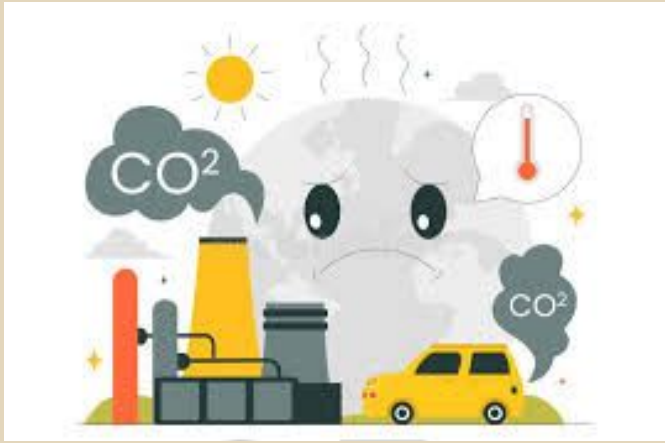
CARBON FOOTPRINT



ECE 143 - Group 9

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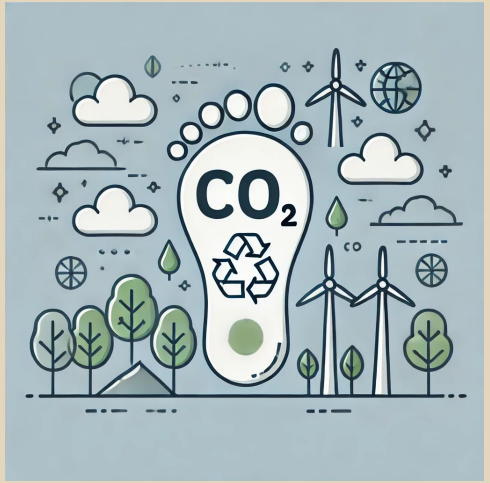
THE IDEA?



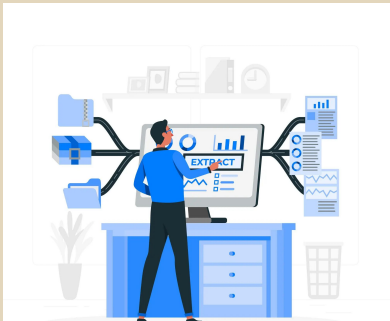
Our project focuses on understanding and analyzing individual carbon emission based on daily activities.

Key Features:

- **Data :** Kaggle dataset on individual carbon footprint calculation.
- **Objective:** Extract key insights and trends in carbon emissions.
- **Outcome:** ML-based recommendation system offering emission reduction solutions for sustainable lifestyle.

Part 1

DATA EXTRACTION



Our Process

SELECTION

We chose to select some of the most relevant features that generally affect an individual's carbon footprint.

- **Heating energy usage**
- **Transportation choices**
- **Waste bag trends**

CLEANING

We manipulated our dataset to allow for easier analysis on it.

- **One-hot-encoding** was used to represent the fields that had non numeric values.
- Grouped and aligned all correlated columns.

BEFORE

Monthly Grocery Bill	Frequency of Traveling by Air	Vehicle Monthly Distance Km	Waste Bag Size	Waste Bag Weekly Count	How Long TV PC Daily Hour	How Many New Clothes Monthly	How Long Internet Daily Hour	Energy efficiency	Recycling	Cooking_With	CarbonEmission
230	frequently	210	large	4	7	26	1	No	['Metal']	['Stove', 'Oven']	2238
114	rarely	9	extra large	3	9	38	5	No	['Metal']	['Stove', 'Microwave']	1892
138	never	2472	small	1	14	47	6	Sometimes	['Metal']	['Oven', 'Microwave']	2595

AFTER

Heating Energy Source				Mode Of Transprt/Fuel Type										Waste Bag Size/Count					Final Output
coal	electricity	natural ga	wood	private	public	walk/bicy	diesel	electric	hybrid	lpg	petrol	Vehicle Monthly Di	Frequency of Tra	extra lar	large wa	mediu	small wa	Waste Bag W	CarbonEmission
1	0	0	0	0	1	0	0	0	0	0	0	210	2	0	1	0	0	4	2238
0	0	1	0	0	0	1	0	0	0	0	0	9	1	1	0	0	0	3	1892
0	0	0	1	1	0	0	0	0	0	0	1	2472	0	0	0	0	1	1	2595
0	0	0	1	0	0	1	0	0	0	0	0	74	1	0	0	1	0	3	1074
1	0	0	0	1	0	0	1	0	0	0	0	8457	3	0	1	0	0	1	4743
0	0	0	1	0	1	0	0	0	0	0	0	658	2	0	1	0	0	1	1647
0	0	0	1	1	0	0	0	0	1	0	0	5363	1	0	0	1	0	4	1832
1	0	0	0	0	0	1	0	0	0	0	0	54	3	1	0	0	0	3	2322

