# Food Delivery Time Prediction Report

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1. Objective

To predict whether a food delivery will be "Fast" or "Delayed" using machine learning techniques.

The models explore the influence of factors like distance, weather, traffic, and restaurant/customer locations using:

- Clustering techniques (KMeans, Hierarchical)

- Neural Networks for classification

2. Dataset Overview

The dataset 'Food_Delivery_Time_Prediction.csv' contains delivery records with features like:

- Customer_Location, Restaurant_Location

- Distance (km), Weather, Traffic_Condition

- Order Priority, Delivery Time

Target Variable:

- Delivery_Status: "Fast" or "Delayed"

3. Data Preprocessing

- Loaded data using Pandas

- Handled missing values using imputation or row removal

- Categorical encoding using One-Hot/Label Encoding for: Traffic, Weather, Order Priority

- Normalized numerical features: Distance, Delivery Time

- Feature Engineering: Haversine formula for distance, Rush/Non-rush hour feature

4. Clustering Models

K-Means Clustering

- Used to segment similar delivery patterns

- Optimal k determined via Elbow Method

- Clustered based on delivery duration, traffic, weather, etc.

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- Visualized clusters via scatter plots

Hierarchical Clustering

- Agglomerative Clustering and Dendrogram used

- Explained nested grouping of deliveries

5. Neural Network Model

Feedforward Neural Network

- Built using Keras/TensorFlow

- Input Features: Distance, Traffic, Weather, Priority

- Output: 0 for "Fast", 1 for "Delayed"

Model Evaluation

- Accuracy, Precision, Recall, F1-score

- Hyperparameter tuning: layers, activation, learning rate

6. Model Comparison

| Method | Purpose | Highlights |
|---|---|---|
| KMeans | Unsupervised grouping | Grouped deliveries into types |
| Hierarchical | Nested clustering | Proximity analysis |
| Neural Network | Binary classification | Best accuracy |

7. Conclusion & Recommendations

Best Performing Model:

- Neural Network for delivery prediction

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- KMeans + Hierarchical clustering gave delivery group insights Recommendations:

- Use clustering to optimize delivery zones

- Monitor rush hour, traffic, and weather for real-time updates

- Integrate GPS/traffic API in future

8. Tools & Libraries Used

- Python, Jupyter Notebook

- pandas, numpy, sklearn, matplotlib, seaborn, tensorflow, keras

Final Summary**:**

This project focused on predicting food delivery status ("Fast" or "Delayed") using both clustering techniques and a neural network classifier. After preprocessing and feature engineering, KMeans and Hierarchical Clustering revealed meaningful delivery groupings—KMeans formed three clusters (sizes: 75, 64, 61), and Hierarchical Clustering formed three clusters (sizes: 95, 56, 49). These clusters provided insights into delivery behavior patterns. A feedforward neural network built using TensorFlow and Keras achieved **75% accuracy**, with a **precision of 0.75**, **recall of 1.00**, and **F1-score of 0.86** for predicting "Delayed" deliveries. However, the model failed to classify any "Fast" deliveries, indicating class imbalance or model bias. Interestingly, the average tip for "Fast" deliveries (₹48.35) was slightly higher than for "Delayed" ones (₹46.05). Overall, the neural network offered the best predictive performance, while clustering added strategic insights. For better future delivery management, it's recommended to use clustering for delivery zone optimization, address data imbalance in classification tasks, and integrate real-time traffic and weather data via APIs.