

footfall prediction for reducing food wastage.



Alli Ajagbe, Divith Narendra & Soham Petkar.

S. No.	Leftover by Thali in Kgs	Frequency/ Percentage shows the number of days		
		Breakfast	Lunch	Dinner
1	< 1.0	6 (8.6%)	0 (0%)	0 (0%)
2	1.0-3.0	47 (67.1%)	40 (57.1%)	29 (41.4%)
3	3.1-6.0	6 (8.6%)	19 (27.1%)	34 (48.6%)
4	6.1- 9	0 (0%)	8 (11.4%)	7 (10.0%)
5	> 9.0	11 (15.7%)	3 (4.3%)	0 (0%)
	Total	70 (100%)	70 (100%)	70 (100%)
	Chi-square value	22.788	18.332	4.802
	p-value	0.05*	0.44	0.05*

Wastage of Food:

1. Buffet System of food.
2. Taking more than you can eat.
3. Difference in food habits.
4. Maximising Utility at a price point.
5. Trying to taste all the dishes.

Particulars	Category	Female	Male	Total
Frequency of leaving food in plate after having meal	Quite often	16	16	16
	Often	60	68	64
	Rarely	24	16	20
Quantum of food being left in plate (as percentage of food taken)	<5	32	16	24
	5-10	60	68	64
	10-15	0	8	4
	15-20	8	0	4
	20-25	0	0	0
Share of food items in the leftover	>25	0	8	4
	Snacks/ starters	12	8	10
	Salad	4	4	4
	Vegetables	20	40	30
	Non-vegetarian	0	0	0
	Rice	44	28	36
	Chapatti	8	16	12
	Dal	4	4	4
Form in which food is wasted	Sweets	0	0	0
	Leftover in plates	68.18	54.55	61.36
	Unserved food	0	9.09	4.55
	Both	31.82	36.36	34.09

**food wastage is a chronic problem, faced by messes
and corporate office spaces.**

impact?

**reduced food
wastage.**



impact?

**optimized menu
for students.**

impact?

**better
inventory
managment.**

applications?

01

Hostel Messes
across India.

02

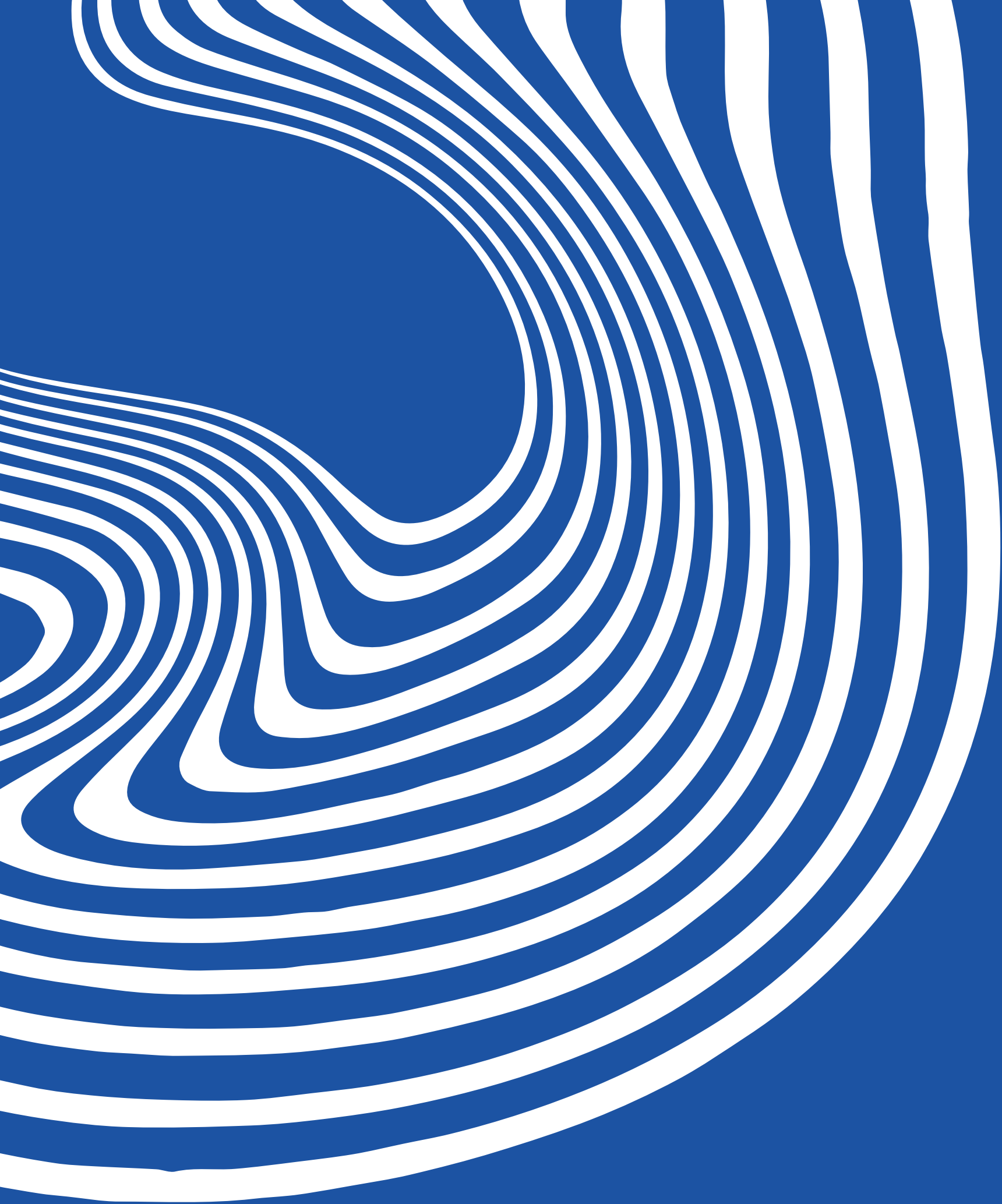
Corporate Office
Spaces.

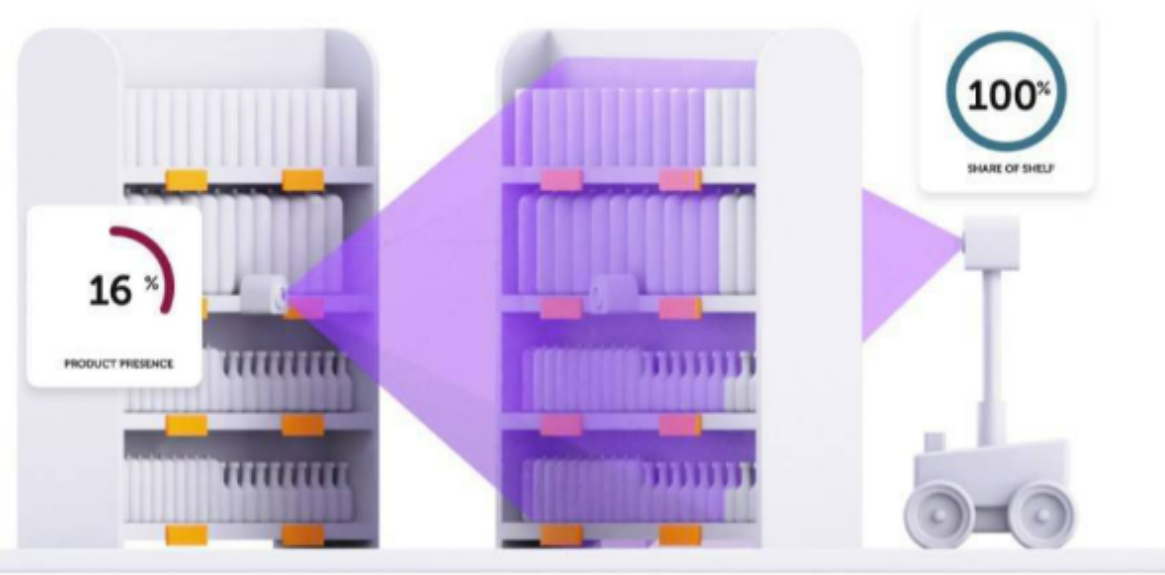
03

Hotels and
Restaurants.

02

**literature
review**





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simplify inventory
 ly stockouts, and boost your
 adsheets.

THURSDAY, JUN 1
 Good Morning, Maria! 🙌

REPLENISH NOW

Review >

REPLENISH SOON

Review >

PURCHASE ORDERS

Review >


Purchasing Updates

0015	<div style="width: 100%; height: 5px; background-color: green;"></div>	Delivered
0022	<div style="width: 100%; height: 5px; background-color: green;"></div>	Shipment
0024	<div style="width: 100%; height: 5px; background-color: green;"></div>	Pre-Shipment

Planned Growth JUN



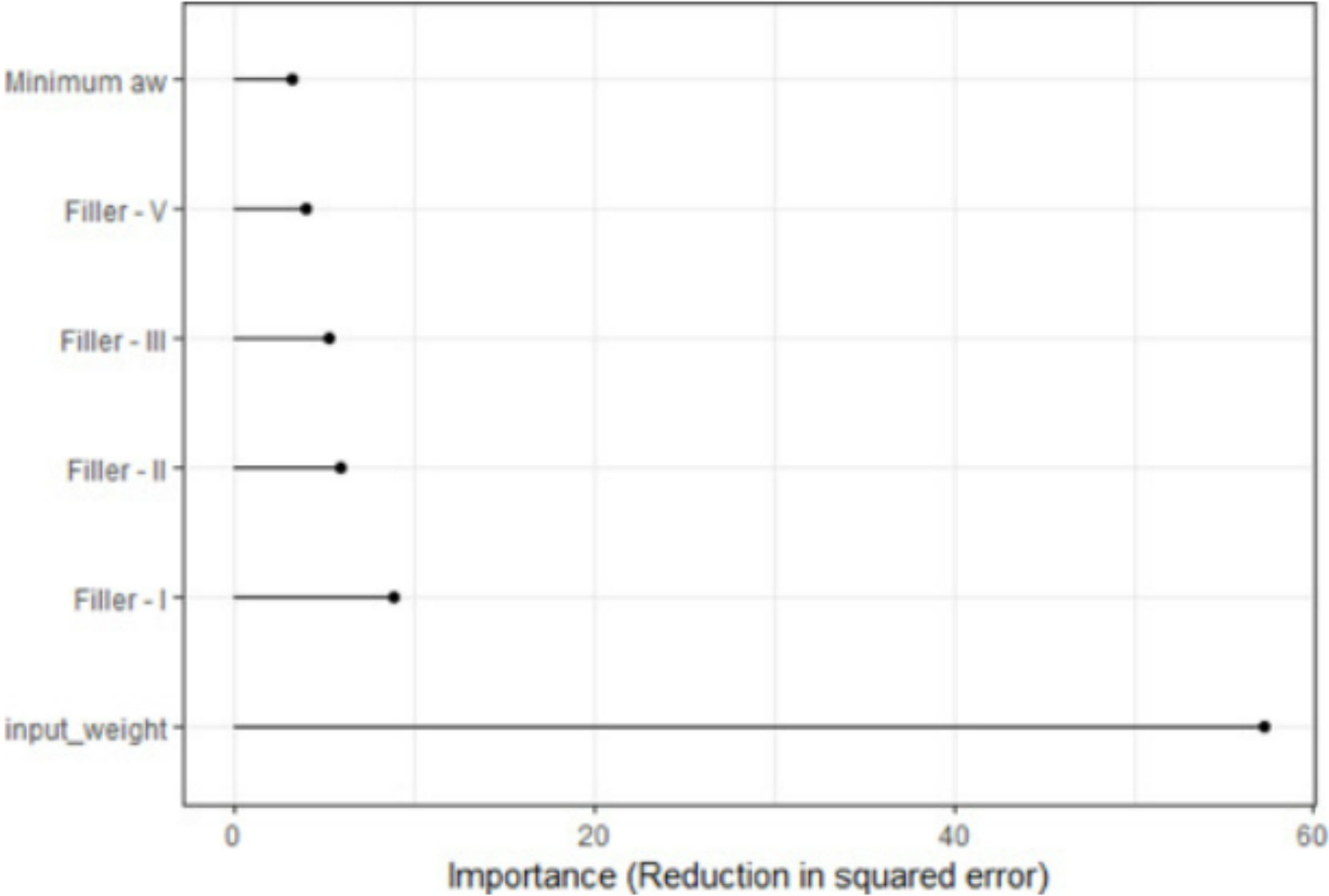
Application of Machine Learning to support production planning of a food industry in the context of waste generation under uncertainty

Alberto Garre^a, Mari Carmen Ruiz^b, Eloy Hontoria^c  

why do linear regression family underperform? bias?

