A

Project Report

On

Weather based Product Recommender System

Submitted by

Ms. Vaibhavi Gaikwad (GL)

Ms. Laharika Gudur

Ms. Shravani Dudhyal

Under the guidance of

Dr. R.R. Mergu

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR

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CERTIFICATE

This is to certify that Major Project entitled

Weather based Product Recommender System(WPR)

Submitted by

Name	Roll no.	Exam Seat No.
Vaibhavi Gaikwad	07	2104111154
Laharika Gudur	08	2104111160
Shravani Dudhyal	09	2204112010

has been approved as the partial fulfilment for the award of Final year of Electronics and Telecommunication Engineering in **Walchand Institute of Technology**, Solapur affiliated to PAH Solapur University, Solapur in the academic year 2024-25.

Dr. R. R. Mergu
Project Guide

Dr. A. V. Thalange
Head, E&TC Department

Dr. V.A. Athavale
Principal

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR, 2024-2025

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The project has certainly enlightened us with the modern era of Technologies and it has boosted our confidence. The project work has certainly rendered us tremendous learning as well as practical experience.

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ABSTRACT

The Weather-Based Recommender System is designed to analyze and forecast sales patterns across various product categories, including electronics, fashion, office technologies, and furniture, with respect to seasonal variations. This project leverages historical sales data to understand how different weather conditions influence purchasing behavior and uses these insights to recommend optimal product offerings for each season. The system consists of two primary components: a recommender engine and an interactive dashboard.

The recommender engine uses data-driven insights to suggest relevant products for each season, helping businesses better align their inventory and marketing strategies with consumer needs. Complementing the recommender system, the interactive dashboard provides a detailed view of seasonal sales trends, broken down by product category and region, with options to filter by specific seasons and product types.

Visualizations include a heatmap displaying region-wise product demand, a line graph showing sales trends across various products, and a bar chart representing seasonal sales distribution. Together, these tools enable users to make data-informed decisions, ultimately enhancing customer satisfaction and boosting sales during peak seasons. This project highlights the importance of seasonal factors in sales forecasting and aims to provide businesses with a competitive advantage by aligning product offerings with seasonal demand.

CHAPTER 1: INTRODUCTION

1.1 Introduction

In today's dynamic retail landscape, understanding customer behavior and preferences is crucial for enhancing sales and improving customer satisfaction. One key factor that significantly influences purchasing behavior is seasonal variation, as weather conditions often affect consumer demand for specific products. For example, demand for winter clothing spikes during colder months, while electronic gadgets may see consistent demand year-round. Recognizing these seasonal shifts allows businesses to tailor their product offerings, optimize inventory, and create more targeted marketing strategies.

This project introduces a Weather-Based Recommender System that combines historical sales data with weather information to predict and recommend products based on seasonal trends. The system is built on two core components: a recommender engine that analyzes past data to suggest products for each season and an interactive dashboard that visually presents sales trends across different categories and seasons.

The dashboard is designed to provide an intuitive interface for exploring sales patterns across diverse categories, including electronics, fashion, office technologies, and furniture. Through visual elements such as maps, heatmaps, and bar charts, users can filter and examine sales data by season, region, and product category. These insights offer businesses valuable information to make data-driven decisions that align product inventory with customer demand across various weather conditions.

1.2 Purpose of the Project

- The purpose of this Weather-Based Recommender System project is to analyze seasonal demand patterns across various product categories, such as electronics, fashion, office technologies, and furniture, in order to better understand consumer purchasing behavior.
- By integrating a recommender system, the project aims to suggest seasonally relevant products, allowing businesses to align their inventory with anticipated demand and enhance product availability throughout the year.
- This system supports more accurate sales forecasting by leveraging historical sales and weather data to predict seasonal sales patterns and helps businesses optimize inventory management, reducing overstock and understock risks.

