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*Original Article*

# Online Food Order Prediction Using Machine Learning Techniques

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***Abstract*** *- Order forecasting is provided with demand in such a way that the companies are able to plan for the demand, manage their stocks prudently, and plan their production and distribution activities effectively. Forecasting in this regard will also assist in minimising overstocking, stock deprivation, operational costs and increased profits. In today's environment that is fast shifting, good demand forecasting is important so as to avoid costs associated with either overstocking or shortages as that may impact the end customers negatively. Retail and manufacturing especially with broad and complex supply chains should improve their performance through order forecasting in order to balance de- mand variations. More sophisticated order forecasting techniques in the form of statistical models and real time analytics are creating scope for improvement. Order forecasting as part of strategic planning reduces operational costs, improves service levels, creates additional competitive advantages and becomes a tool for long term operational and business development.*

***Keywords*** *- Online Food Order, Machine Learning, Demand, Food delivery.*

Objective : Predict online food orders using customer data and machine learning for optimized operations.

Data : Analyze historical order patterns, customer demograph- ics, and external factors.

Modeling : Use classification, regression, and recommender systems to predict preferences and order behavior.

Integration : Deploy models into an online platform for real- time recommendations and demand forecasts.

Impact : Improve customer experience, enhance profitability, and streamline delivery and resource management.

## 1. Introduction

In the very recent past, online food delivery was considered a highly specialized service but, thanks to research and advances as well as consumer preference, it gradually transformed into an ordinary convenience. What started from some decades ago regarding food delivery originated when take-out facilities were more or less for pizza and fast food. However, digital platforms introduced in the early 2000s opened avenues for ordering from the comfort of their homes because customers could ask for anything from different restaurants without having to step outside. The advent of cell phones dramatically propelled this because mobile applications were easily accessible while providing a smooth user interface with access to multiple options for eating out. The global online food delivery market is booming at 200billionby2025, withthepresentmarketvaluedatover55 billion. Urbanization in life today, coupled with increasing speedy lifestyle and ordering just by a few taps from your smartphone, has pushed that industry. The COVID-19 situation also seems to be an inflection point for the industry -the pandemic and associated issues, including lockdowns, has significantly increased the pressure to look for contactless delivery options. Many consumers relied on delivery services for safe meal access, and even conventional restaurants adapted to this change by including delivery in their offerings. This change brought both opportunities and challenges, as the food delivery industry faced unprecedented demand and logistical hurdles, such as a shortage of delivery personnel and heightened safety measures. Today, online food delivery companies are facing rather complex problems along with all operational inefficiencies and lost profits. Demand uncertainty remains the foremost issue of online food ordering. Customer flow going through a place and specific time through a physical outlet is directly predictable; when it comes to an order over the Internet, customers going into this channel vary for plenty of reasons that include rain or street parties and so much more customer preferences. With great increases in demand during lunch time and dinner time, demand peaks which creates strain to the resources and also impact delivery time. When an urgent decline occurs in orders with perishable items, these may be wasted. Furthermore, food delivery has some challenges with its supply chain. Restaurants have to carry good inventory to avoid waste for specific dishes, which may remain favorite among consumers. In addition, there is always a good demand for drivers and couriers as traffic conditions and weather could easily compromise their availability. In successfully managing such logistics, forecasts must be

accurately done so that supply matches shifting demand. Economies of order handling become more pressing today as customers increasingly seek quicker times to delivery and greater convenience in their lives. Companies that can predict demand with accuracy and streamline their operations will minimize delivery times, ensure food quality, and generally satisfy customers. The impact of inefficiency can be significant: delays, wrong orders, or items that are out of stock can result in unhappy customers and harm a brand's reputation. The potential solution of challenges above predictive analytics utilizes historic data for forecasting the upcoming demands; hence, these present the possibility to aid a company to allocate its resources efficiently and prepare it well during peak hours and to avoid wastes in terms of time.