Table 1. RMSE, MAE and R² calculated for the training and test sets for each predictive model.

	Training			Test		
	RMSE	MAE	R ²	RMSE	MAE	R ²
Linear model	0.018	0.014	0.442	0.019	0.015	0.421
Regression tree	0.016	0.012	0.553	0.016	0.013	0.586
Bagged tree	0.016	0.012	0.599	0.016	0.013	0.577
Random forest	0.014	0.010	0.705	0.016	0.012	0.596
Gradient boosting	0.014	0.011	0.654	0.016	0.012	0.623
Lasso	0.019	0.014	0.425	0.020	0.015	0.401
Ridge regression	0.018	0.014	0.448	0.019	0.015	0.426
Elastic net	0.019	0.014	0.428	0.020	0.015	0.404
Spline	0.016	0.012	0.591	0.016	0.012	0.594

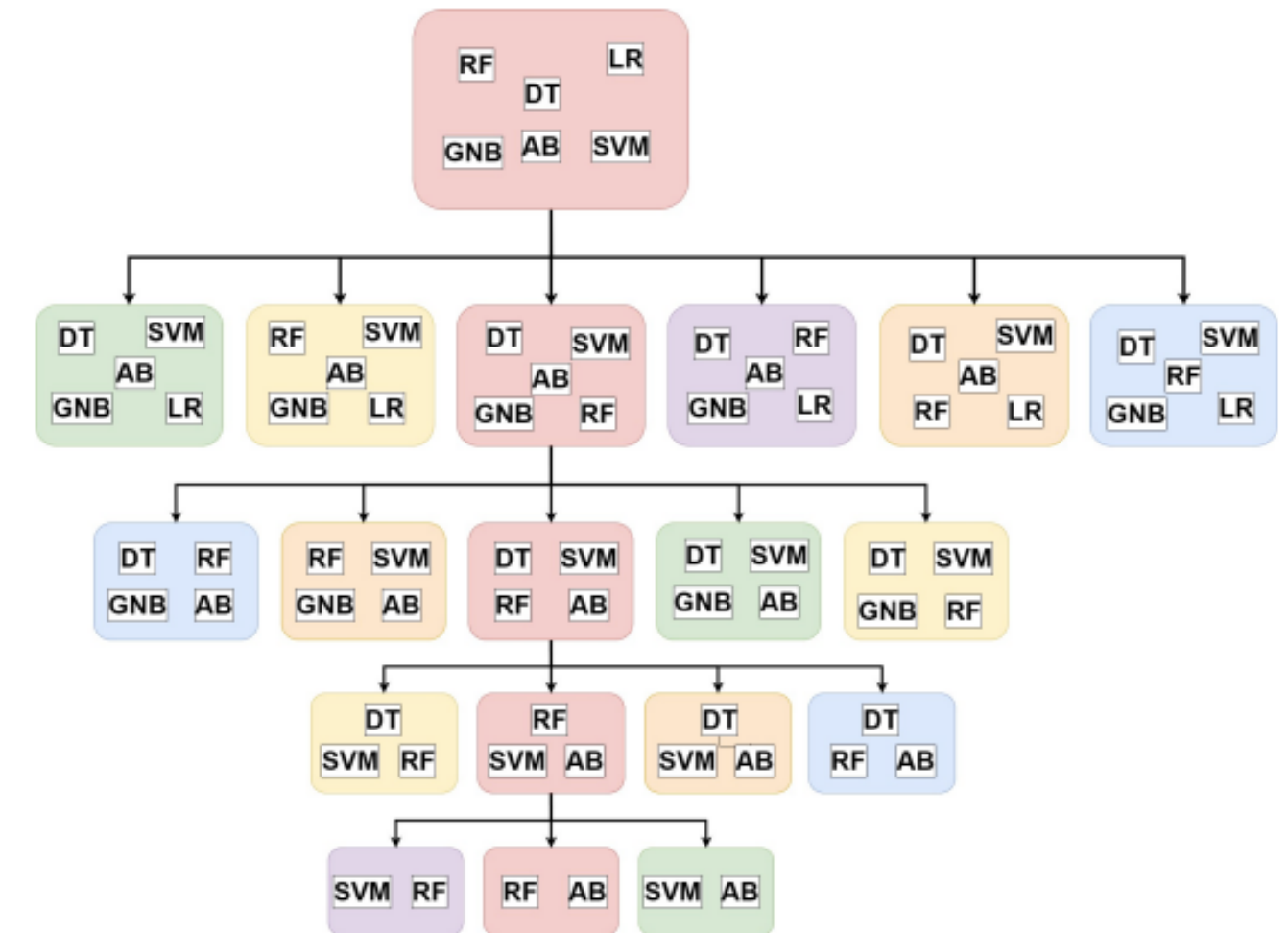


An Ensemble ML Model to Predict the Wastage of Food: Towards Achieving the Food Sustainability

Combination	F1-Score
RF, DT, ADA, SVM, GNB, LR	0.803278
RF, DT, ADA, SVM, GNB	0.819672
RF, DT, ADA, GNB	0.819672
RF, ADA, SVM	0.819672
RF, ADA	0.868852

TABLE I
EVALUATION METRICS OF DIFFERENT ML MODELS

ML Model	Accuracy	Precision	Recall	F1-Score
Random Forest	0.754098	0.773342	0.754098	0.747922
Logistic Regression	0.704918	0.664178	0.704918	0.683492
Support Vector Machine	0.770491	0.716397	0.770491	0.739905
Decision Tree	0.754098	0.751078	0.754098	0.752366
Gaussian Naive Bayes	0.655737	0.683326	0.655737	0.609667
AdaBoost	0.622950	0.745810	0.622950	0.622125



The image features a solid blue background with abstract white wavy lines. These lines are composed of multiple parallel, slightly irregular curves that flow from the left and right edges towards the center, creating a sense of movement and depth. The lines vary in thickness and spacing, contributing to a dynamic, organic feel.

the data.

19	20	21	22	23	24	25	26	27	28	29	30	31																								
MAY 2023					JUNE 2023					JULY 2023																										
F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25												
26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

AST	LUNCH	Snacks
111	195	108
95	175	115
95	203	129
93	184	131
112	121	95
107	119	99
85	126	100
112	112	95
90	112	95
126	193	113
56	166	122

Breakfast	Monday - 28 Aug	Cal
Assorted Flakes	Cornflakes	
Seasonal Fruit	banana	
Egg	Boiled Eggs	
Main1	Aloo Bhaaji	
Main2	Poori	
Accompaniment	Coffee Powder/Butter/Jam	1kcal
Bread	Brown Bread	
Beverage1	Adrak Elaichi Masala Tea	
Beverage2	Cold and Hot Milk	
Lunch		
Salad/Soup	Sweet Lassi	
Salad	Onion Rings	
dry Veg	NA	
Gravy Veg/ Dal	Yellow moong daal	
Paneer	Paneer Toofani	
Non Veg	Butter chicken(Tandoori)	
Accompaniment	Papad/Pickle/jaggery	321.5kc

MARCH 2023

DATE	WET WASTAGE	WET WASTAGE	WET WASTAGE
1-3-23	wet wastage	26.21g	Nehit
2-3-23	wet wastage	27.11g	Nehit
3-3-23	wet wastage	28.21g	Nehit
4-3-23	wet wastage	23.21g	Nehit
5-3-23	wet wastage	24.21g	Nehit
6-3-23	wet wastage	26.21g	Nehit
7-3-23	wet wastage	27.11g	Nehit
8-3-23	wet wastage	28.21g	Nehit
9-3-23	wet wastage	29.21g	Nehit
10-3-23	wet wastage	27.31g	Nehit
11-3-23	wet wastage	26.32g	Nehit
12-3-23	wet wastage	24.11g	Nehit
13-3-23	wet wastage	23.21g	Nehit
14-3-23	wet wastage	22.21g	Nehit
15-3-23	wet wastage	21.21g	Nehit
16-3-23	wet wastage	26.21g	Nehit
17-3-23	wet wastage	27.21g	Nehit
18-3-23	wet wastage	28.21g	Nehit
19-3-23	wet wastage	27.21g	Nehit
20-3-23	wet wastage	28.21g	Nehit
21-3-23	wet wastage	29.31g	Nehit
22-3-23	wet wastage	25.21g	Nehit

chaos.

Tuesday - August 15	Calories per 100g	Wednesday - August 16	Calories per 100g	Thursday - August 17	Calories per 100g	Friday - August 18
Wheatflakes	356kcal	Chocos	387kcal	Wheatflakes	356kcal	Chocos
Apple	59kcal	Banana	116kcal	Muskmelon	17kcal	papaya
chana chaat	147kcal	Egg bhurji	243kcal	Sprouts	153kcal	Boiled Eggs
Aloo Poha, Indori Sev	239kcal	Onion Aloo Paratha	185kcal	Idli	135kcal	Mix Paratha
Red & Green Chutney	149kcal	Curd & Pickle	58kcal, 32.8kcal	Mysore Sambhar/peanut chutney	207kcal, 321kcal	Curd & Pickle
Coffee Powder/ Butter/ Jam	1kcal/724kcal/285kcal	Coffee Powder/ Butter/ Jam	1kcal/724kcal/285kcal	Coffee Powder/ Butter/ Jam	1kcal/724kcal/285kcal	Coffee Powder/ Butter/ Jam
Brown Bread	248kcal	Brown Bread	248kcal	Brown Bread	248kcal	Brown Bread
Masala Tea	63kcal	Masala Tea	63kcal	Masala Tea	63kcal	Masala Tea
Hot & Cold Milk	72kcal	Hot & Cold Milk	72kcal	Hot & Cold Milk	72kcal	Hot & Cold Milk

the story -

796 datapoints, 9 features.

- Four months of data on average footfall from May - October 2023.
- Highly Unstructured
- Available in multiple different formats.

Data Integrity.

Our data was ethical and maintained robust standards of user consent.

- Data was anonymized.
- Consent was obtained from the administration.
- Log Files and manual checks were conducted to ensure privacy.