Part 2
DATA ANALYSIS

Four ways of clustering

Core Methods

- **Single Linkage (Minimum Distance)**:

$$d(C_i, C_j) = \min_{x \in C_i, y \in C_j} d(x, y)$$

- **Complete Linkage (Maximum Distance)**:

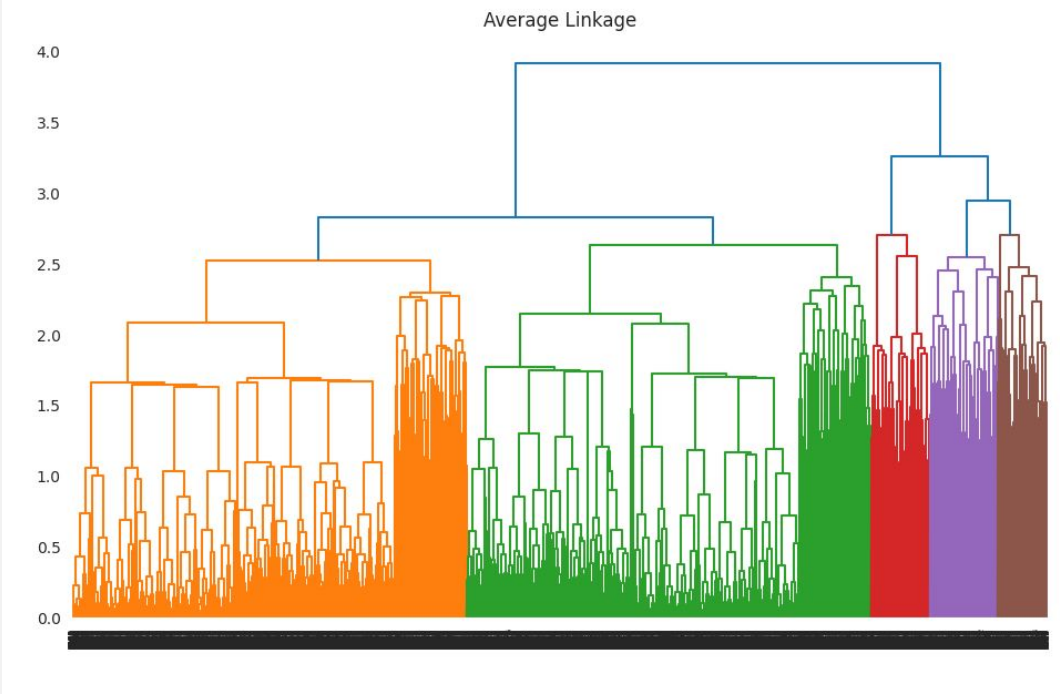
$$d(C_i, C_j) = \max_{x \in C_i, y \in C_j} d(x, y)$$

- **Average Linkage (Mean Distance)**:

