

Review Article

Behavioral Segmentation of Black Friday Consumers

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ABSTRACT

This study explores Black Friday sales by looking at customer behaviour, store dynamics, and sales patterns, with a focus on how these factors affect international retail events both offline and online. The study reveals customer preferences impacted by marketing tactics, product availability, and discounts using statistical analysis, predictive modelling, and historical sales data. By utilising insights into consumer behaviour during high-demand times like Black Friday, the findings seek to help businesses improve marketing strategies, improve customer experiences, and increase revenue. In the end, they provide useful ideas for optimising sales performance.

Keywords: Customer Behaviour, Black Friday Sale, Shopping

Introduction

In order to improve consumer behaviour, use technology for smooth shopping experiences, and implement data-driven tactics to increase customer happiness and revenue, the study focuses on examining many facets of the Black Friday sales event. Retailers throughout the world take advantage of Black Friday by luring customers with alluring prices, time-limited offers, and tailored recommendations.¹ During this crucial time, it is difficult to forecast sales trends, comprehend customer preferences, and improve marketing tactics. Large volumes of Black Friday data, including purchase histories, online reviews, and social media interactions, are analysed using cutting-edge technologies like machine learning (ML) and natural language processing (NLP). Creating a data-driven framework to predict and examine customer purchasing

trends during Black Friday deals is the main goal. The study attempts to derive useful insights from both structured and unstructured data sources by combining machine learning algorithms with natural language processing methods. The importance of sentiment analysis, text mining, and predictive analytics in the retail industry is highlighted by their critical roles in understanding consumer sentiments and preferences. The study aims to accomplish two primary objectives: it uses trained machine learning models to improve the accuracy of sales projections, and it uses natural language processing of textual data from social platforms to detect trends and sentiment shifts. In order to boost Black Friday sales, consumer segmentation and personalisation are investigated, enabling companies to develop customised pricing and marketing plans based on consumer preferences. Businesses may increase customer satisfaction and boost sales during important shopping

events by highlighting the significance of a smooth cross-platform experience for customers who buy both online and in-person.

Black Friday Sale Prediction using Supervised Machine Learning

The section explains how machine learning has developed into an important area of study that enables computers to learn and make better decisions. The following are the main points:²

- Machine learning models increase the intelligence of business decisions by using past experiences to accurately predict future results.
- Recent developments in machine learning have a wide range of applications, including natural language processing and facial recognition, which improve forecasting abilities.
- To help with decision-making, businesses use prediction models to project anticipated outcomes based on available data.
- The part focuses on building a prediction model to improve sales management specifically for Black Friday, testing it using multiple categorisation techniques.
- The goal is to forecast customers' future purchasing behaviour about various products utilising demographic and feature data.
- The authors highlight the usefulness of machine learning in sales forecasting by using a Random Forest regression technique to estimate Black Friday sales.

Machine Learning Application for Black Friday Sales Prediction Framework

- Black Friday Sales Prediction Framework Using Machine Learning. The use of machine learning techniques to forecast Black Friday sales trends is covered in this section. The main points are as follows
- Research Goal: The study focuses on leveraging machine learning to improve the predictive power of software programs without the need for explicit programming.
- Fundamental Idea of Machine Learning: o Machine learning entails building models and applying algorithms to evaluate data, forecast results, and gradually increase accuracy with fresh data inputs.
- Adaptability of Machine Learning Models: These predictive models can be customised for different scenarios and adjusted to meet specific monitoring requirements for ensuring accuracy.

The section highlights a study on the future of cyber security that was carried out at a National Conference on Robotics & AI in March 2025. This is a summary: In order to forecast sales of various products and comprehend the factors influencing product revenue, the research analyses Huge Mart, a comprehensive shopping centre.

A predictive model and several Big Mart dataset components are used to produce extremely accurate results. Decisions intended to increase revenue can be influenced by these findings. The study presented at the conference focuses on using advanced analytics to maximise revenue generation and sales projections, especially in retail settings like Huge Mart and Big Mart.