1.3 Scope of the Project

The scope of this Weather-Based Recommender System project encompasses the analysis and recommendation of products based on seasonal variations and their impact on consumer demand across various categories. The project scope includes the following key components:

- Data Collection and Integration: Gathering historical sales data across different product categories (electronics, fashion, office technologies, furniture) and merging it with weather data to analyze seasonal demand trends.
- Recommender System Development: Creating a recommendation model that uses past sales and weather data to suggest products that are most likely to perform well in each season.
- Dashboard Visualization: Developing an interactive Tableau dashboard to provide a comprehensive view of sales trends, with various visualizations like maps, heatmaps, and bar charts to display seasonal, regional, and category-specific data.

CHAPTER 2: LITERATURE SURVEY

Recommender systems are widely used in e-commerce to improve user experience and increase sales by suggesting products that align with user preferences. Ricci et al. (2015) emphasize that recommender systems are built on techniques like collaborative filtering, content-based filtering, and hybrid models, which combine user preferences and historical interactions. Recently, researchers have explored incorporating external contextual factors, such as seasonality, location, and weather, into recommendation models to provide more relevant suggestions (Bobadilla et al., 2013). This project builds on these advancements by integrating seasonal and weather data, thus enhancing recommendation relevance.

Seasonality is crucial in forecasting demand for products, especially in retail, where consumer demand fluctuates based on time of year. According to Hyndman and Athanasopoulos (2018), models such as ARIMA, exponential smoothing, and machine learning techniques capture seasonality patterns, making them ideal for demand forecasting in retail. Understanding seasonal trends allows businesses to manage inventory efficiently and reduce costs associated with overstock or stockouts (Chatfield, 2000). This project utilizes seasonal forecasting to predict demand for different products, helping optimize inventory and marketing strategies.

Weather is known to impact consumer purchasing behavior significantly. Research by Murray et al. (2010) highlights that weather conditions affect the demand for specific products, such as apparel and beverages, and can lead to fluctuations in sales. More recent studies by Demir et al. (2018) suggest that combining weather and sales data improves predictive accuracy for retail demand. In this project, weather data is integrated with sales data to create a model that offers contextually relevant recommendations.

Data visualization plays a vital role in retail analytics by helping decision-makers quickly interpret complex data. Cawthon and Moere (2007) argue that clear and intuitive visualizations enhance user understanding and improve decision-making processes. Additionally, Few (2006) highlights that dashboards should be user-friendly to enable stakeholders to interact with data effectively. In this project, an interactive Tableau dashboard visualizes seasonal sales patterns across product categories and regions, allowing users to filter and explore data according to specific needs.

Integrating multiple data sources, such as weather and sales data, enriches recommendation models by providing a broader perspective on factors influencing demand. Zhang et al. (2017) discuss the benefits of combining external data sources, like economic and environmental factors, to create robust recommendation systems. For this project, merging weather data with sales data adds depth to the recommender system, allowing for more accurate and context-sensitive suggestions aligned with seasonal demand.

CHAPTER 3: SYSTEM DESCRIPTION

Below is the flowchart outlining the key stages involved in the project :

