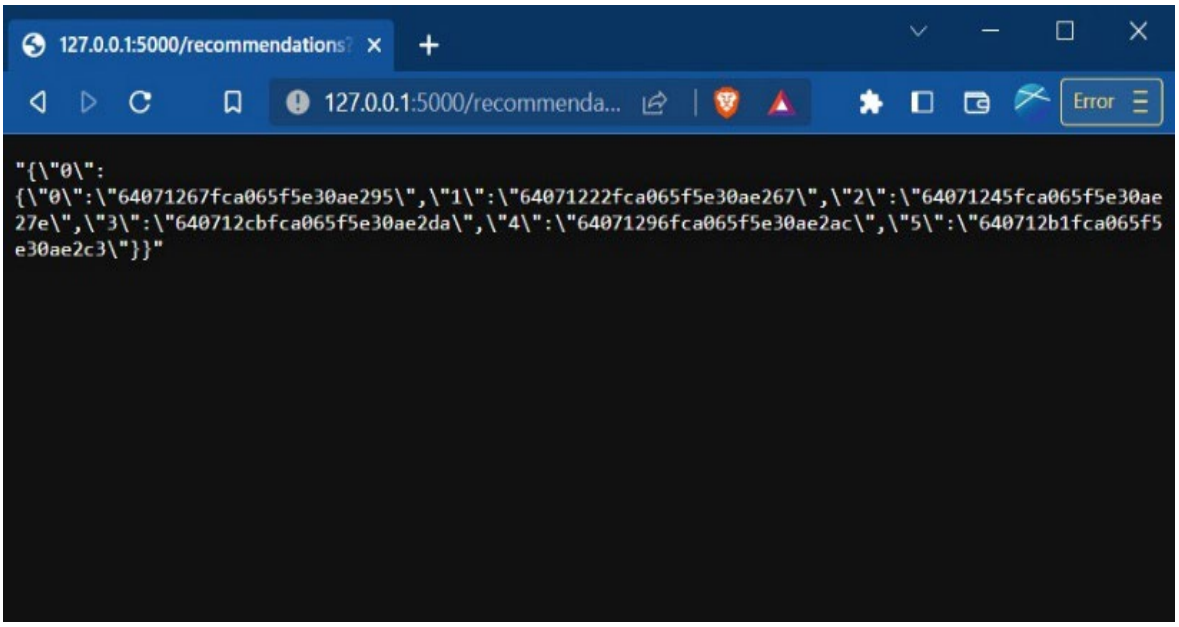

Fig. 1. Recommended System API

Recommendation Page: It displays the personalized recommended products to the users based on customer interactions on websites such as product review and rating, search engine queries, purchase histories, production data as parameters.

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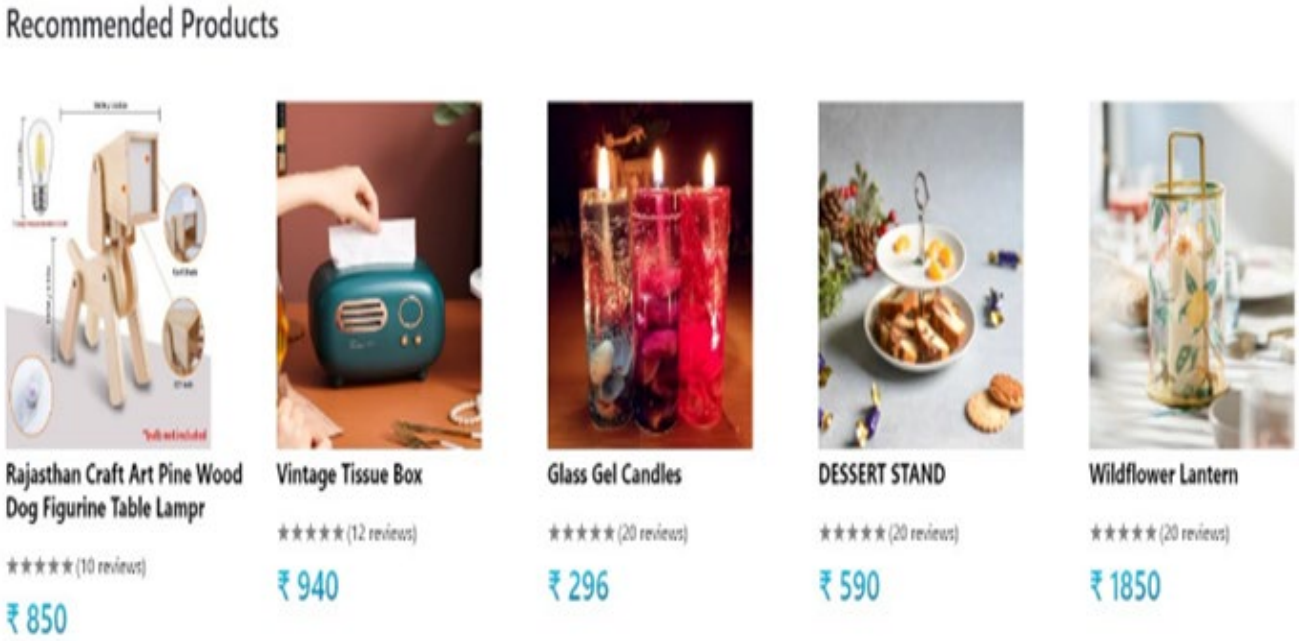