Data Format

Our data was

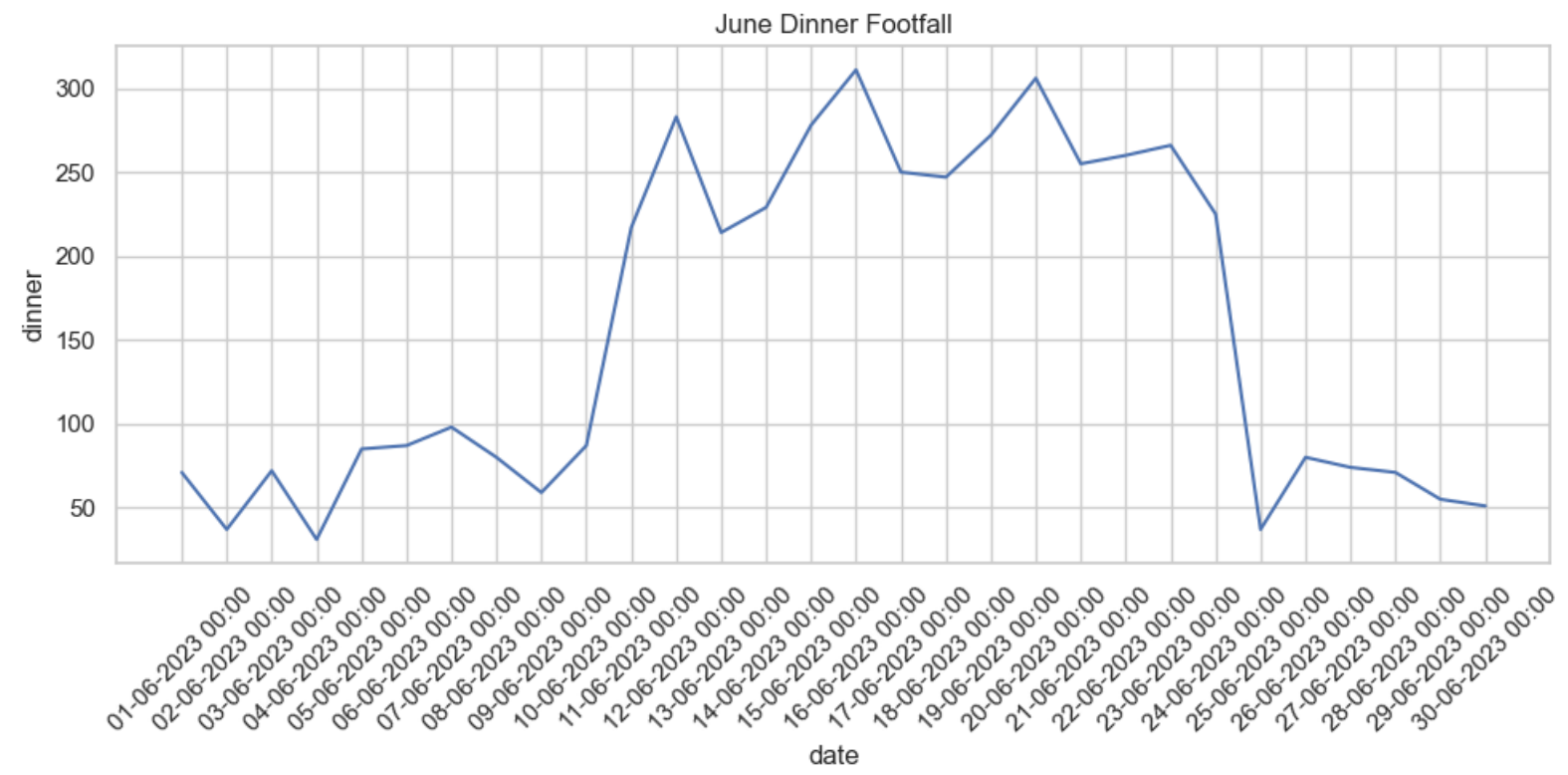
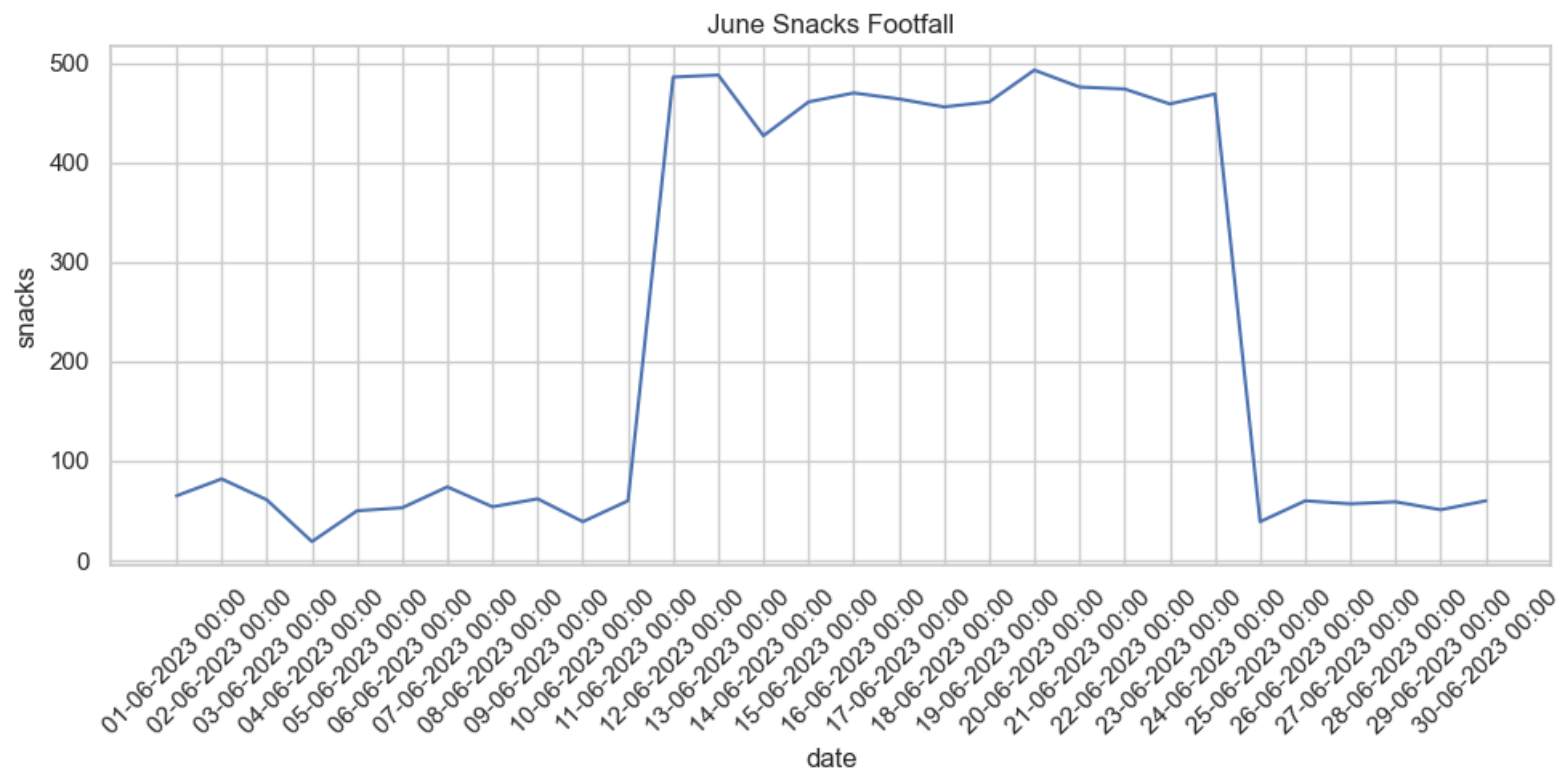
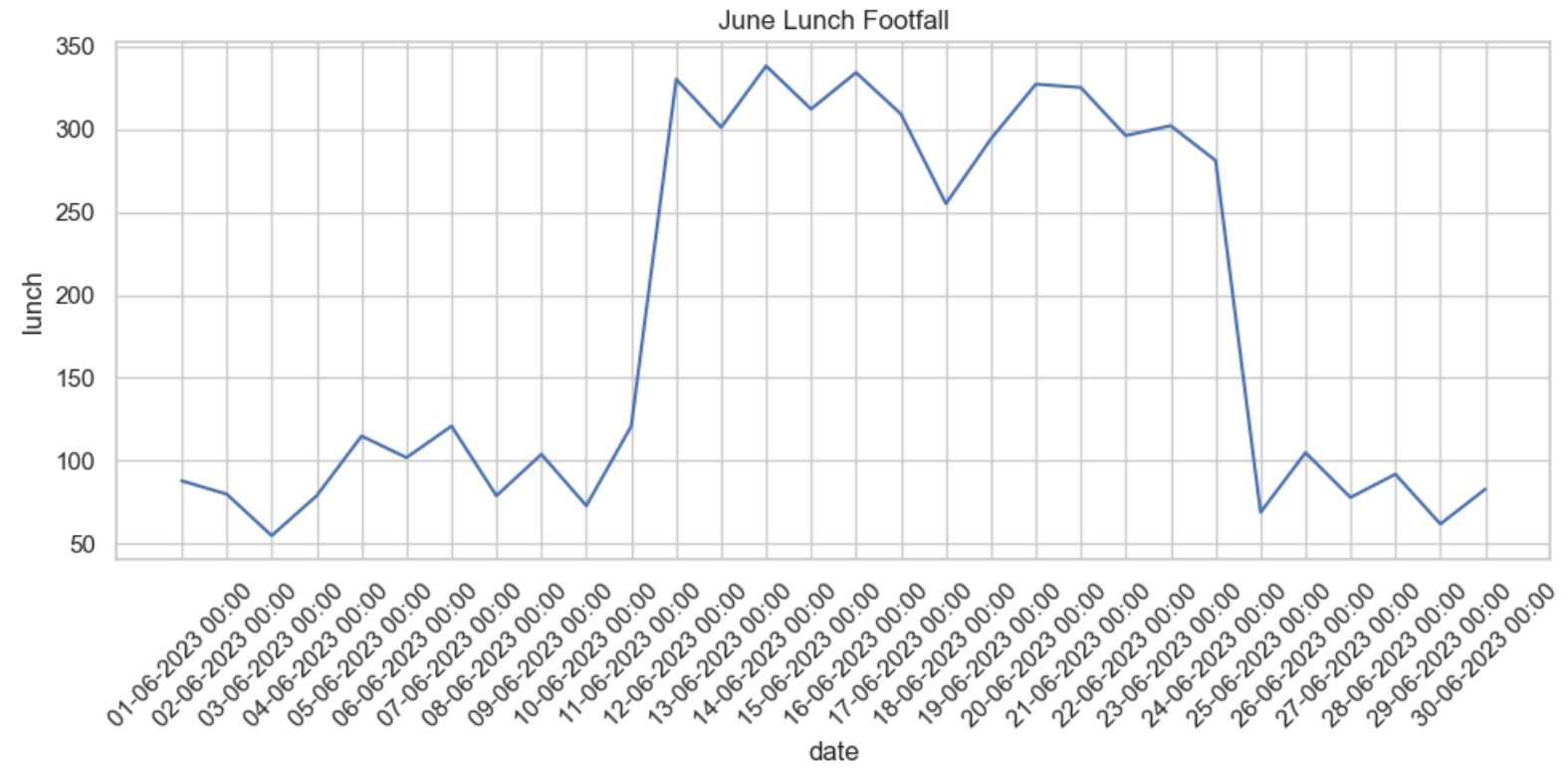
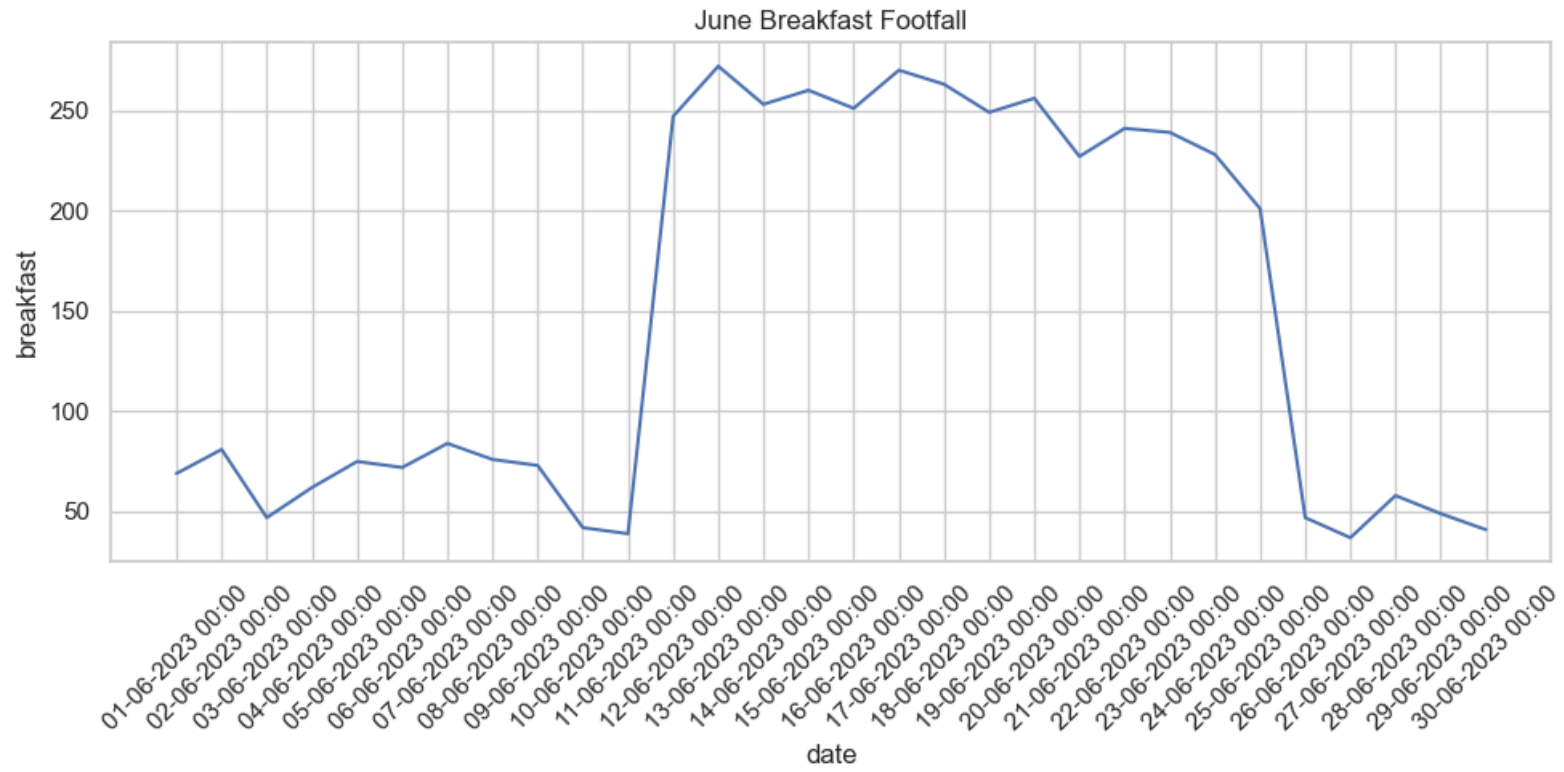
- Highly Unstructured.
- Reliant on secondary sources.
- Purely footfall data.
- We assumed standard Indian population and eating habits, i.e. vegan-centric and roti/rice-centric populace.