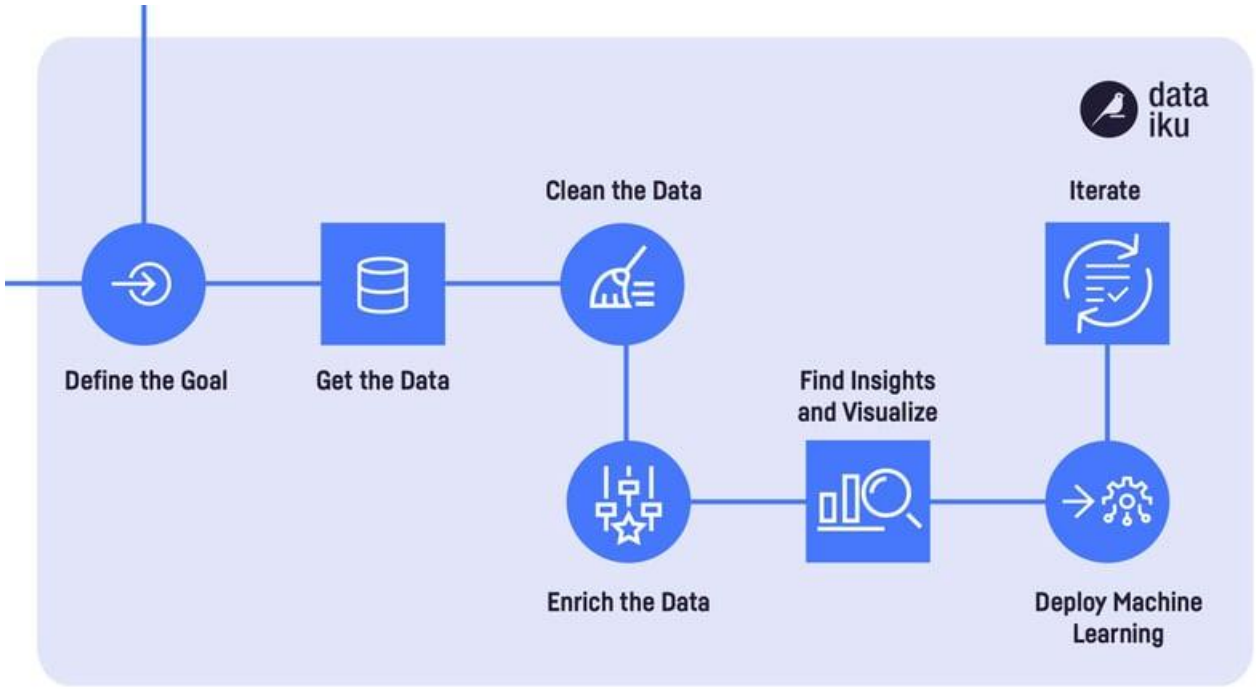


Figure 3.1: Weather based Product Recommender System Flowchart

3.1. Brief Approach

Gather historical sales data across categories (electronics, fashion, furniture, office supplies) along with weather data (temperature, humidity, seasonal information) for various locations and time periods. Clean and prepare the data by removing inconsistencies, handling missing values, and merging sales data with corresponding weather data to enable context-based analysis. Extract relevant features like product category, season, weather conditions, and location. Create new features that highlight seasonal demand patterns, such as popular products during rainy or summer seasons. Use a machine learning approach, such as collaborative filtering or a hybrid model, to build the recommender system. Train the model to recognize patterns in sales and predict relevant products based on season and weather data.

3.2. Dataset

For this project, four distinct datasets—Electronics, Fashion, Furniture, and Office Supplies & Technology—were collected to analyze sales trends across different product categories. Each dataset contains historical sales data with the following common attributes:

- Product Name: Identifies the specific product sold.
- Purchase Date: Represents the date on which each transaction occurred, essential for identifying seasonal trends.
- Location: Indicates the geographic region where the sale took place, allowing for regional trend analysis.
- Sales: Reflects the quantity sold or the revenue generated, crucial for assessing product demand.

These shared columns made it possible to integrate all four datasets into a single, unified dataset, enabling holistic analysis across product categories.

To prepare the data for seasonal analysis, additional columns were created through feature engineering:

- Season Column: Based on the Purchase Date, each transaction was assigned a season (e.g., summer, winter, or rainy). This categorization allows for a focused analysis of how sales vary across different seasons, contributing to the recommendation model's ability to suggest season-appropriate products.
- Category Column: A new column, Category, was introduced to differentiate products from the various datasets. For example, products from the electronics dataset were labeled as "Electronics," while those from the fashion dataset were labeled as "Fashion." This categorization facilitates data segmentation, making it easier to analyze sales by product category.