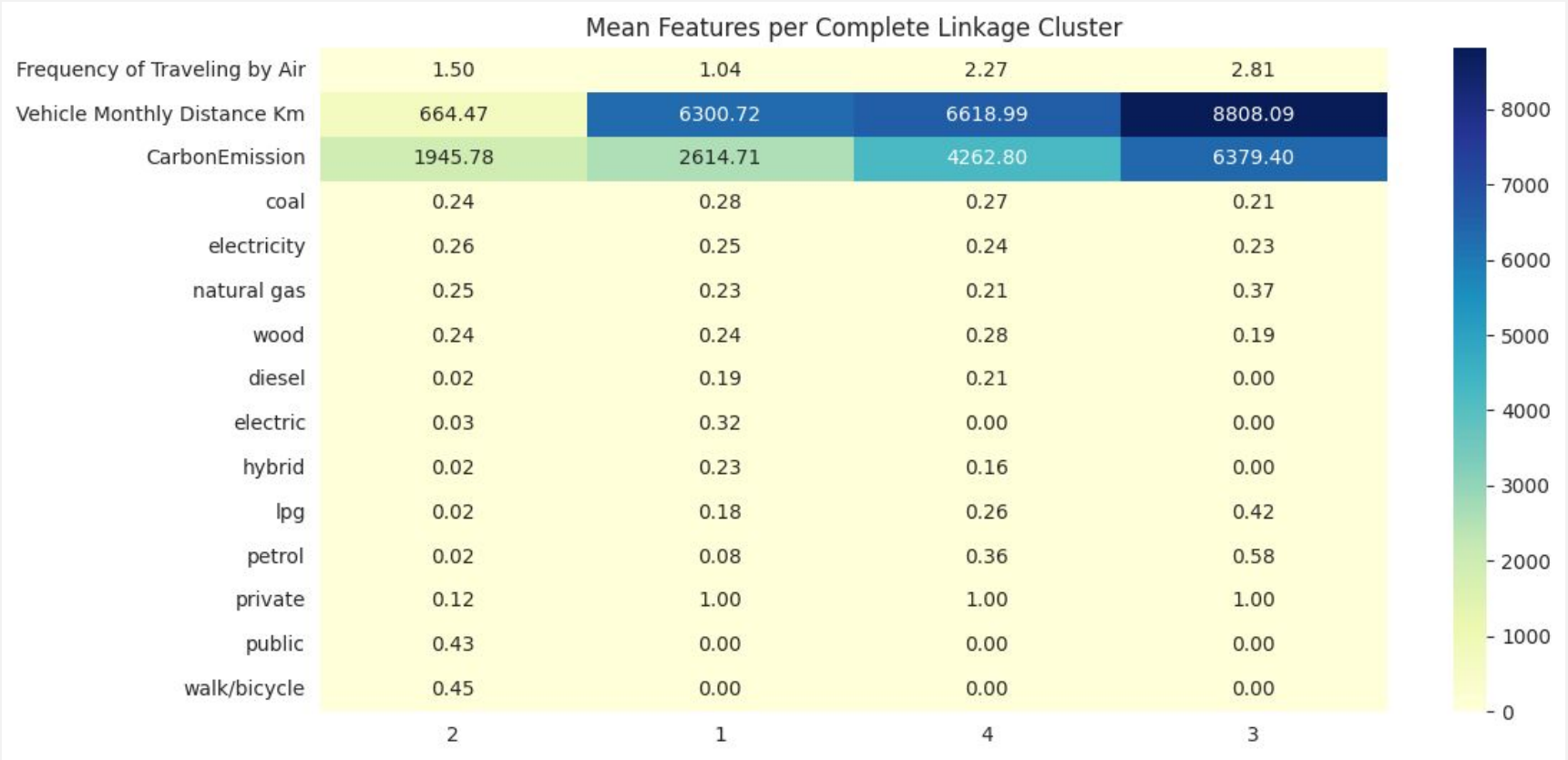
$$d(C_i, C_j) = \frac{1}{|C_i||C_j|} \sum_{x \in C_i} \sum_{y \in C_j} d(x, y)$$

- **Ward's Method (Variance Minimization)**:

$$d(C_i, C_j) = \sqrt{\frac{|C_i||C_j|}{|C_i| + |C_j|}} \|\bar{x}_i - \bar{x}_j\|_2$$