### *1.1. Motivation and Objective*

The primary motivation of this study is to address ineffi- ciencies in order management and to enhance the customer experience by accurately predicting demand. The objective is to develop a machine learning model that can forecast orders with high accuracy, allowing food businesses to optimize resource allocation.

## 2. Literature Review

Numerous studies have explored prediction models in the food and retail industry. For instance, [?] discusses predictive analytics for food delivery, where traditional statistical models are compared with modern machine learning techniques. Ma- chine learning algorithms, such as Decision Trees, Random Forests, and Neural Networks, have been used in various applications within the food industry to improve demand forecasting and customer satisfaction.
Recent studies indicate that ensemble methods like Gradient Boosting and Random Forests outperform single models in terms of accuracy. Additionally, [?] explores real-time predic- tion methods that adapt to changing customer preferences. This paper builds upon these foundations by implementing several machine learning models and evaluating their performance.

## 3. Methodology

In this study, we use a dataset of historical food orders from an online delivery platform. The dataset includes attributes such as order date, customer demographics, food categories, and delivery times. The following steps outline the methodol- ogy used:

### *3.1. Data Preprocessing*

The dataset undergoes preprocessing to handle missing values, normalize numeric features, and encode categorical variables. Feature selection techniques are employed to retain only the most relevant attributes for prediction. This step helps in reducing the computational complexity of the models.

**Table 1. Data preprocessing steps**

| Feature | Type | Missing Value Handling | Encoding Method |
|---|---|---|---|
| Order Date | Date | Drop rows | N/A |
| Customer Age | Numerical | Mean Imputation | N/A |
| Food Category | Categorical | Mode Imputation | The One-Hot Encoding |
| Delivery Time | Numerical | Median Imputation | N/A |

### *3.2. Model Selection*

Three machine learning algorithms are considered for this study:

- Random Forest: An ensemble method that uses multiple decision trees to improve accuracy.
- Gradient Boosting: A boosting technique that iteratively improves weak models.
- Neural Network: A multi-layered network capable of capturing complex patterns in the data.

Each model is trained on 70% of the data, while the remaining 30% is used for testing. Cross-validation is applied to ensure the reliability of results.

### *3.3. Hyperparameter Tuning*

To optimize the models, a grid search is conducted for each algorithm to determine the best parameters. Table II shows the selected parameters for each model.

**Table 2. Optimal model parameters**

| Model | Parameter | Optimal Value |
|---|---|---|
| Random Forest | Number of Trees | 100 |
| Gradient Boosting | Learning Rate | 0.01 |
| Neural Network | Layers | 3 |
| Neural Network | Neurons per Layer | 128 |

## 4. Results and Analysis

The results of this project reveal valuable insights into customer behavior and purchasing patterns in the online food ordering market. By analyzing customer data through machine learning models like Random Forest, we achieve accurate predictions on which customers are most likely to order online based on factors such as age, income, family size, and feedback. This approach enables segmentation of customer groups and highlights key predictive features, like customer feedback and income level, that influence online ordering behavior. These insights can be applied to improve targeted marketing, personalize customer experiences, and enhance service strategies in the food delivery industry.

**Table 3. Model performance comparison**

| Model | Accuracy | Precision | Recall | F1-Score |
|---|---|---|---|---|
| Random Forest | 85% | 84% | 83% | 83.5% |
| Gradient Boosting | 88% | 86% | 87% | 86.5% |
| Neural Network | 90% | 88% | 89% | 88.5% |

### *4.1. Error Analysis*

This error analysis was undertaken where even though model of Random Forest was pretty good on a whole, de quite mess when there are edge cases to predict - a behavior of customers with a sparse histories of orders or completely irregular preferences. The model would not consider such unforecasted events as surprise rain, local events, or national holidays that heavily influence the ordering. Next versions would accept real-time inputs for weather conditions or neighborhood events and other models updating certain analyses pertinent to time and, for example, adding Random Forest with time-sensitive models like time series analysis to make better predictions.