After these preprocessing steps, the datasets were merged based on common attributes, resulting in a comprehensive dataset that includes details across all product categories, enriched with seasonal and categorical information. This unified dataset serves as the foundation for model training and visualization, allowing for effective analysis of

seasonal demand patterns and enabling the recommendation engine to provide personalized product suggestions based on seasonal trends and weather conditions.

3.3. Feature extraction

In the Weather-Based Recommender System, feature extraction was a crucial step to transform raw data into meaningful inputs that enhance the model's ability to recommend products effectively. The main goal of feature extraction in this project was to derive attributes that could provide insights into seasonal trends and demand patterns across different product categories. The following features were extracted and engineered from the original datasets:

1. Seasonal Feature Extraction

Season Column: Based on the Purchase Date, a new feature called Season was created. The Purchase Date was analyzed to classify each transaction into one of the four primary seasons: summer, winter, rainy. This seasonal categorization provides a time-based context, allowing the recommendation model to make predictions based on seasonal demand patterns. For example, winter-related products like coats or jackets may see higher demand in the winter season.

2. Category Identification

Category Column: A Category column was added to each dataset, identifying the product's category, such as Electronics, Fashion, Furniture, or Office Supplies & Technology. This feature was essential to differentiate products when the datasets were merged, enabling the recommendation model to consider the type of product when generating recommendations. For instance, office supplies may be recommended during specific times, like back-to-school seasons, while electronics may show higher sales during holiday seasons.

3. Time-Based Sales Trends

Month and Year Columns: To gain further insight into sales trends, the Purchase Date was decomposed into Month and Year columns. The Month feature provides a finer temporal granularity for identifying monthly trends, which may reveal patterns such as increased sales during certain months (e.g., December holiday season).

3.4 Model Architecture

The Weather-Based Recommender System is designed to suggest top products based on seasonal demand and product category. The system architecture follows a structured approach to filter, group, and rank products according to their sales, providing users with relevant product recommendations. The following key components define the architecture:

1. Data Filtering by Season and Category: The system first filters the dataset based on the specified season and category. This enables the model to focus on a targeted subset of data relevant to the user's input, narrowing down the product recommendations to those most likely in demand for the selected season (e.g., Winter, Summer, or Rainy) and category (e.g., Electronics, Fashion, Furniture, Office Supplies & Technology). If no data is available for a particular season and category combination, an error message is returned, indicating that there are no matching records.

2. Sales Aggregation for Products: After filtering by season and category, the model groups the data by Product Name and aggregates the total sales for each product. This aggregation step is essential to understand each product's popularity within the filtered subset of data. By summing up the sales, the system identifies which products are best-selling within the specified season and category.

3. User Input and Interactive Recommendations: The system architecture includes a user input interface, where users specify the season and category they are interested in. Based on the input, the recommendation system dynamically generates the top 5 products for the specified season and category. This interactive component enhances user engagement, allowing users to explore popular products across various seasons.