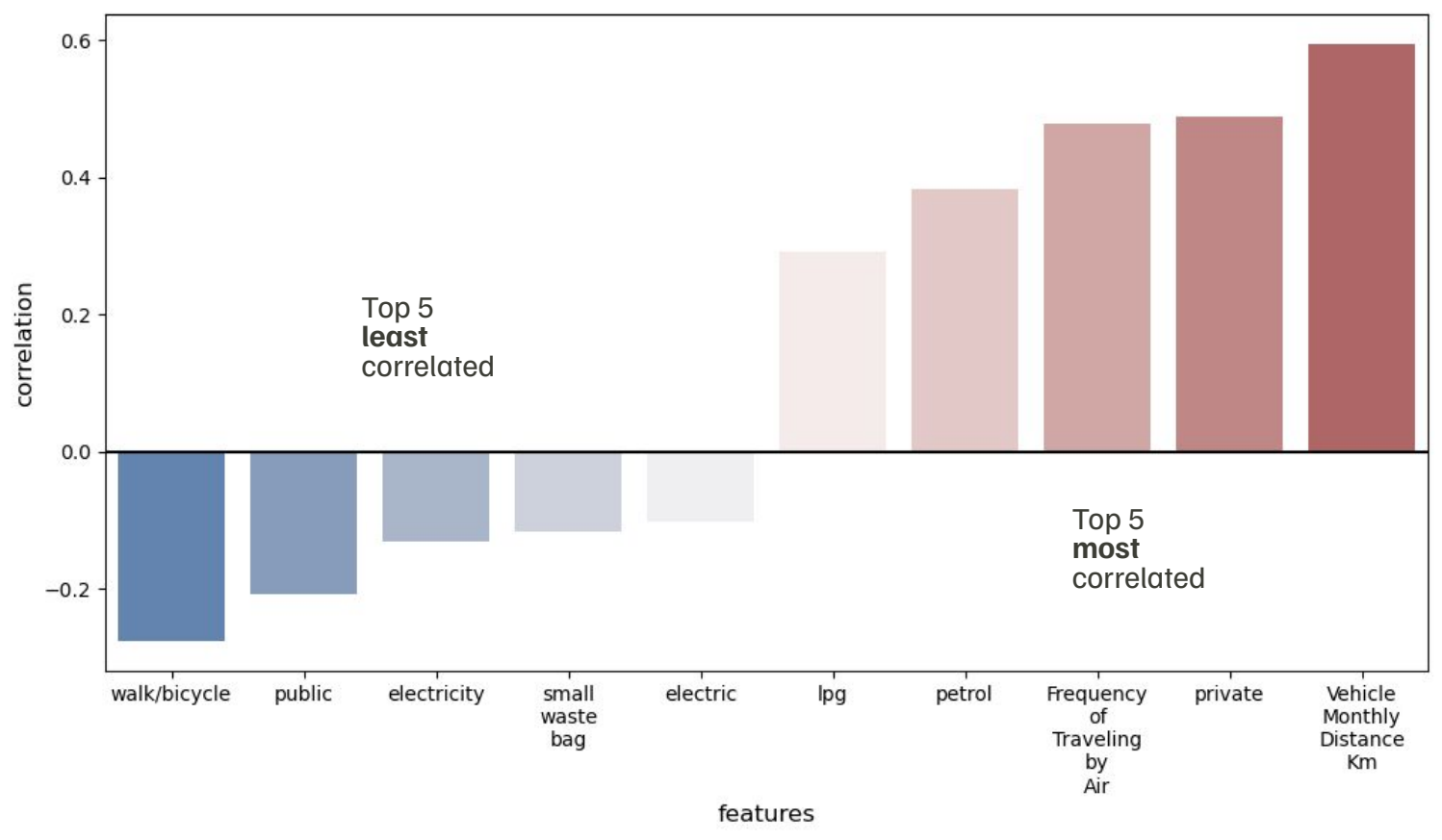


Heatmap of cluster means

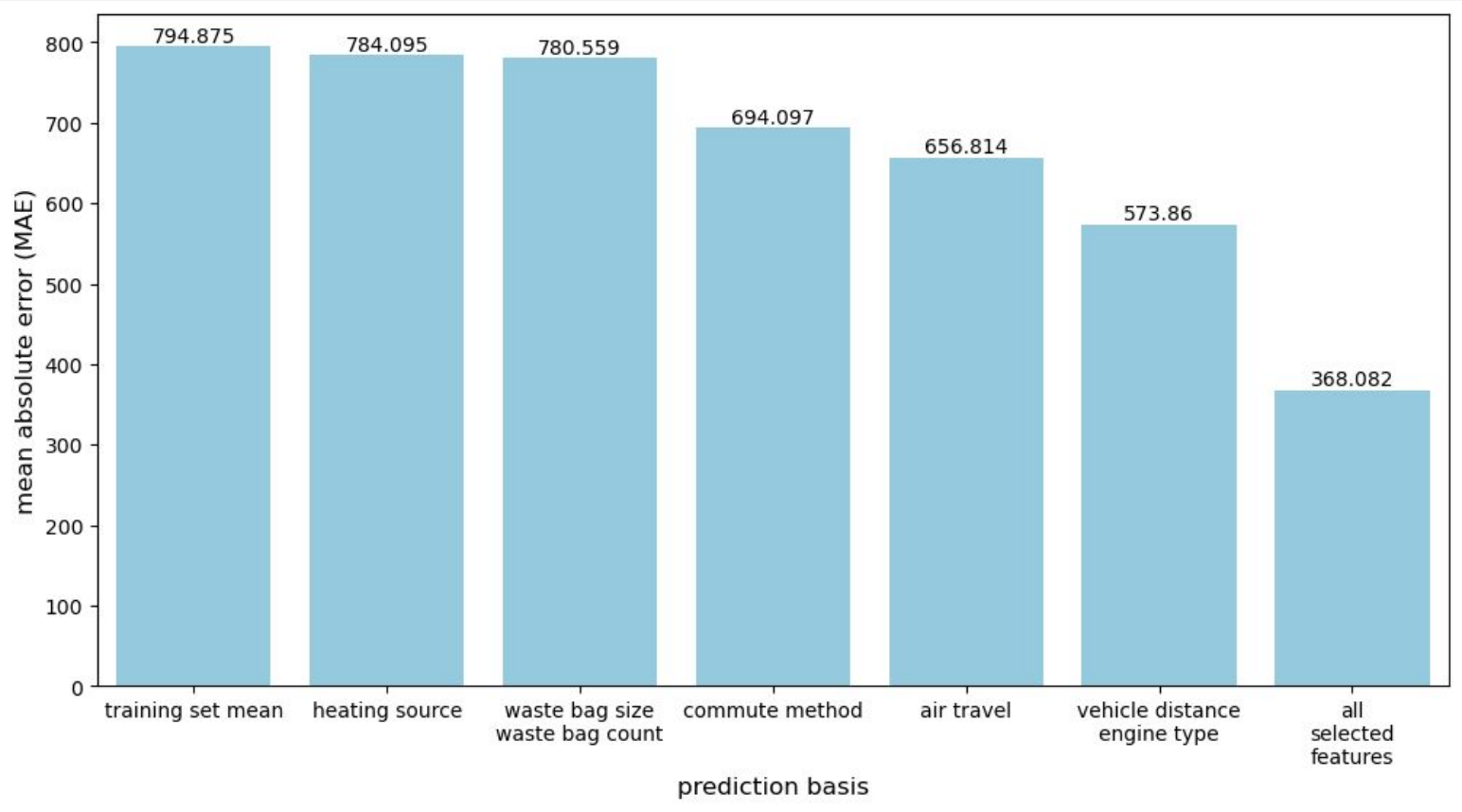


This heatmap shows four classic types of people and the mean features of their travelling habit.