Fig. 2. Product Recommendation System

Sales forecasting output: The following output shows the real and estimated sales given by ARIMA model of a particular product of seller this helps seller to get insights on future sale, manage inventory and strategies plan for future.

```
forecast = model_fit.forecast(steps=12)
forecast
```

```
2023-01-01    205.851360
2023-02-01    202.674998
2023-03-01    203.932834
2023-04-01    204.973124
2023-05-01    204.590497
2023-06-01    204.250604
2023-07-01    204.366532
2023-08-01    204.477416
2023-09-01    204.442441
2023-10-01    204.406321
2023-11-01    204.416822
2023-12-01    204.428571
Freq: MS, Name: predicted_mean, dtype: float64
```

Fig. 3. Sales Forecast Output

Sales Forecasting Page: This page displays the future predicted sales based on past sales data. It displays a graph that gives important insights to the seller about the performance of a product in future.

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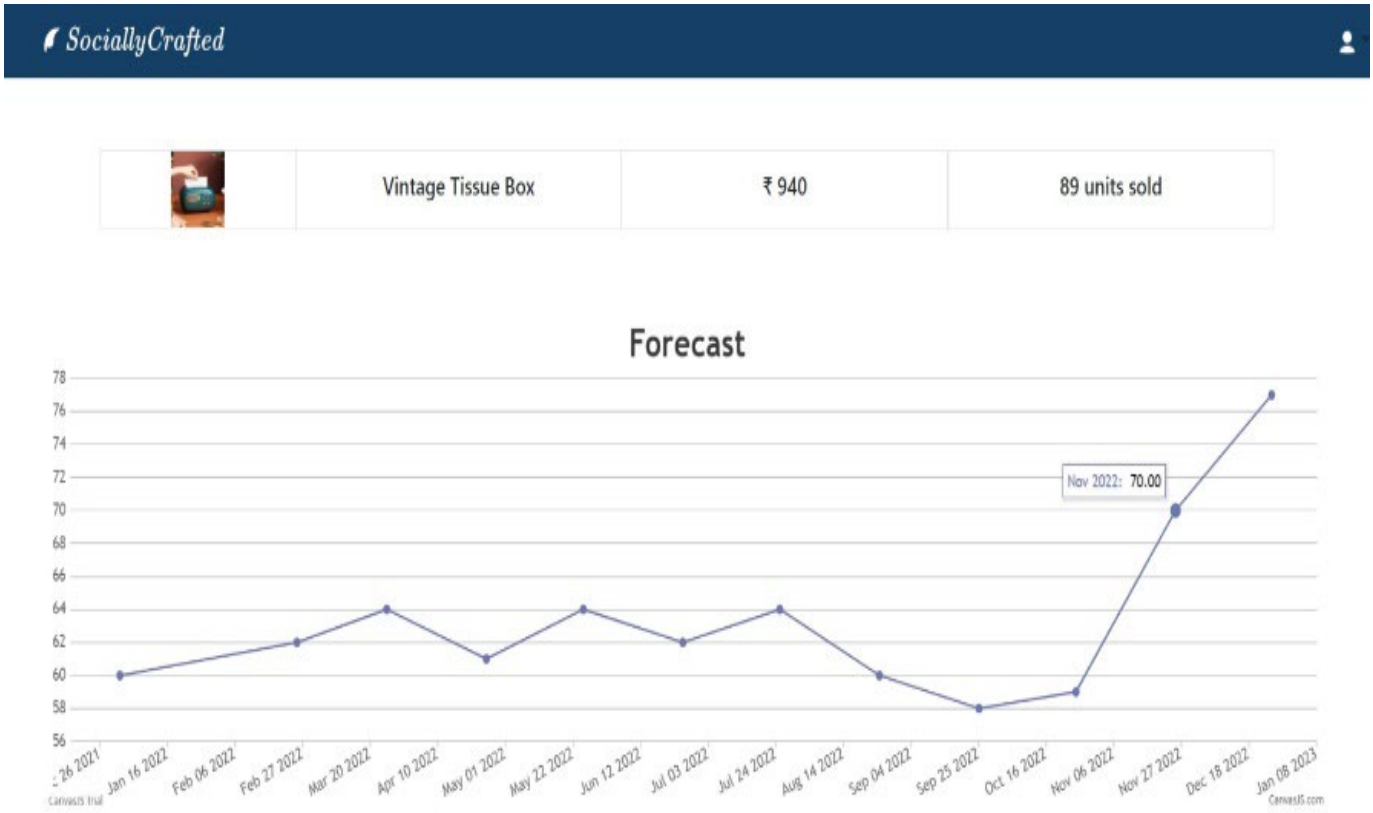

Fig. 4. Sales Forecasting Page

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VI. CONCLUSION

The project provides small businesses to grow and establish their own brand. It provides functionalities such as signup page, product display page, cart, checkout page, seller profile page to customers. The project is built over the MERN stack. It provides personalized recommendations to customers based on customer interactions such as product review and rating, search engine queries, purchase histories, production data as parameters. Various recommendation system techniques like Collaborative filtering, Content based filtering, Hybrid recommendation were compared to get the best fit algorithm for the project. Recommendation System based on collaborative filtering technique is built to provide accurate product recommendation. The additional feature of sales forecasting is added to project to show sellers the overview of their sales it is built using ARIMA model.

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