#### **Product Recommendation System**

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### **1. Introduction**

This project focuses on building a Product Recommendation System using collaborative filtering and data preprocessing techniques. The system aims to enhance customer experience by suggesting personalized product recommendations based on purchase history and user behavior.

### **2. Dataset Description**

#### **Source**

* The dataset consists of synthetic data containing information on customer purchases and interactions.

#### **Key Attributes**

* **customer\_id**: Unique identifier for each customer.
* **product\_id**: Unique identifier for each product.
* **rating**: Rating given by customers to products.
* **timestamp**: Time of the interaction.

### **3. Exploratory Data Analysis (EDA)**

* **Summary Statistics**:  
  + Dataset shape: Verified the number of rows and columns.
  + Checked for missing values and ensured data completeness.
  + Unique customers and products were identified.
* **Visualizations**:  
  + Frequency distribution of ratings.
  + Top-rated products and their counts.

### **4. Methodology**

#### **Data Preprocessing**

1. Handled missing values by removing incomplete rows.
2. Encoded categorical variables such as customer\_id and product\_id using Label Encoding.
3. Standardized the dataset to ensure compatibility with machine learning algorithms.

#### **Recommendation Algorithm**

* **Collaborative Filtering**:
  + Implemented user-based and item-based filtering methods using the Surprise library.
  + Evaluated the recommendation system by splitting the data into training and testing sets.

#### **Dimensionality Reduction**

* Applied Truncated Singular Value Decomposition (SVD) to reduce the dimensionality of the user-item interaction matrix.

### **5. Modeling and Evaluation**

#### **Model**

* Utilized a matrix factorization approach to predict user-product ratings.

#### **Evaluation Metrics**

* **Precision and Recall**:
  + Calculated precision and recall scores to evaluate the relevance of recommendations.
* **Precision-Recall Curve**:
  + Visualized precision and recall trade-offs for better insights.

### **6. Visualization**

#### **Top N Recommendations**

* Created visualizations to highlight the top recommended products for individual customers.
* Analyzed product popularity based on the number of recommendations.

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### **7. Conclusion**

This project demonstrates the development of a robust Product Recommendation System using collaborative filtering and dimensionality reduction techniques. The following outcomes were achieved:

1. **Personalized Recommendations**: Customers receive tailored suggestions based on their purchase history and preferences.
2. **Scalability**: The use of dimensionality reduction ensures the system performs efficiently on large datasets.

#### **Recommendations**

* Deploy the recommendation model into a production environment to provide real-time product suggestions.
* Integrate with a feedback mechanism to continuously refine recommendations based on user interactions.