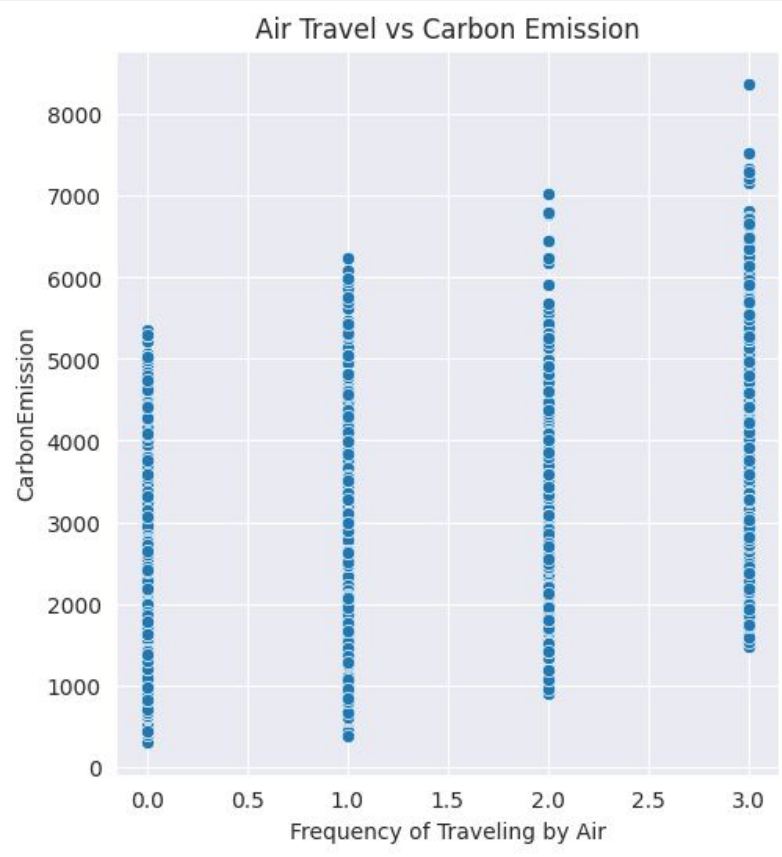
Correlations with Carbon Emission

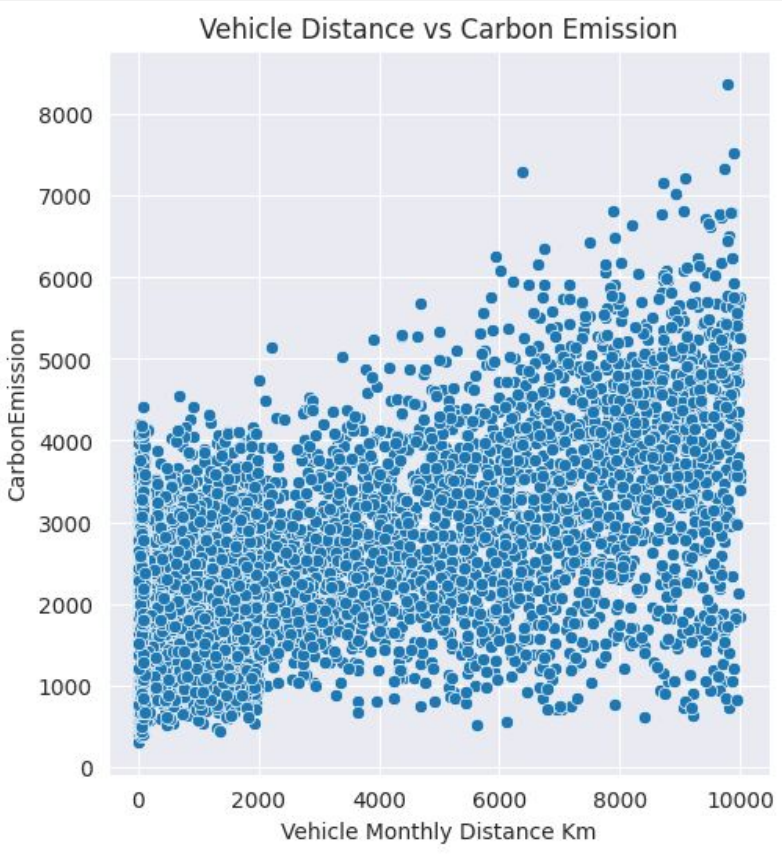


Linear Regression Performance

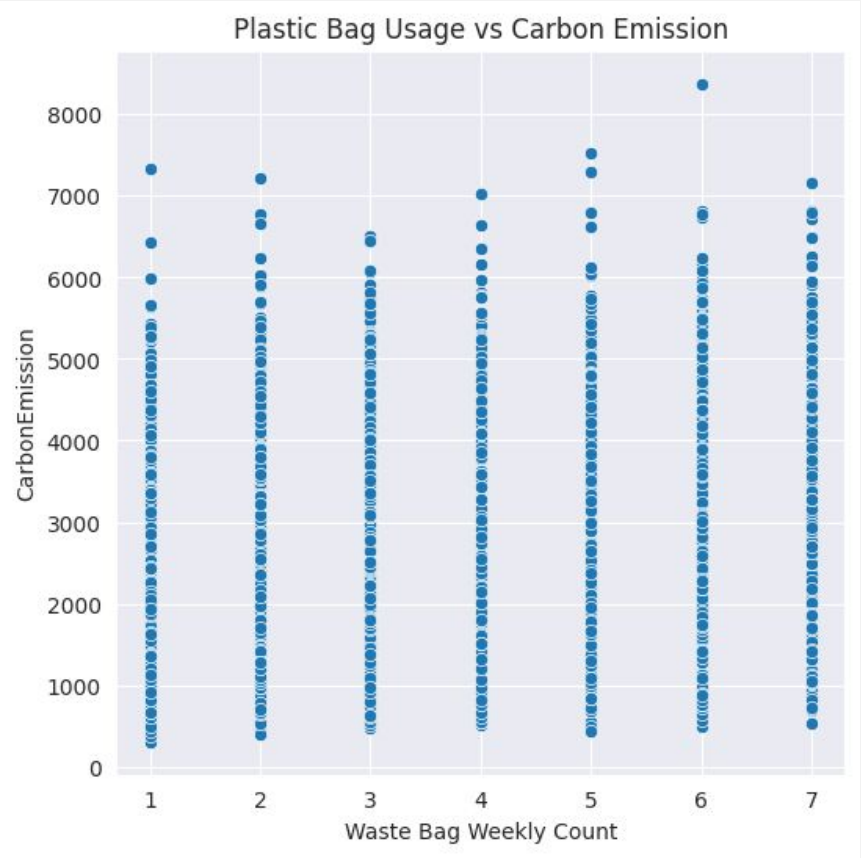


Linear Regression Performance





Linear Regression Performance



Part 3
RECOMMENDATION

Recommendation Approach : Targeted Top Contributor

Identify Top Contributors

- Contribution of each distinct group using learned model parameters
- Target the two highest contributing groups for reduction