CHAPTER 4: IMPLEMENTATION DETAILS

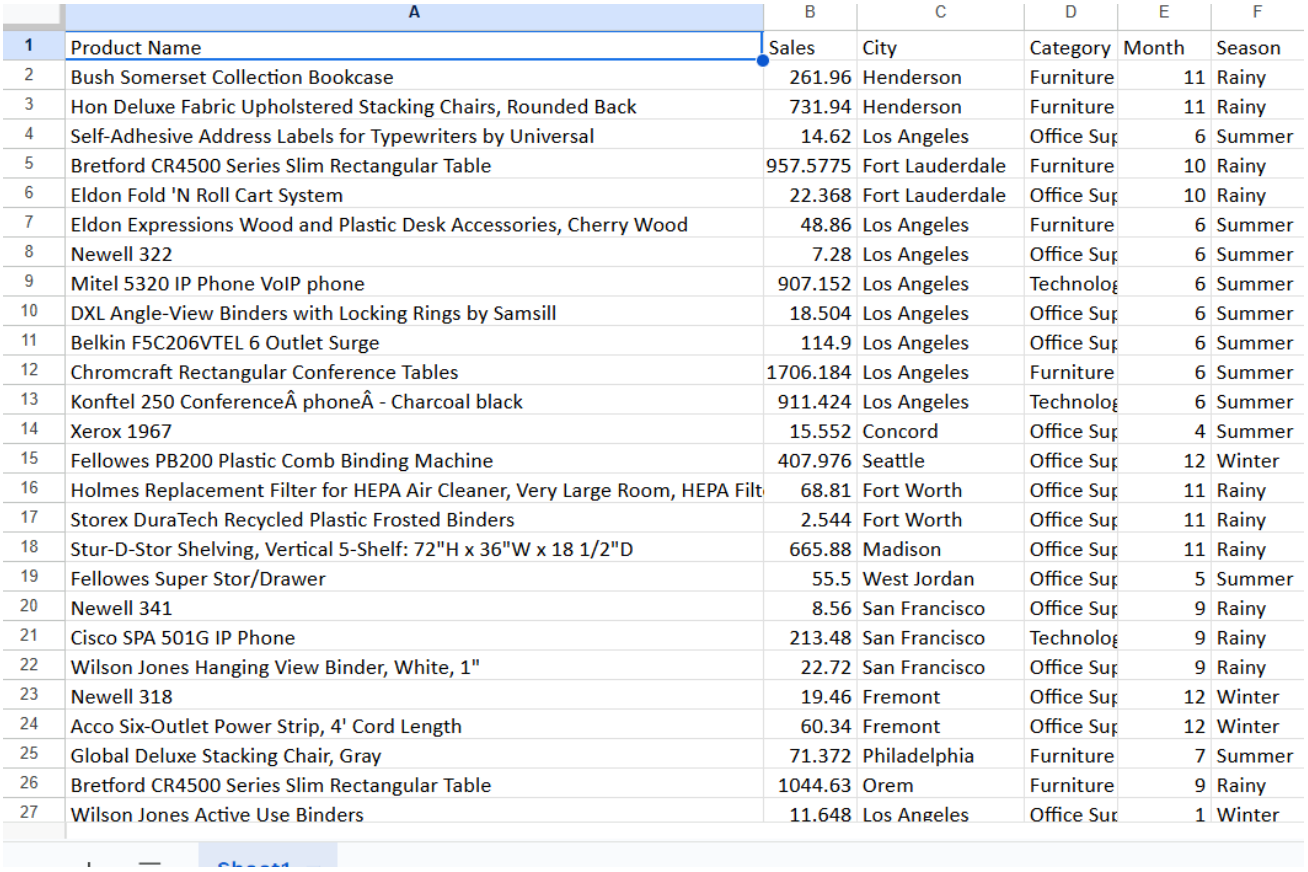
The Implementation Details section provides an in-depth explanation of how the weather-based recommender system was developed. This section covers the data processing techniques, integration of datasets, recommendation algorithm, and the use of visualization tools like Tableau to present findings effectively. Here's a breakdown of each step in the implementation process:

1. Data Collection and Integration:

To create a comprehensive recommendation system, four datasets were utilized, each covering different product categories: electronics, fashion, office supplies, and furniture. Each dataset contained essential information, including product names, purchase dates, sales, and locations. After loading each dataset, similar columns across the datasets (such as "Product Name," "Purchase Date," "Location," and "Sales") were identified, which enabled easy integration. Additional columns were created for "Season," based on purchase dates, and "Category," to distinguish among the types of products. Once the columns were harmonized, the datasets were merged into a single, unified dataset, forming the basis for further analysis.

2. Data Preprocessing and Feature Extraction:

Preprocessing involved handling missing values, normalizing sales data, and extracting seasonal features. Based on the "Purchase Date," a "Season" feature was derived, categorizing each sale as "Winter," "Summer," or "Rainy." This seasonal classification facilitated recommendations specific to different times of the year, enhancing the relevance of the recommended products.