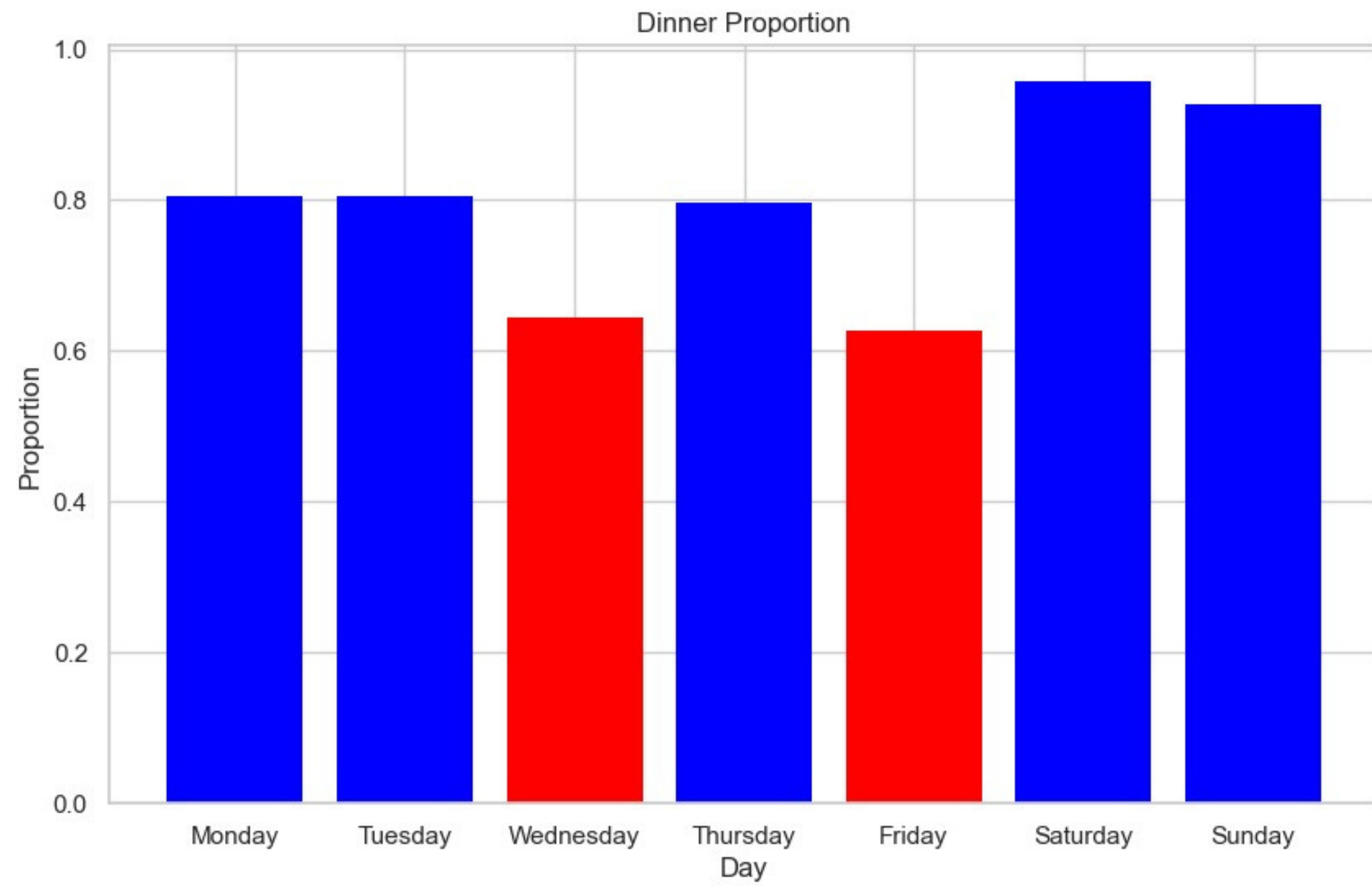
DATE	day	month	bogo	paneer	guest	test	breakf...	lunch_...	snacks...	dinner...	meal_t...	footfall
2023-05-...	Monday	May	1	1	0	0	225	277	225	225	Breakfast	111
2023-05-...	Tuesday	May	0	0	0	0	225	277	225	225	Breakfast	95
2023-05-...	Wednesd...	May	1	1	0	0	225	277	225	225	Breakfast	95
2023-05-...	Thursday	May	0	0	0	0	225	277	225	225	Breakfast	93
2023-05-...	Friday	May	1	1	0	0	225	277	225	225	Breakfast	112
2023-05-...	Saturday	May	0	0	0	0	163	215	163	163	Breakfast	107
2023-05-...	Sunday	May	0	0	0	0	163	215	163	163	Breakfast	85
2023-05-...	Monday	May	0	1	0	0	225	277	225	225	Breakfast	112
2023-05-...	Tuesday	May	0	0	0	0	225	277	225	225	Breakfast	90
2023-05-...	Wednesd...	May	1	1	0	0	225	277	225	225	Breakfast	126
2023-05-...	Thursday	May	0	0	0	0	225	277	225	225	Breakfast	56
2023-05-...	Friday	May	1	1	0	0	225	277	225	225	Breakfast	92
2023-05-...	Saturday	May	0	0	0	0	163	215	163	163	Breakfast	78
2023-05-...	Sunday	May	0	0	0	0	163	215	163	163	Breakfast	83
2023-05-...	Monday	May	0	1	0	0	225	277	225	225	Breakfast	99
2023-05-...	Tuesday	May	0	0	0	0	225	277	225	225	Breakfast	127

	Date	breakfast_merge	lunch_merge	snacks_merge	dinner_merge
0	24-07-2023	Wheatflakes, Baa, Omelette, Aloo Poha, Indori ...	Sweet Lassi, , Dal Fry, Paneer do pyaza, Chic...	Corn sandwich, Tomato Ketchup, Masala Tea, Hot...	Lemonade, Alu beans, , Mix Dal,
1	25-07-2023	Cornflakes, Papaya, BOILED EGGS, Aloo Pyaaz Pa...	Lemonade, Chole masala, Aloo bhaji, , , Phirni	Samosa, ketchup, Masala tea, Hot & Cold Milk	mango tang, Mixed Vegetables, , rajma rasila,
2	26-07-2023	Chocos, muskmelon, Sprouts, besan Chilla with ...	mango tang, , urad dal chilka, Cheese tomato, ...	paneer kathi roll, Tomato Ketchup, Lemon Iced ...	veg raita, Kaddu masala, , Arhar dal,
3	27-07-2023	Chocos, baa, BOILED EGGS, Dal Paratha, Curd & ...	orange tang, Kadhi Pakora, aloo palak, , ,	Dahi bhalla, Green / Red sweet chutney, Lemon ...	Cream Tomato Soup, Red Sauce Pasta, , Cajun Po...
4	28-07-2023	Cornflakes, cut apple, sprouts, Uttapam, Cocon...	Lemonade, , green moong dal, Kadhai Paneer, C...	french fries, chaat masala/Tomato Ketchup, Mas...	SWEET LASSI, black chana, , Kathal masala, Tha...
...
100	20-09-2023	Chocos, guava, chana chaat, Upma, Coconut chutney	Lemonade, , Dal bukhara, Paneer Lajawab, Mala...	Vada Pav, Fried chilli/Thecha chutney, Masala ...	Curd, Stuffed capsicum, , Dal panchratni, moon...
101	21-09-2023	Chocos, Apple, Boiled egg, Masala idli, Sambha...	Minestrone soup, Vegetable stew, Musroom velou...	Mix bhajiya, Chat masala, Lemon Tang, Hot & Co...	Lemon Tang, Veg jalfrezi, , Black masur dal,
	22-09-	Cornflakes, papaya, veg oats, aiwain nuri	Lemon tang, Arhar dal tadka, Palak	Khasta kachori, Tomato Ketchup, Milk	Sweet lassi, Kathal masala, Kadhi pakoda