Smart Adjustments for Emission Reduction

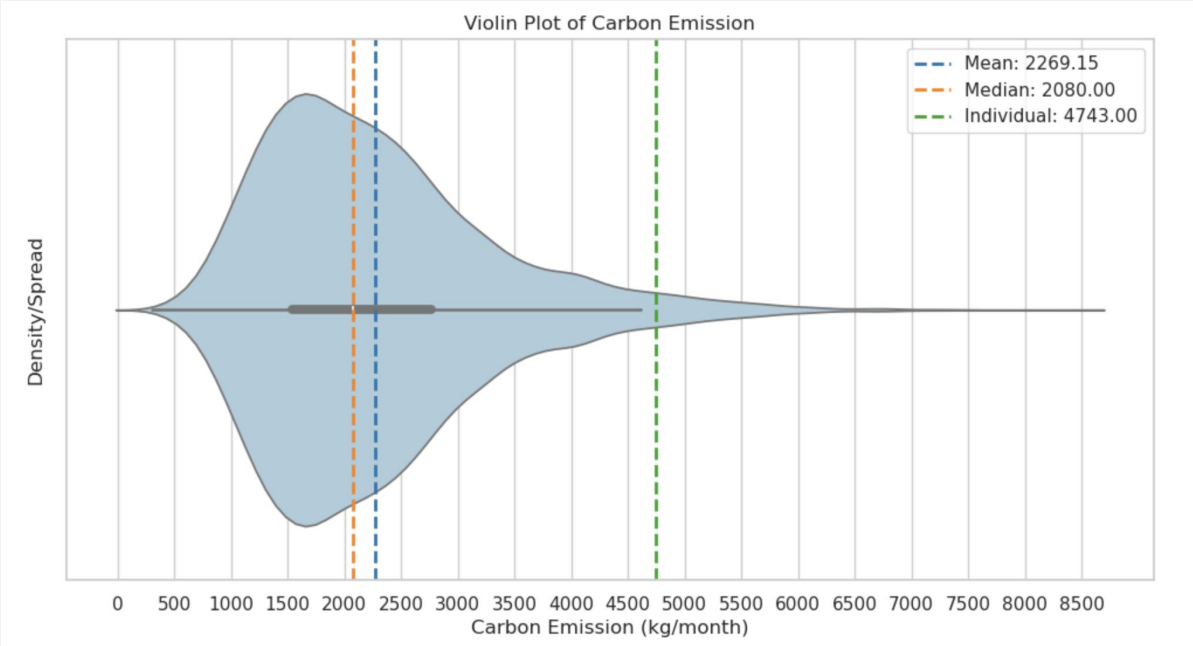
- Suggest changes within the targeted groups
- Selecting alternative values while ensuring logical consistency (e.g., only one heating source, one vehicle type)

Apply Practical Constraints

- Ensure that only valid values are selected (e.g., cannot reduce air travel frequency below 1 unless originally 0)
- Another example, If using public transport, avoid selecting a private vehicle fuel type