	A	B	C	D	E	F
1	Product Name	Sales	City	Category	Month	Season
2	Bush Somerset Collection Bookcase	261.96	Henderson	Furniture	11	Rainy
3	Hon Deluxe Fabric Upholstered Stacking Chairs, Rounded Back	731.94	Henderson	Furniture	11	Rainy
4	Self-Adhesive Address Labels for Typewriters by Universal	14.62	Los Angeles	Office Sup	6	Summer
5	Bretford CR4500 Series Slim Rectangular Table	957.5775	Fort Lauderdale	Furniture	10	Rainy
6	Eldon Fold 'N Roll Cart System	22.368	Fort Lauderdale	Office Sup	10	Rainy
7	Eldon Expressions Wood and Plastic Desk Accessories, Cherry Wood	48.86	Los Angeles	Furniture	6	Summer
8	Newell 322	7.28	Los Angeles	Office Sup	6	Summer
9	Mitel 5320 IP Phone VoIP phone	907.152	Los Angeles	Technolog	6	Summer
10	DXL Angle-View Binders with Locking Rings by Samsill	18.504	Los Angeles	Office Sup	6	Summer
11	Belkin F5C206VTEL 6 Outlet Surge	114.9	Los Angeles	Office Sup	6	Summer
12	Chromcraft Rectangular Conference Tables	1706.184	Los Angeles	Furniture	6	Summer
13	Konftel 250 ConferenceÂ phoneÂ - Charcoal black	911.424	Los Angeles	Technolog	6	Summer
14	Xerox 1967	15.552	Concord	Office Sup	4	Summer
15	Fellowes PB200 Plastic Comb Binding Machine	407.976	Seattle	Office Sup	12	Winter
16	Holmes Replacement Filter for HEPA Air Cleaner, Very Large Room, HEPA Filt	68.81	Fort Worth	Office Sup	11	Rainy
17	Storex DuraTech Recycled Plastic Frosted Binders	2.544	Fort Worth	Office Sup	11	Rainy
18	Stur-D-Stor Shelving, Vertical 5-Shelf: 72"H x 36"W x 18 1/2"D	665.88	Madison	Office Sup	11	Rainy
19	Fellowes Super Stor/Drawer	55.5	West Jordan	Office Sup	5	Summer
20	Newell 341	8.56	San Francisco	Office Sup	9	Rainy
21	Cisco SPA 501G IP Phone	213.48	San Francisco	Technolog	9	Rainy
22	Wilson Jones Hanging View Binder, White, 1"	22.72	San Francisco	Office Sup	9	Rainy
23	Newell 318	19.46	Fremont	Office Sup	12	Winter
24	Acco Six-Outlet Power Strip, 4' Cord Length	60.34	Fremont	Office Sup	12	Winter
25	Global Deluxe Stacking Chair, Gray	71.372	Philadelphia	Furniture	7	Summer
26	Bretford CR4500 Series Slim Rectangular Table	1044.63	Orem	Furniture	9	Rainy
27	Wilson Jones Active Use Binders	11.648	Los Angeles	Office Sup	1	Winter