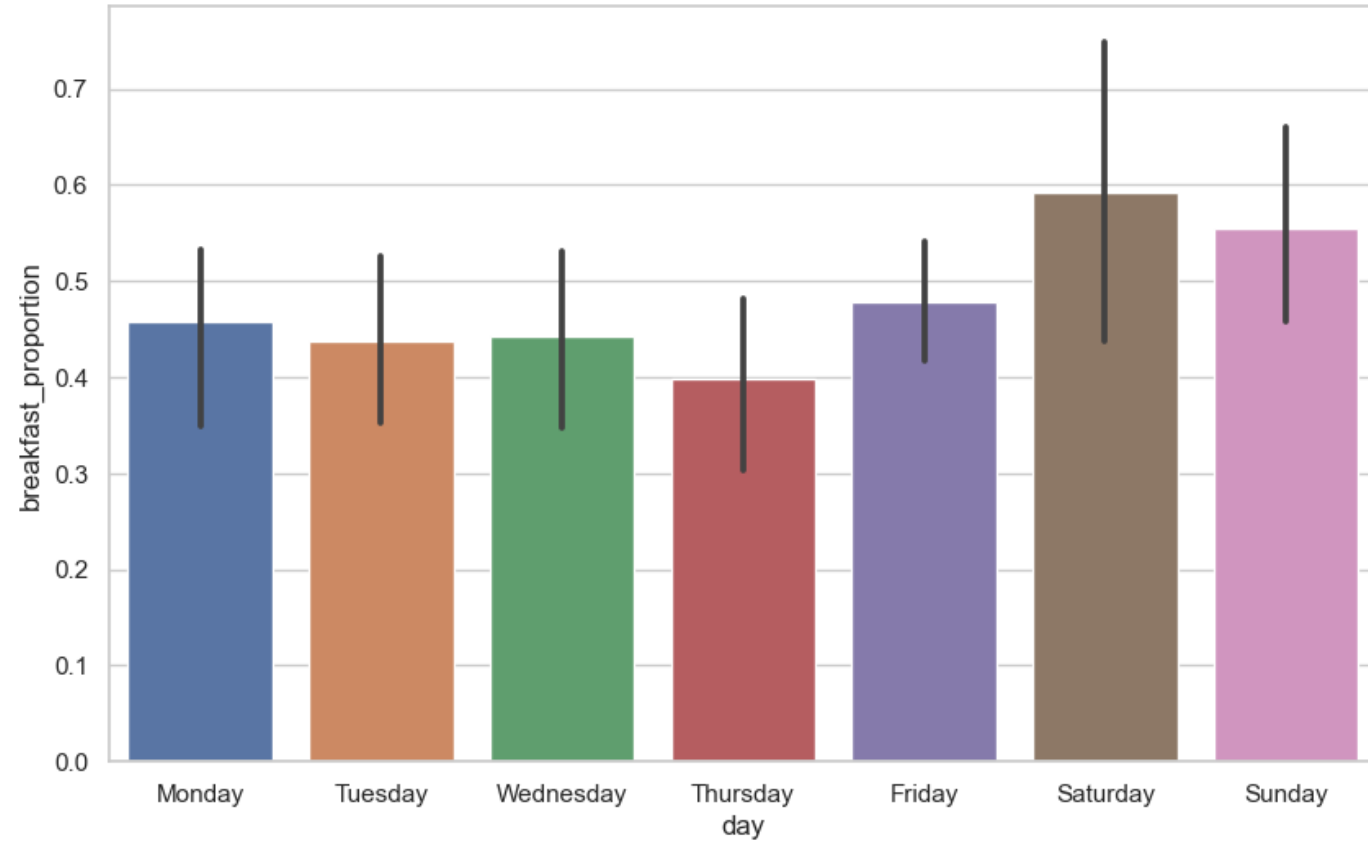


**exploratory
data
analysis.**

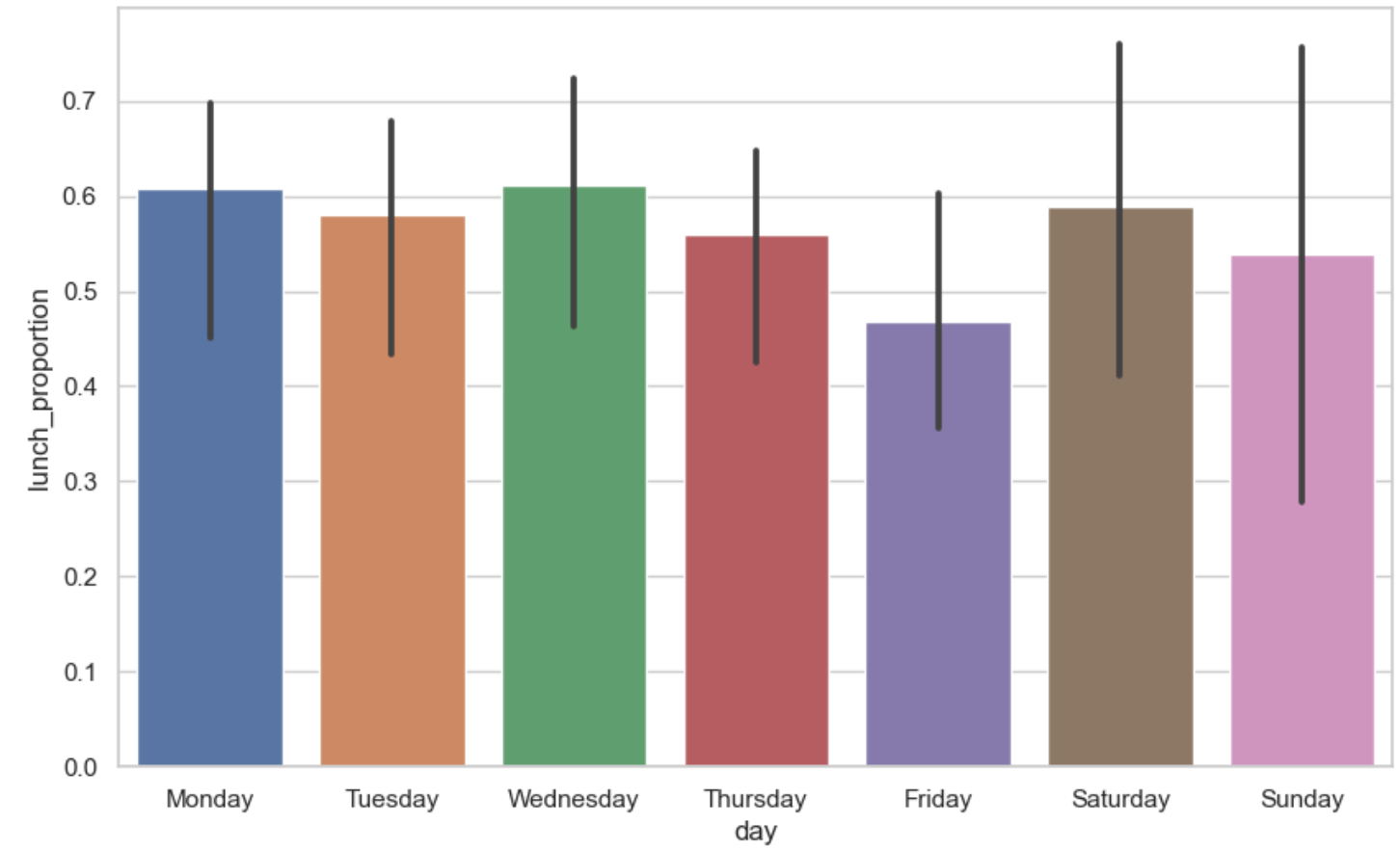




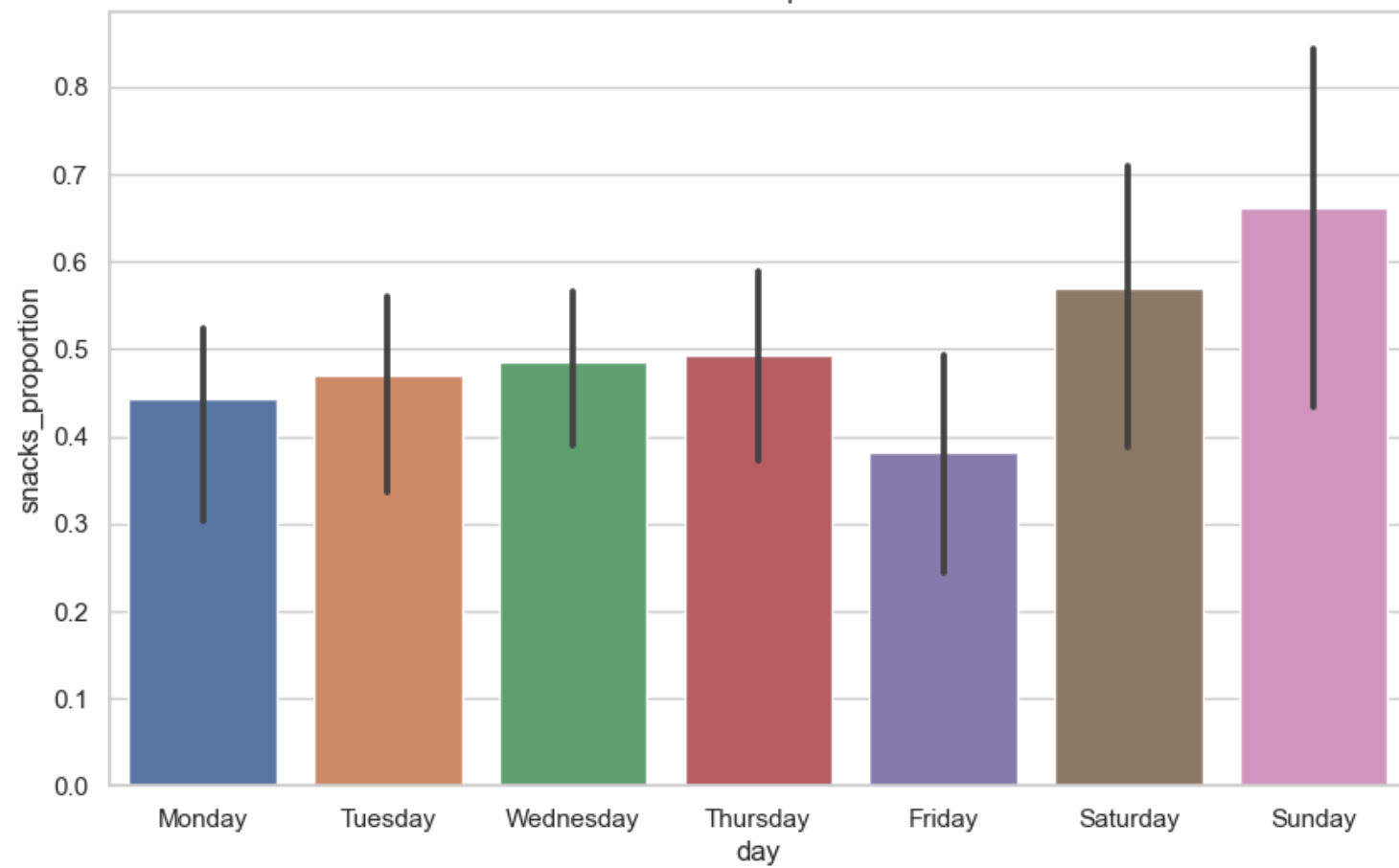
Breakfast Proportion



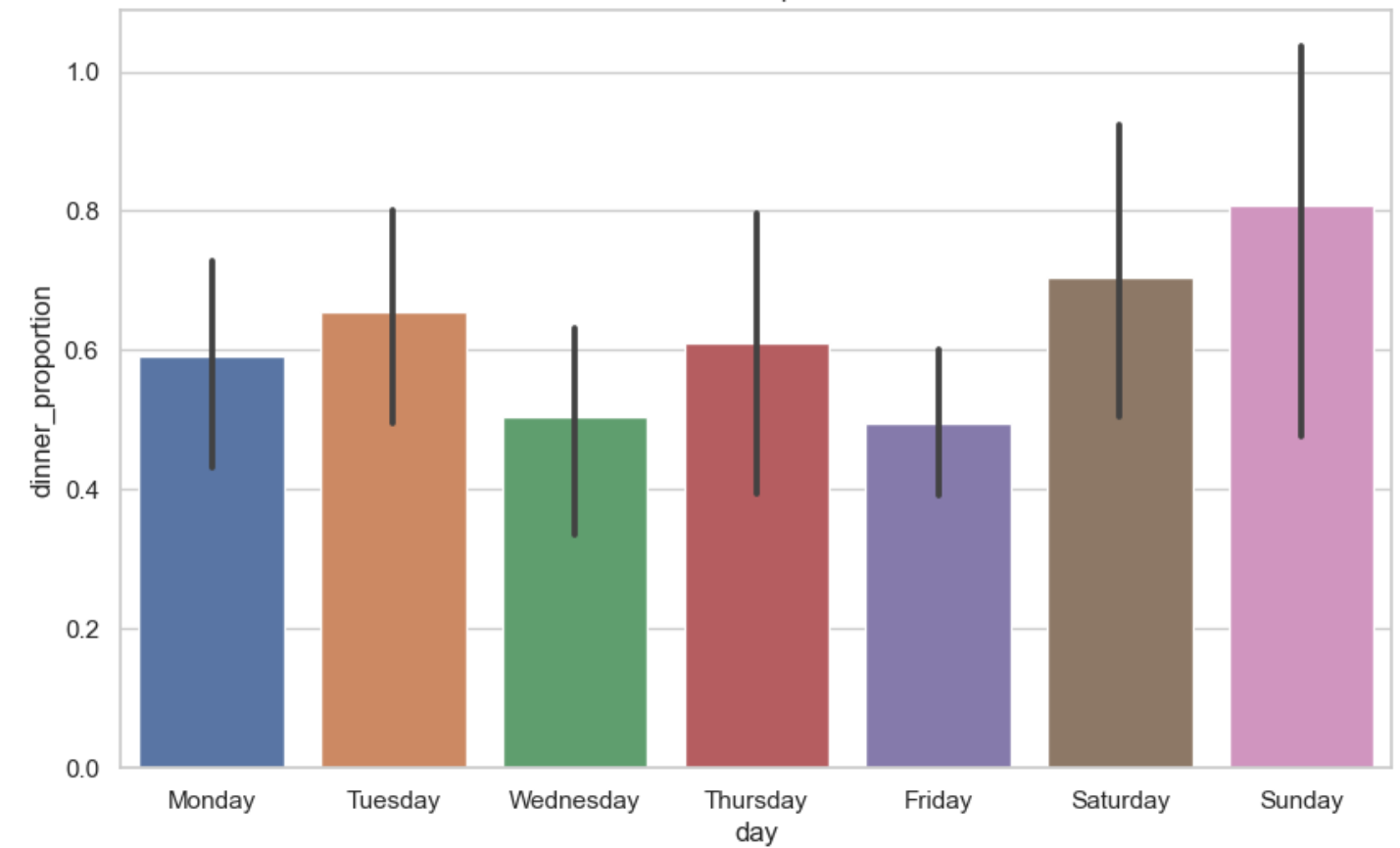
Lunch Proportion



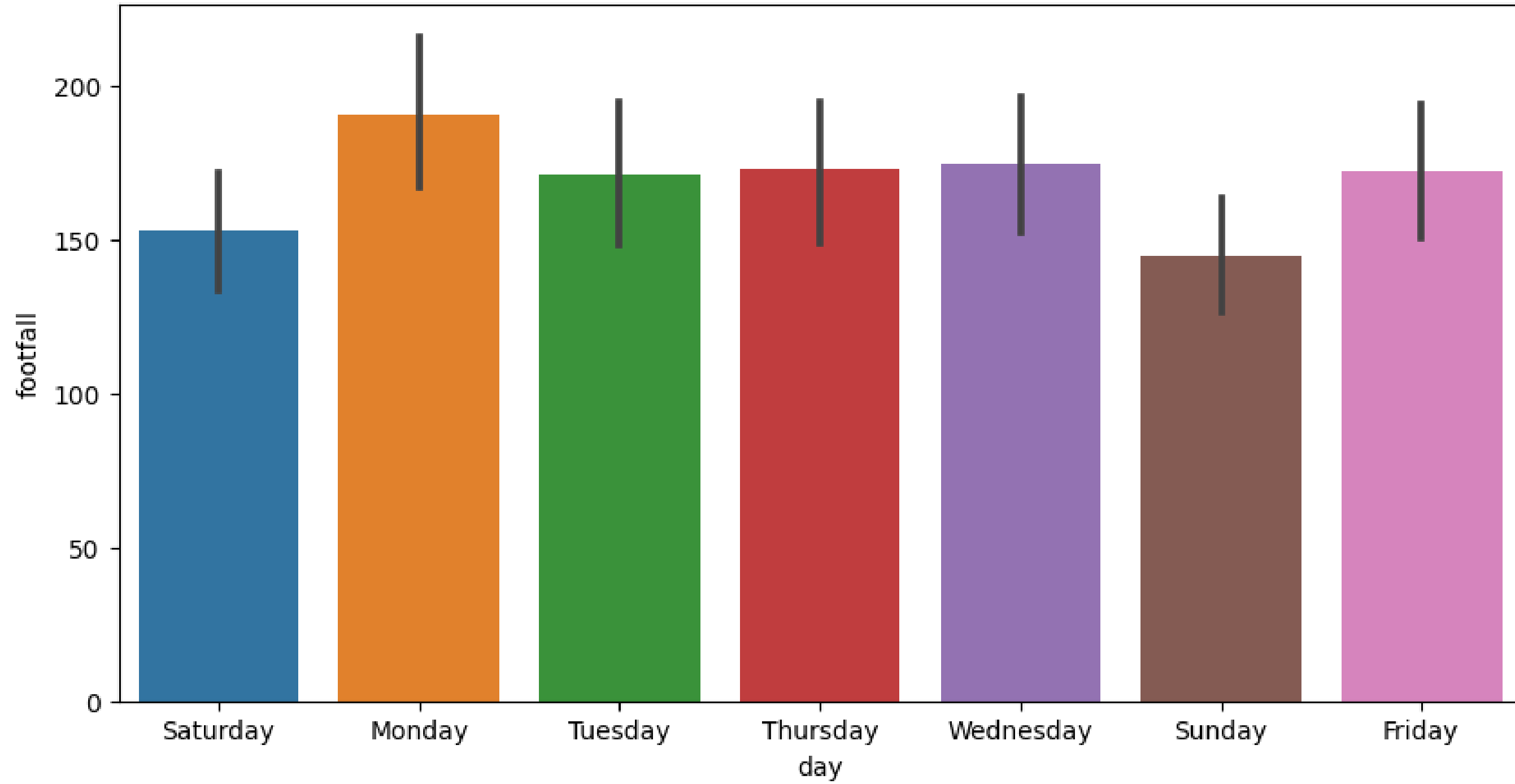
Snacks Proportion



Dinner Proportion



Footfall for each day of the week





ml methodology