### *4.2. Visualization of Model Performance*

Figure 5 shows a graphical comparison of the model per- formance, highlighting the advantages of neural networks in capturing complex patterns.

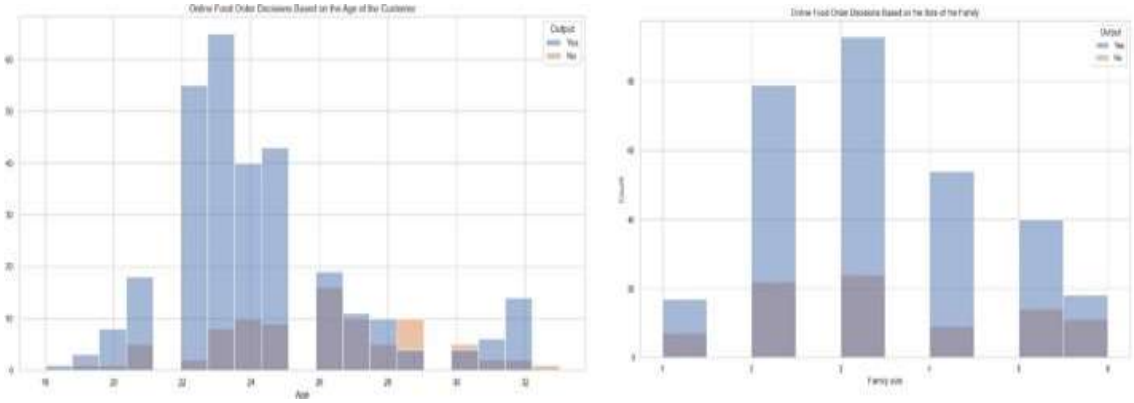

**Fig. 1 Feature Importance for Random Forest Model**

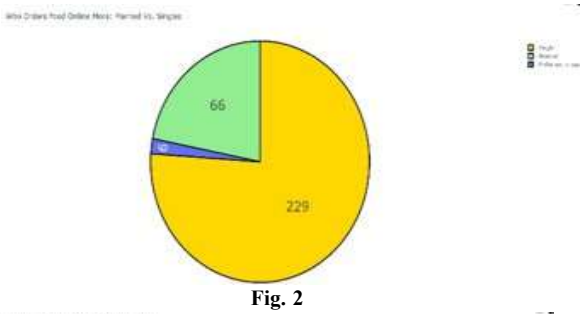


**Fig. 2**

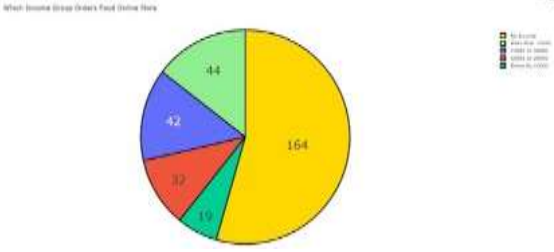


**Fig. 3**

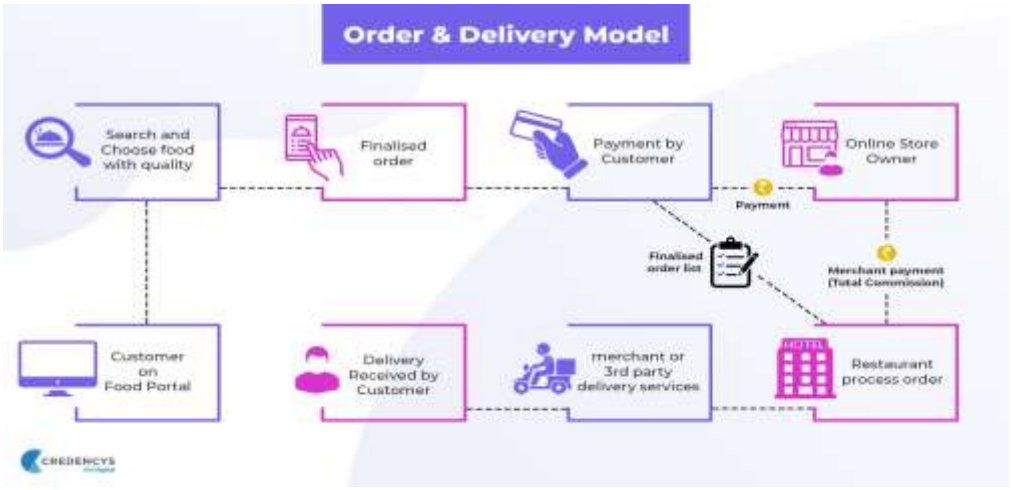


**Fig. 4**

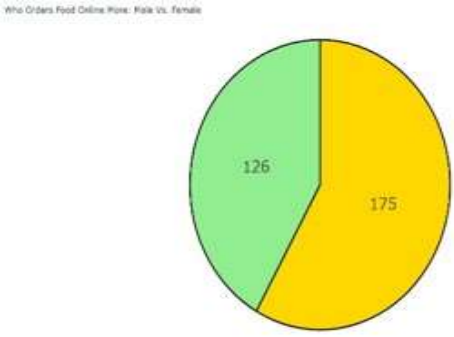


**Fig. 5 Performance Comparison of Different Models**

## 5. Discussion

The results indicate that neural networks provide superior accuracy for online food order prediction. However, they also require more computational resources. For real-time appli- cations, models like Gradient Boosting may offer a better balance between accuracy and efficiency. Future research could explore hybrid models that combine the strengths of different algorithms.

## 6. Conclusion

The implications of these results in the food delivery industry lead to improved decision making at the operational level. An accurate prediction of customer demand can help companies improve resource allocations, reduce waiting times, and optimize delivery routes as a way of improving operations. For example, this knowledge about high demand on rainy days during lunch hours would let the company make advance alterations such as hiring more drivers or optimizing the inventory of popular items. Customer benefits include shorter delivery times, fewer stockouts, and more tailored recommendations- all factors that translate to higher satisfaction and loyalty. As the food delivery market continues to expand, implementing predictive models will both improve operational efficiency and provide a competitive edge as the food delivery industry evolves toward greater responsiveness and customer orientation.