A Big Data Approach to Black Friday Sales

The report emphasises how crucial it is for retailers to comprehend sales trends and customer behaviour pertaining to various product categories by utilising big data for Black Friday sales analysis and forecasting. The strategy seeks to assist retail businesses in improving their marketing and sales tactics, particularly in light of obstacles like the COVID-19 pandemic.³

Key Points:

- The study makes use of a big data platform to effectively analyse massive sales statistics, allowing businesses to customize offers and deals for consumers even in the midst of the pandemic.
- Black Friday sales were examined using data from a Kaggle dataset with roughly 550,000 observations and 10 features (qualitative and quantitative), with an emphasis on purchase and sales numbers in US dollars.
- The dataset was analysed using regression models, which are appropriate for continuous predictor labels.
- To successfully forecast future pricing trends and sales results, the researchers used the Apache Spark big data framework with the MLI machine learning library to create two machine learning models: random forest and linear regression.

Predictive Analytics for Black Friday Sales using Machine Learning Technique

Saravanan's study explores the introduction of several products in daily life and how consumer behaviour toward various products can be used to predict sales success. The main ideas discussed in this part are as follows:

- **Machine Learning approaches:** To predict consumer behaviour during product purchases, the study uses a variety of machine learning approaches.
- **Prediction Model:** To comprehend customer wants and preferences, a prediction model is created by combining regression and Boost techniques.
- **Black Friday Significance:** Depending on their interests, product prices, and comparisons with other products, consumers can recognise Black Friday as a day when goods are offered at drastically lower costs.

By utilising predictive analytics and machine learning techniques, the study aims to provide insights into consumer behaviour and preferences during Black Friday sales, ultimately aiding retailers in better understanding and catering to customer needs for improved sales performance.⁴

Predictive Modelling of Black Friday Sales Using Machine Learning Approaches

In order to accurately evaluate and forecast sales patterns, the researchers explore the intricate dynamics of Black Friday sales using Multilayer Perceptron (MLP) models:

Application of the MLP Model

The study uses MLP models to analyse a large dataset that includes promotions, product categories, consumer demographics, and temporal trends. A thorough analysis of the Black Friday sales dynamics is made possible by these models.⁵

- **MLP Model Benefits:** By accounting for uncertainties and minute variances in sales data, MLP models provide a thorough insight of Black Friday sales dynamics. The model learns from past trends and adapts to evolving patterns by utilising machine learning techniques within the MLP structure.
- **Capabilities for Prediction:** The program improves its capacity to predict upcoming Black Friday sales events by utilising past sales data. By identifying underlying trends and patterns, the algorithm improves its ability to forecast future Black Friday events.

Data Analysis and Price Prediction of Black Friday Sales using Machine Learning Techniques

The study's main objective is to employ machine learning techniques to analyse and forecast Black Friday sales. The main ideas from this section are as follows:⁶

- **Product Categories:** The research covers various product categories such as electronics, apparel, kitchen appliances, and décor, aiming to forecast sales trends and provide insights for discount strategies across these categories.
- **Models Used:** The researchers utilised three main models for analysis and sales prediction:
 1. Decision Tree Regressor
 2. Random Forest Regressor
 3. Ridge Regression, Lasso Regression, and Linear Regression
- **Dataset:** The analysis is based on the Black Friday Sales Dataset available on Kaggle, which provides valuable information for training and testing the models for accurate predictions.
- **Performance Evaluation:** The Mean Squared Error (MSE) metric is employed to evaluate the models' performance. The Random Forest Regressor outperforms other models, showing the lowest MSE score, indicating its effectiveness in predicting Black Friday sales prices accurately.

A Single Page Application to Predict Black Friday Sales

The section focuses on the difficulties retailers encounter on Black Friday, when shoppers compete fiercely to make purchases due to high demand and several deals. The researchers suggest using a prediction model to assist merchants in efficiently managing sales in order to address these issues.⁷

Key Points:

- Due to the intense competition and overwhelming desire for discounted goods, retailers have challenges on Black Friday.

Managing a small workforce and effectively serving potential consumers are concerns for store owners, requiring tactics that work.

- By developing algorithms that examine previous consumer spending trends and estimate future expenditures based on similarities, the prediction model provides a solution.
- A variety of data analysis methods, including regressors and classifiers, are used to guarantee the precision and precision of the algorithm's predictions.
- The prediction model's ability to handle Black Friday sales is improved by the application of several machine learning methods.