feature selection

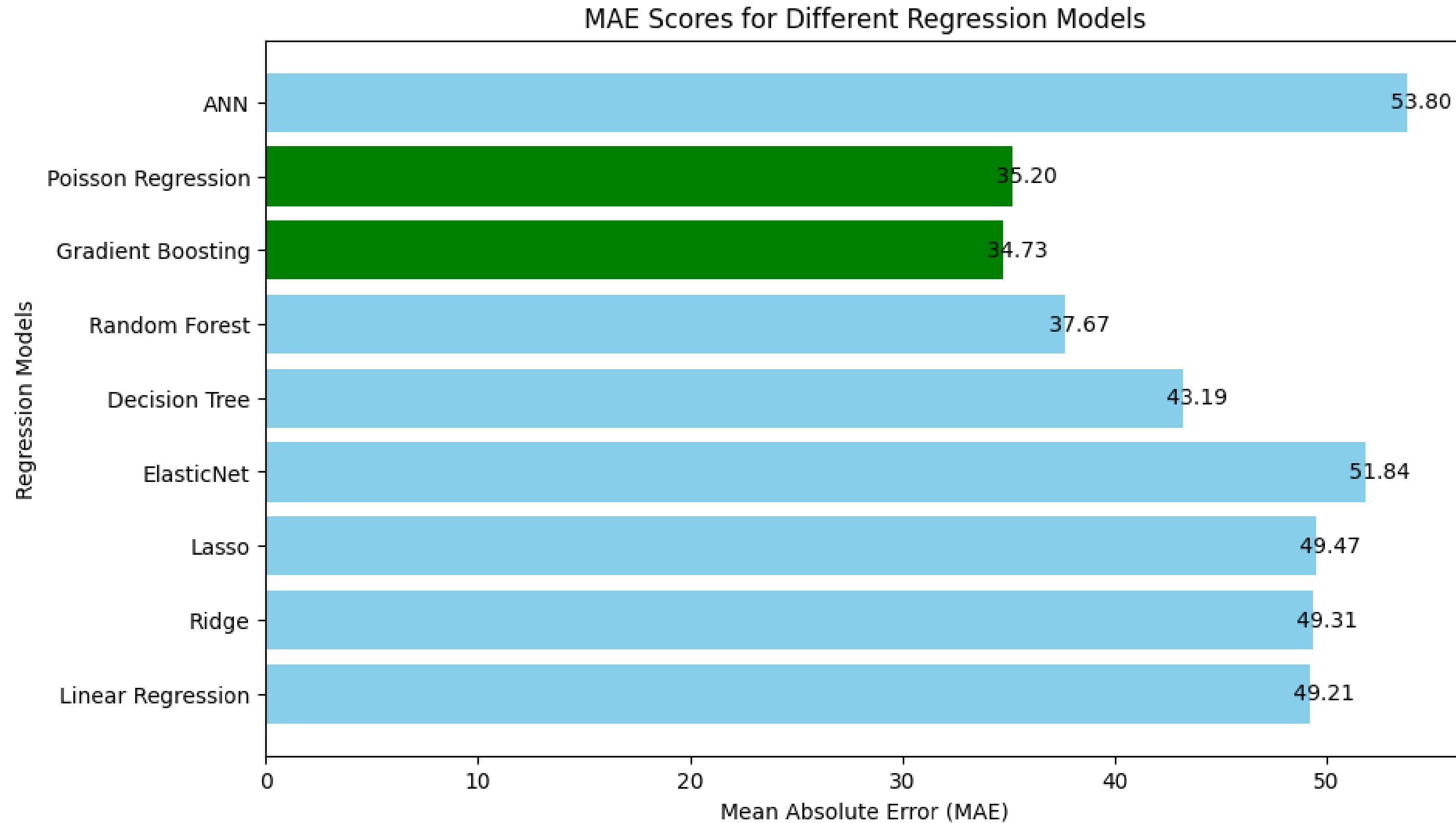
**forward
selection.**

**backward
elimination.**

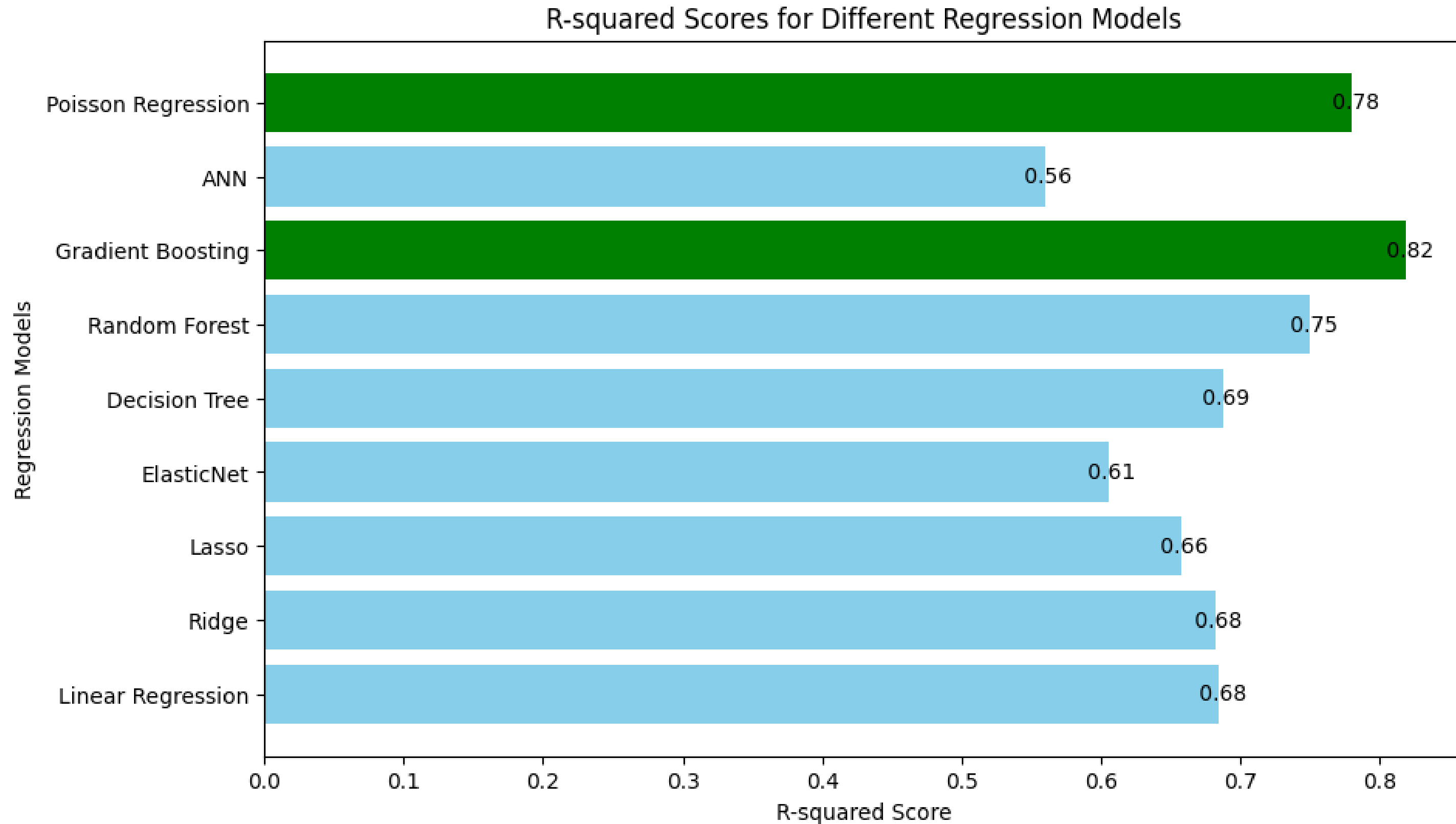
f-tests.



mean absolute error



R - Squared Error

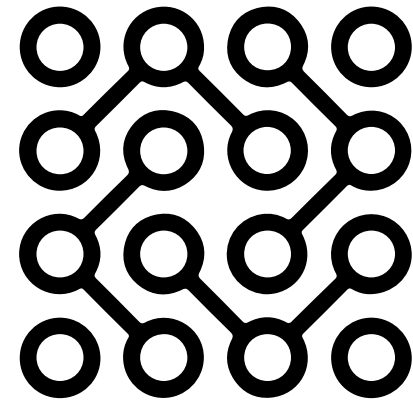


gradient boosting

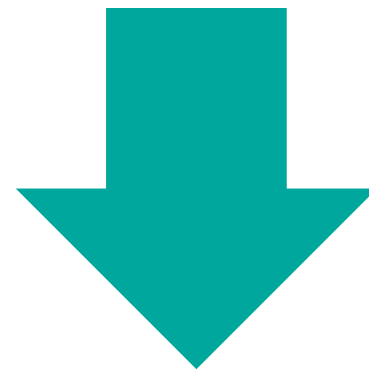
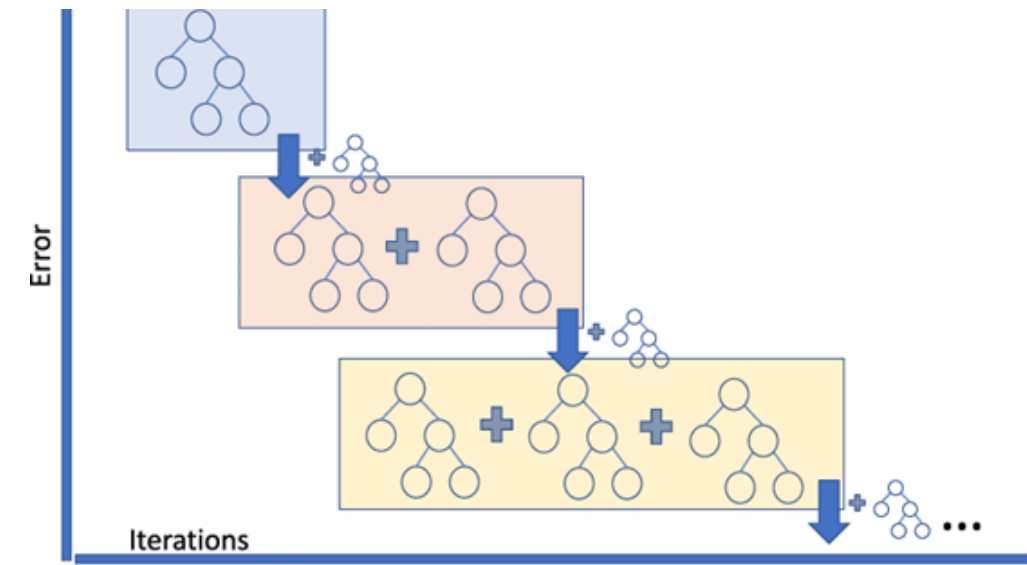
Weak Learner (Decision Trees)



