Introduction

India generates millions of tons of waste annually, and efficient waste management is crucial for environmental sustainability.
This project aims to predict the Recycling Rate (%) of cities based on various urban and municipal factors such as population density, waste type, and landfill data.
The goal is to support data-driven decisions for improving recycling efficiency and sustainability in Indian cities.

Problem Statement

The challenge is to develop a **machine learning model** that accurately predicts the **Recycling Rate (%)** of Indian cities using city-specific waste management data.

Objectives

- To analyze patterns in waste generation and recycling across Indian cities.
- To clean, preprocess, and visualize waste management data effectively.
- To build and evaluate regression models for predicting recycling rates.

Methodology

Data Preprocessing

- Loaded dataset using Pandas
- Filled missing numerical values with median
- Encoded categorical columns using OneHotEncoder
- Scaled numeric features using StandardScaler
- Split data into 80% training and 20% testing

Exploratory Data Analysis (EDA)

- Distribution of Recycling Rate (%)
- Correlation heatmap
- City-wise and waste-type-wise recycling comparison
- Outlier detection and trend analysis

Model Development

Models tested:

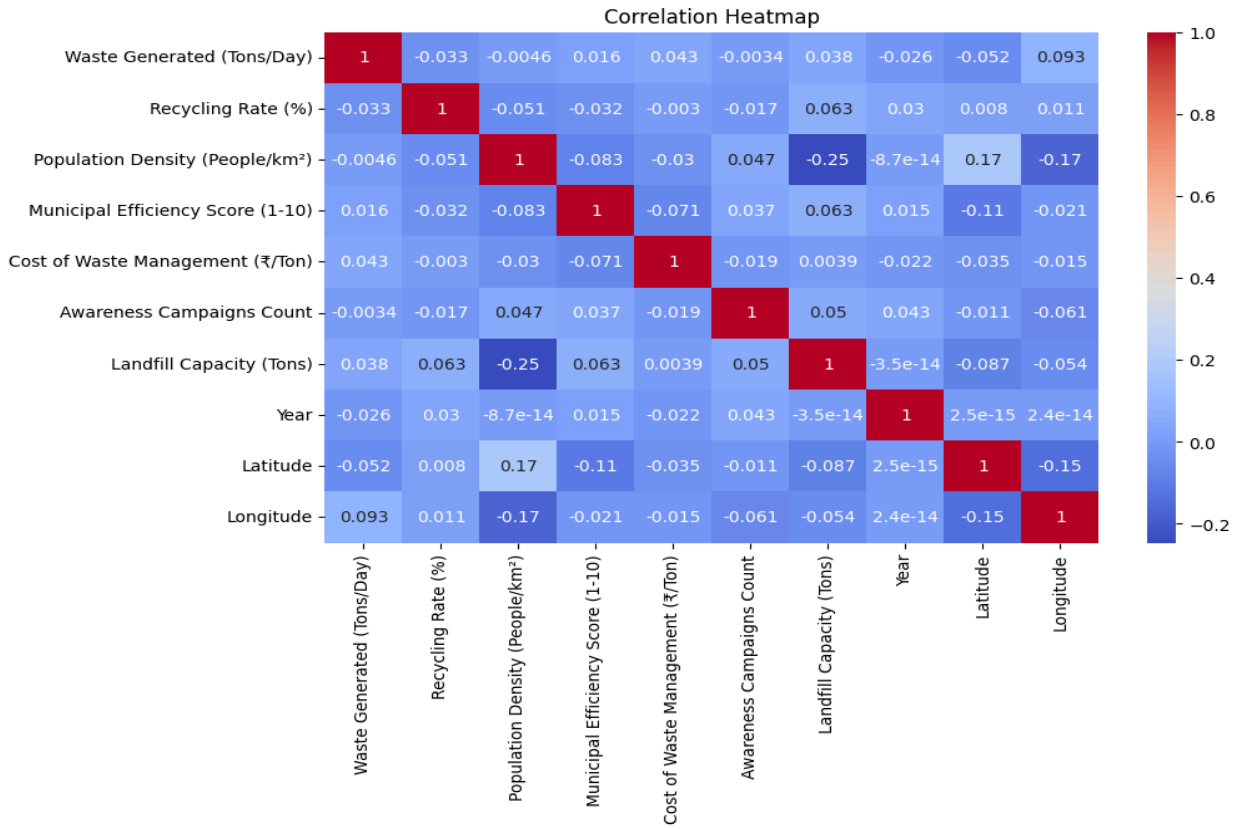
- Linear Regression
- Random Forest Regressor

Model	RMSE
Linear Regression	*17.32*
Random Forest	*17.43*

Result

- The final model achieved an **RMSE of ~17.32** on test data.

Visualization Examples



Challenges Faced

- Handling many categorical variables (City, Landfill, Disposal Method).
- Balancing between model interpretability and performance.
- Integrating Flask form fields cleanly with the trained pipeline.

Future Scope

- Extend model with real-time waste data APIs.
- Build a city dashboard for monitoring waste trends.
- Deploy with Docker or on a cloud platform like AWS.

Conclusion

This project demonstrates how machine learning can be applied to urban waste management for sustainable city planning.

By predicting recycling rates accurately, municipal bodies can plan better resource allocation, optimize costs, and improve environmental outcomes.