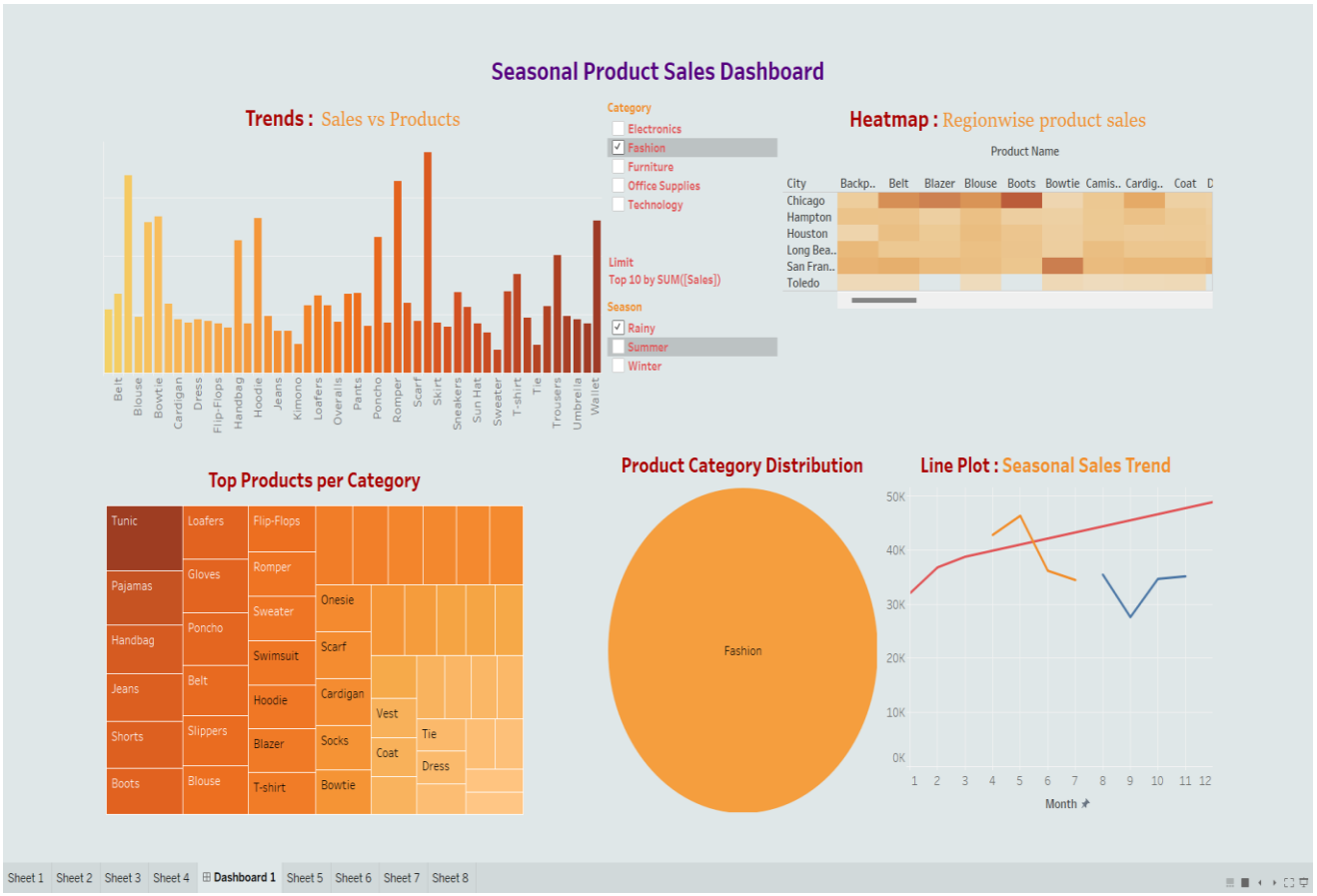
3. Recommendation Algorithm:

A custom recommendation function was developed to suggest top products based on season and category. This function filters the dataset for a selected season and category, groups data by "Product Name," and calculates total sales. Products are then ranked by their sales figures in descending order, allowing the system to return the top N items for any given category and season. This structure ensures that the recommendations are driven by historical sales data, aligning with customer purchase patterns for each season.

4. Visualization in Tableau:

Tableau was used to design an interactive dashboard, enabling end-users to explore sales trends across seasons and categories visually.

CHAPTER 5: RESULT



CHAPTER 6: ADVANTAGES AND DISADVANTAGES

6.1. Advantages

1. Seasonal Recommendations: By recommending products based on the current season and weather conditions, the system can help increase sales by suggesting relevant items to customers.