Boosting Concept

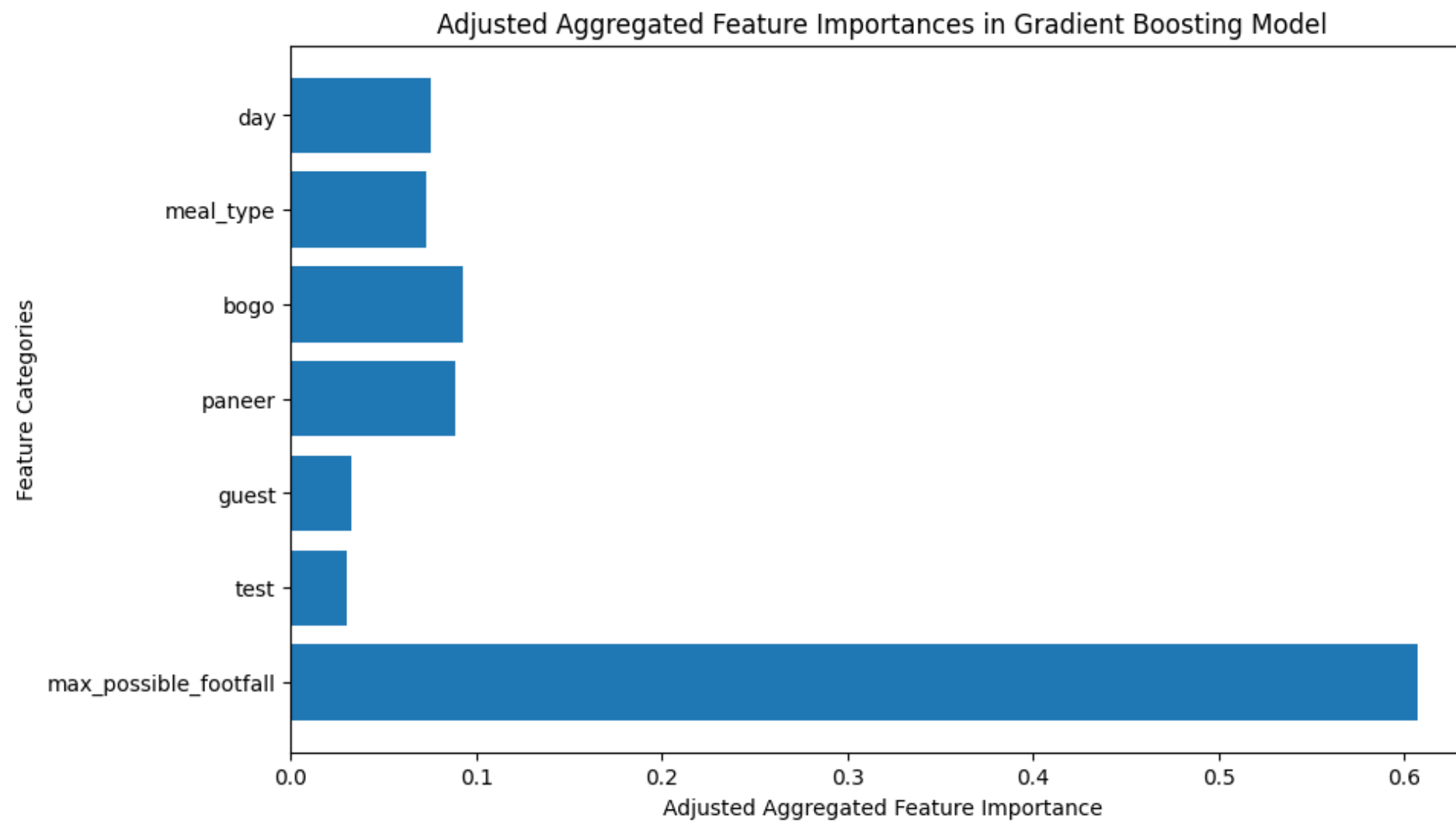


Iterative Training:
and
Combining Trees

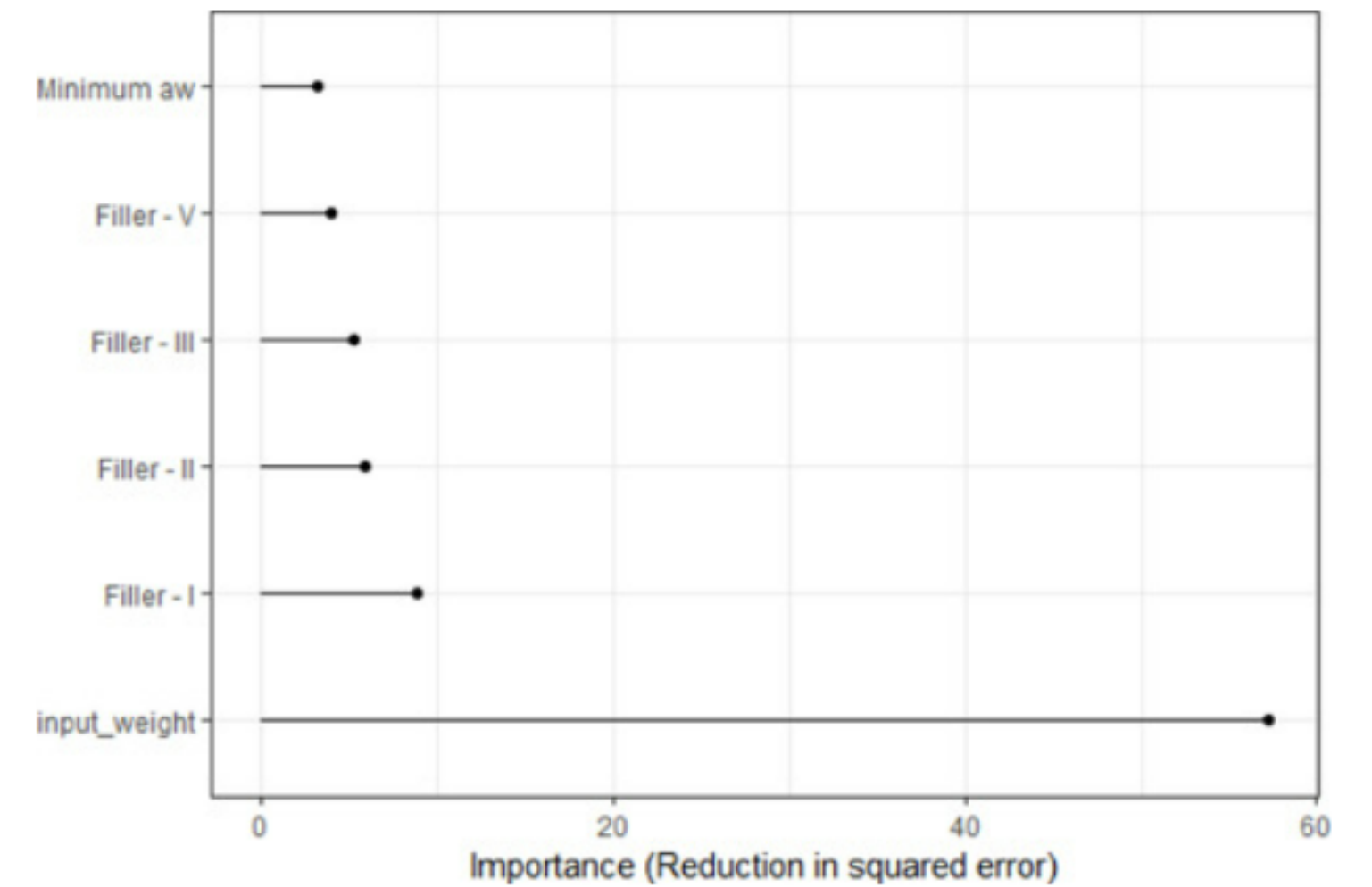


Ensemble Prediction

feature importance - as expected?



SAD Model (our model)

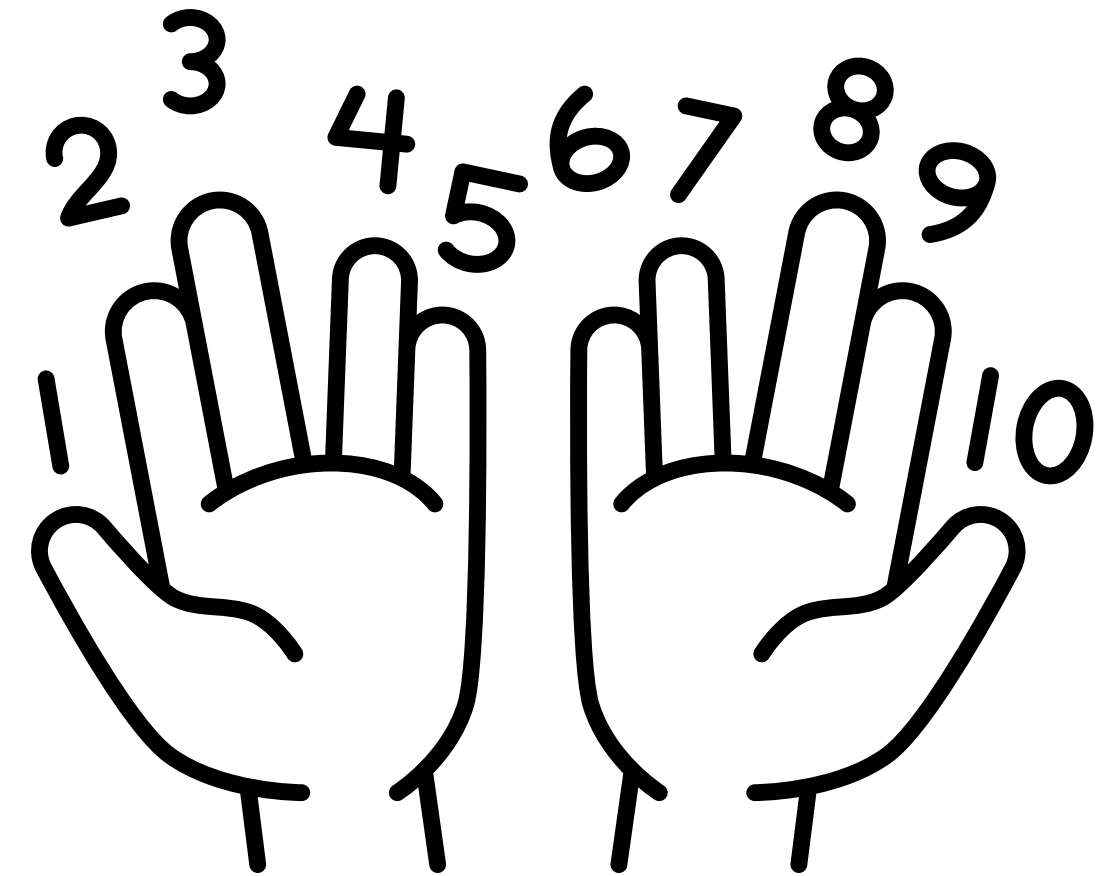


lit - review

models considered

poisson regression

- models the footfall prediction by considering the count nature of the data
- captures the relationship between predictor variables like the meal types and other exogenous variables and the expected footfall count using a Poisson distribution



robustness?

variables	p-values
bogo	0.00
paneer	0.02
guest	0.03
test	0.03
max_possible_footfall	0.00