Carbon Emissions : Before vs After recommnedations

➢ **Before recommendations**

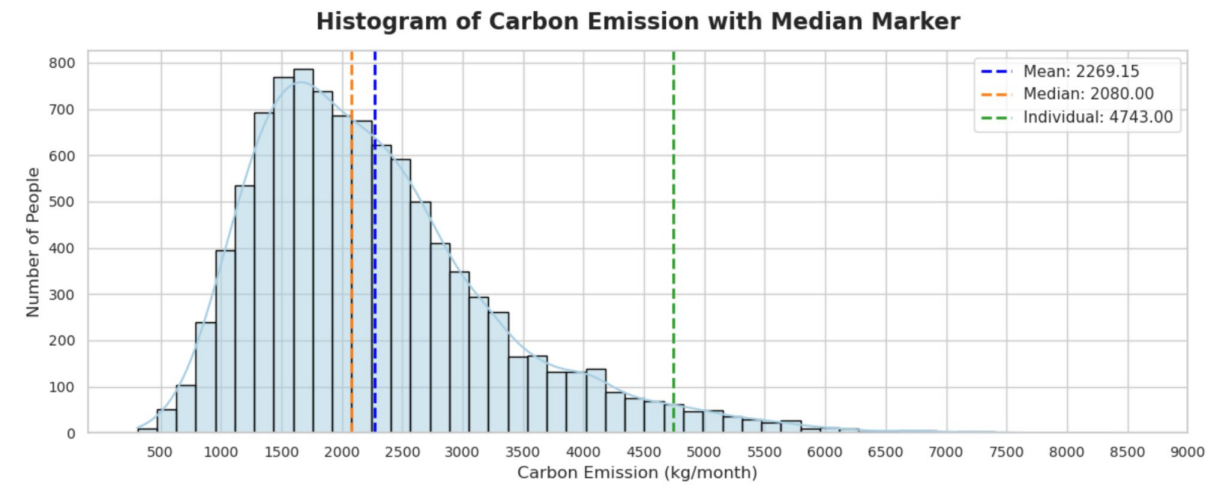


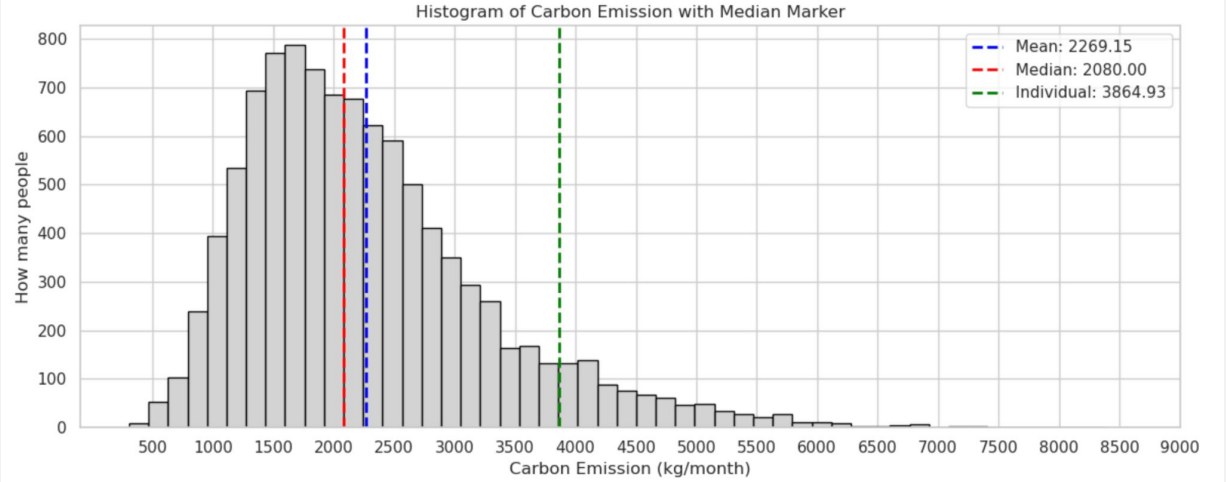
➢ **Recommendations : 10 % reduction**

```
Vehicle Monthly Distance Km: 6352
Frequency of Traveling by Air: 2
```

```
Original Emission: 4743
Target Emission (10% Reduction): 4268.7
New Emission: 3864.934439288471
```

➢ Side by Side : Post recommendations (10% reduction)






THANK YOU