A Perfect Storm for Consumer Misbehaviour: Shopping on Black Friday

The study employs various machine learning models (Linear Regression, Ridge Regression, Lasso Regression, Decision Tree Regressor, and Random Forest Regressor) to predict customer behaviour during Black Friday sales. Key points include:⁸

Objective

Forecasting customer spending on Black Friday based on variables like product categories, age, gender, and occupation.

Methodology

- Utilisation of cross-validation and data preprocessing techniques like label encoding for model training and evaluation.
- Comparison of different models based on Mean Squared Error (MSE), with the Random Forest Regressor showing the lowest MSE.
- Dataset-Includes variables such as product categories, purchase quantities, and consumer demographics for analysis.
- Analysis-Visualisation tools like count plots and heatmaps are used to explore trends and correlations in the data.

- Findings- The results indicate the importance of certain factors in predicting customer spending behaviour during Black Friday.⁹

The study focuses on Black Friday sales, a significant shopping season globally, impacting both online and physical stores, although not well-recognized in India.

Key Points:

- The research aims to understand how consumers in Chennai behave during Black Friday sales, specifically exploring their perception of product price changes.
- It utilizes both secondary and primary data collected through semi-structured questionnaires to help businesses gain insights into customer behaviour during Black Friday, leading to increased sales.
- The study delves into the decision-making process of customers during peak shopping events like Black Friday, highlighting that online shopping complements rather than replaces physical stores due to its convenience and product variety.
- Customers are observed to value the instant access and personal interaction provided by physical stores, while also leveraging online platforms for price comparisons and unique product discoveries, showcasing a preference for a multichannel shopping experience.¹⁰

Summary

- Through the examination of past data, customer profiles, and sophisticated algorithms, the researchers in this study concentrate on using machine learning (ML) techniques to improve Black Friday sales forecasts. Important ideas from this section consist of:
- Sales managers can increase sales results by using supervised learning models, such as Random Forest, to predict consumer data-driven purchasing behaviours.
- Large datasets are handled by big data systems like Apache Spark and MLlib, which use models like Random Forest and linear regression to precisely forecast future sales.
- To find customer demand trends and improve prediction accuracy, strategies like XG Boost and regression approaches are investigated.
- To capture complex sales trends and provide insights into customer behavior and product performance, Multilayer Perceptron (MLP) models are used.
- A number of predictive models are evaluated, including Decision Tree Regressor, ridge regression, and linear regression; Random Forest is found to be more successful in lowering prediction errors.
- Understanding customer behaviour is crucial for accurate revenue optimisation and sales forecasting, and data preparation methods like label encoding and heatmaps highlight important trends in datasets.

- The study explores the distinctions between in-store and online purchasing habits, emphasising the allure of in-store shopping for face-to-face interactions as well as the usage of the internet for pricing comparisons and browsing choices.
- Businesses can use machine learning and predictive analytics to create customised marketing strategies, individualised promotions, and pricing schemes to increase engagement and revenue on Black Friday by taking into account factors like price sensitivity, sales trends, and demographics.

Conclusion

The project leverages historical sales data and unstructured customer reviews to develop models for predicting customer behaviour, optimising inventory management, and guiding targeted marketing efforts.

- Natural language processing (NLP) and machine learning are important tools for improving customer analysis and sales forecasting, especially for Black Friday.
- Businesses may make better judgments by combining machine learning and natural language processing (NLP) to gain insightful information about consumer mood, preferences, and purchasing patterns.
- To increase sales and boost customer satisfaction on Black Friday, better inventory management, increased client segmentation, tailored promotions, and improved sales predictions are anticipated results. The study highlights the importance of advanced data analytics in the retail industry and lays the groundwork for future developments in data-driven decision-making for major retailers.
- By examining historical data, customer demographics, and product categories, techniques like Random Forest, regression approaches, XGBoost, and Multilayer Perceptron (MLP) enable precise sales trend forecasts.
- Using big data frameworks like Apache Spark and MLlib simplifies the processing of large amounts of sales data, improving decision-making and prediction accuracy.
- Developing customized marketing strategies, flexible pricing plans, and focused advertising campaigns requires an understanding of consumer behaviour through data visualization and behavioural analysis.
- The interaction between in-person and online buying habits highlights how crucial it is for businesses to successfully adjust to the changing demands of their clientele.

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