2. Targeted Marketing: The system can be used to target specific customer segments with personalized recommendations, increasing the effectiveness of marketing campaigns.

3. Personalized Recommendations: By tailoring product recommendations to individual customer preferences and weather conditions, the system can provide a more personalized and relevant shopping experience.

4. Actionable Insights: The dashboard provides valuable insights into sales trends, regional variations, and customer preferences, enabling businesses to make data-driven decisions to improve their operations.

5. Competitive Advantage: By leveraging data and technology, businesses can gain a competitive advantage by offering more relevant and personalized products and services.

6. Demand Forecasting: By analyzing historical sales data and weather patterns, the system can help predict future demand for different products, enabling businesses to optimize their inventory levels and reduce stockouts or overstock.

7. Reduced Costs: Efficient inventory management can lead to significant cost savings, such as reduced storage costs and lower write-offs.

6.2. Disadvantages

1. Weather Data Reliability: The accuracy of the system's recommendations depends heavily on the quality and accuracy of the weather data used. Inaccurate weather forecasts can lead to suboptimal recommendations.

2. Data Privacy Concerns: Collecting and analyzing customer data, including location and purchase history, raises privacy concerns. It is crucial to implement robust data privacy measures to protect customer information.

3. Technical Complexity: Developing and maintaining a complex recommender system requires significant technical expertise and resources.

4. Integration Challenges: Integrating the system with existing e-commerce platforms and weather data sources can be challenging, requiring careful planning and execution.

CHAPTER 7: APPLICATION

1. E-commerce:

- Personalized Product Recommendations: Recommend products based on the current weather conditions and customer preferences.
- Seasonal Promotions: Create targeted promotions for specific products based on seasonal trends and weather patterns.
- Inventory Management: Optimize inventory levels by predicting demand based on weather forecasts and historical sales data.

2. Retail:

- In-Store Recommendations: Use in-store displays and digital signage to recommend products based on the current weather.
- Seasonal Merchandising: Adjust store layouts and product displays to align with seasonal trends and weather patterns.
- Demand Forecasting: Predict demand for specific products based on weather forecasts, helping retailers optimize their stock levels.

3. Travel and Tourism:

- Destination Recommendations: Recommend destinations based on the traveler's preferences, budget, and current weather conditions.
- Packing Recommendations: Provide personalized packing recommendations based on the destination's weather forecast.
- Activity Recommendations: Suggest outdoor activities based on the local weather conditions and the traveler's interests.

CHAPTER 8: CONCLUSION AND FUTURE SCOPE

5.1 Conclusions

The Conclusion of this project highlights the successful development of a weather-based recommender system that provides valuable insights into product sales across various categories, tailored by season. By integrating and analyzing data from multiple datasets covering electronics, fashion, office supplies, and furniture, the system enables businesses to make informed decisions based on seasonal trends and customer preferences. This project demonstrated the effectiveness of data preprocessing, feature extraction, and season-based categorization in enhancing recommendation accuracy. With the interactive Tableau dashboard, users can visualize trends, explore sales patterns, and filter data by season and category, making the tool both user-friendly and insightful.

5.2 Future Scope

The future scope of a weather-based recommender system is vast and holds significant potential for innovation and growth. Here are some key areas for future development:
Combine multiple recommendation techniques, such as collaborative filtering, content-based filtering, and knowledge-based systems, to improve accuracy and personalization. Consider additional contextual factors beyond weather, such as user location, time of day, and social interactions, to provide more relevant recommendations. Utilize real-time weather updates and user behavior data to deliver dynamic and timely recommendations. Integrate the system with smart home devices to automate tasks based on weather conditions, such as adjusting thermostat settings or activating security systems. Develop algorithms that are fair and unbiased, avoiding discriminatory recommendations based on factors like race, gender, or socioeconomic status.

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