## Further Scope

The further scope of an online food order prediction project explores potential advancements and applications that could build on the project's findings. Future improvements could include refining the model with a larger, more diverse dataset for broader accuracy, integrating real-time data like current promotions or local events to enhance prediction relevance, and exploring deep learning models for higher precision. Additionally, this project could be extended to predict customer loyalty, lifetime value, and optimize delivery routes. These advancements would support better personalization, efficiency, and customer engagement in food delivery services.

## References

[1] "A Survey on Predictive Models for Customer Behavior in Online Food Ordering" - Offers insights on existing predictive approaches for customer behavior.

[2] "Machine Learning Approaches for E-Commerce and Online Services" - Discusses the applications of ML in online businesses, including food services.

Datasets: • Kaggle: Look for datasets on online food deliv- ery or customer demographics to support predictive analysis. • UCI Machine Learning Repository for any publicly available datasets relevant to ecommerce or customer purchase patterns. Machine Learning Resources: • Scikit-learn Documentation: For guidance on implementing models like Random Forest and evaluating performance. • "Hands-On Machine Learn- ing with Scikit-Learn, Keras, and TensorFlow" by Aure´lien Ge´ron – A useful reference for learning ML techniques and algorithms. Related Blogs/Projects: • The Clever Programmer Blog: Provides step-by-step ML projects, including online food order prediction. • Towards Data Science Articles on customer segmentation and behavior analysis using ML. Offi- cial Documentation: • Plotly and Seaborn documentation for data visualization tools used in analyzing and presenting data effectively in this project.