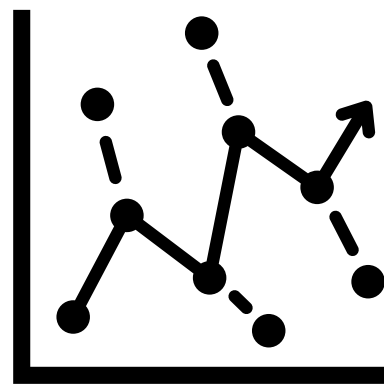
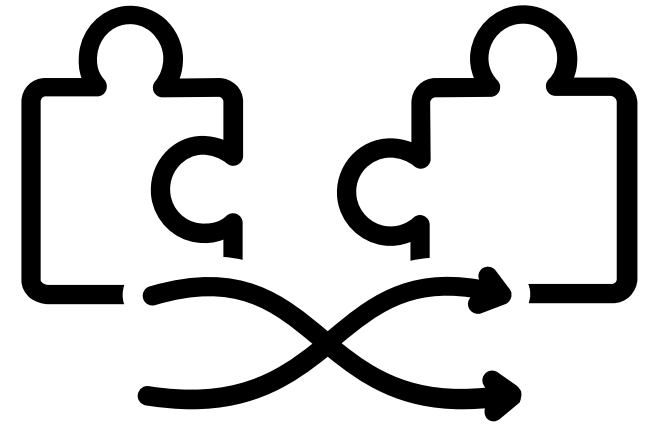
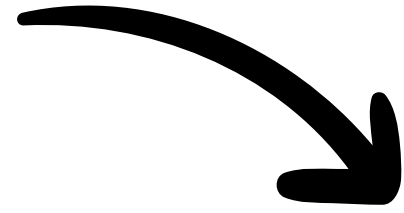
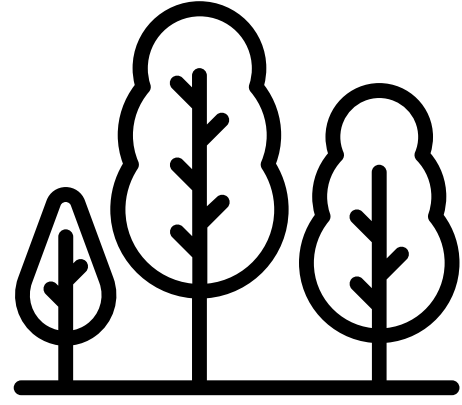
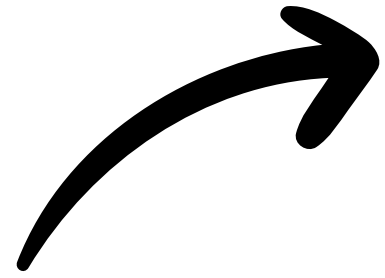
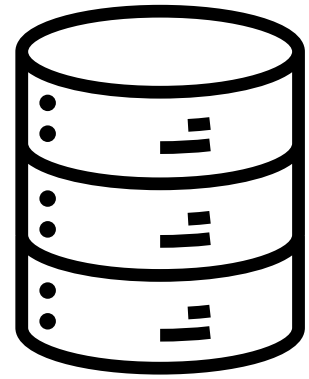
all statistically significant at the 5% significance level

SAD

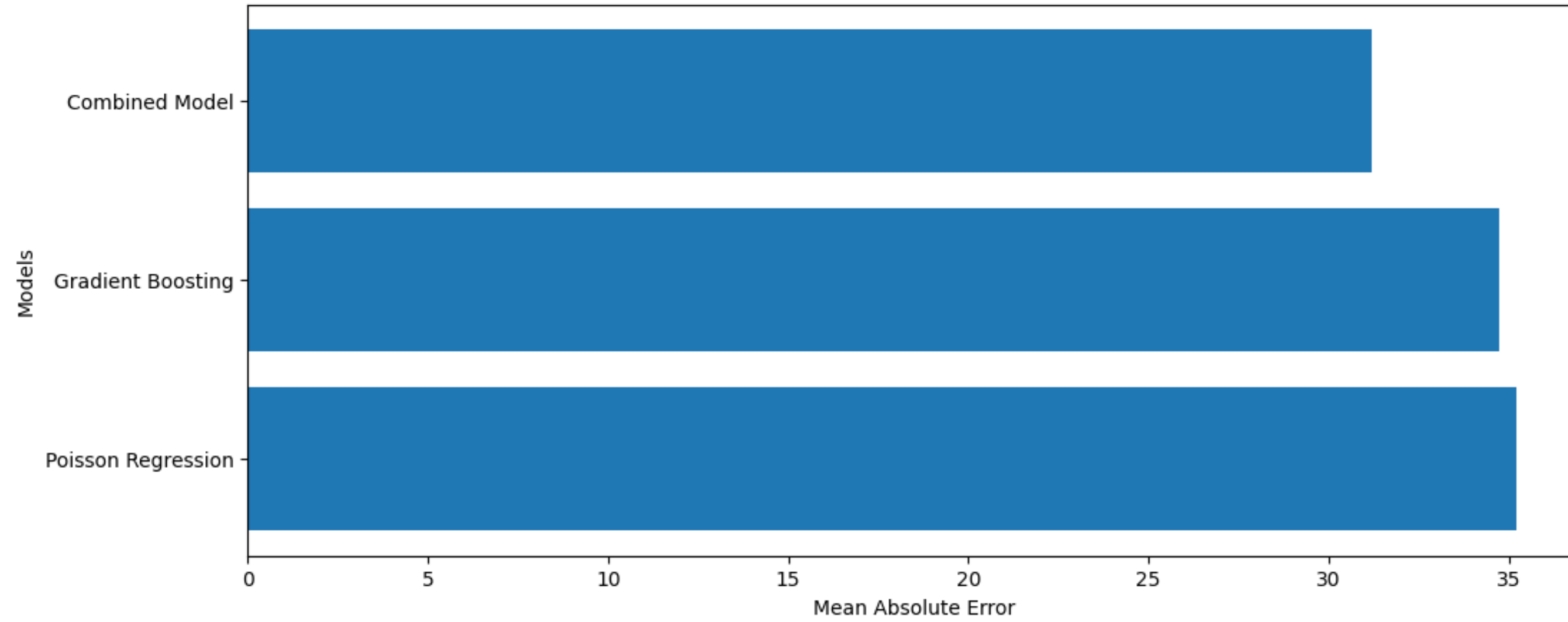
**gradient boosting
+
poisson regression**

addressing the shortcomings of the done research

SAD



Mean Absolute Error for each model

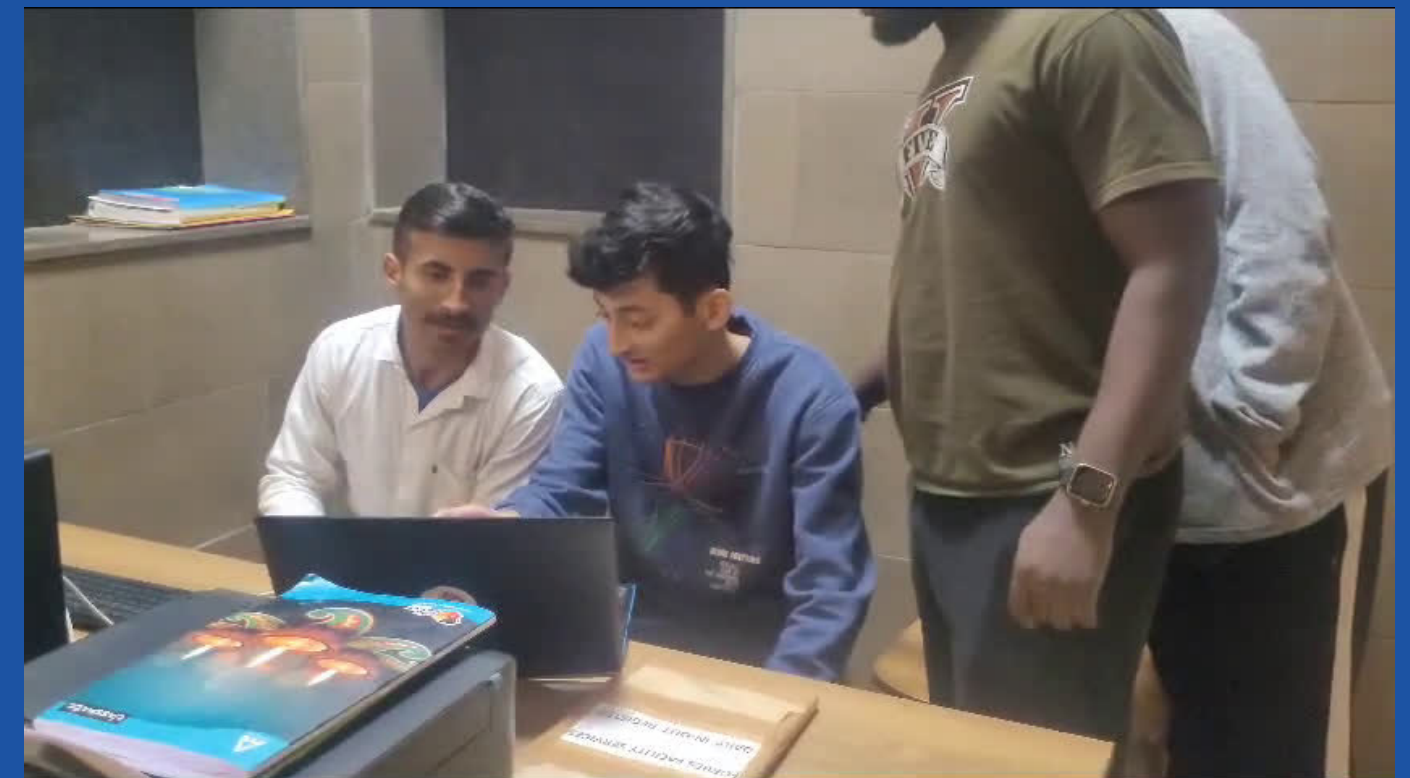


deployment

we've already started ground-level implementation of our models.

Over the past exam week, we've implemented our models to estimate projected footfall and validate our results by co-relating the corresponding values with the team.

This would require us to consistently stay in frequent contact with the mess, and familiarizing the team with our interfaces!



insights?

01

We found out that linear regression models fail to perform due to the non-linear, heterogeneity.

02

Our model could account for a roughly 40% decrease in the food wastage.

03

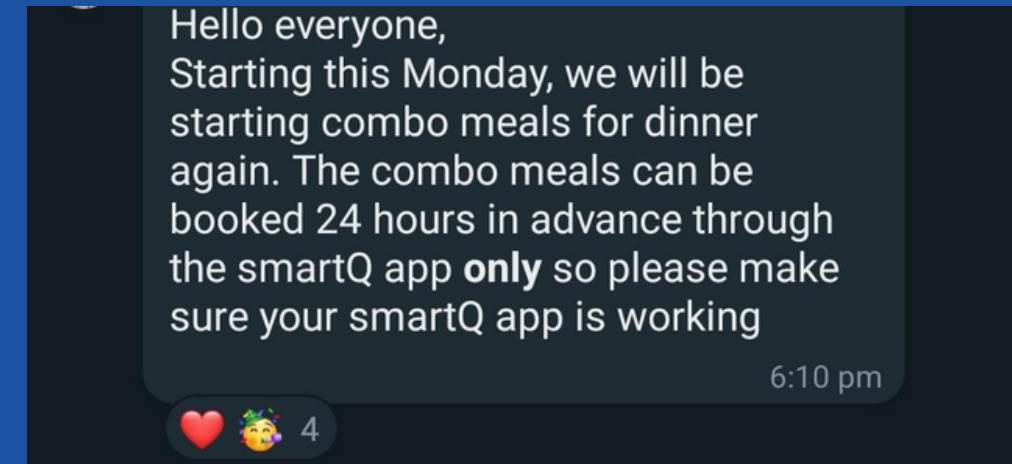
The mess could look towards incorporating more combinations of Panner/Chicken, as we observe a 16% increase.

04

We project a staggering 24% decrease in footfall during weekends, so we would ask decrease in food.

challenges?

- Data - Frequent back and forth with the mess team would need to be resolved.
- Estimating the total number of people on the campus.
- External Shocks (combos!!).
- Getting the team accustomed to our modeling.
- Combos and promos?
- How do we account for mess employees, guards and their consumption.



it's not today, it's almost every time **mess secretary** look into it.

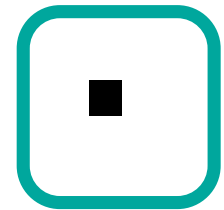
people dont scan

1-5-23	Fruit and vegetable	12.2 Kg	X	X
2-5-23	Fruit and vegetable	12.1 Kg	X	X
3-5-23	Fruit and vegetable	10.2 Kg	X	X
4-5-23	Fruit and vegetable	X	X	X
5-5-23	Fruit and vegetable	X	X	X
6-5-23	Fruit and vegetable	X	X	X
7-5-23	Fruit and vegetable	X	X	X
8-5-23	Fruit and vegetable	X	X	X
9-5-23	Food wastage vegetable	12.3 Kg	X	X
10-5-23	Food wastage vegetable	7.1 Kg	X	X
11-5-23	Food wastage vegetable	10.3 Kg	X	X
12-5-23	Food wastage vegetable	5.1 Kg	X	X
13-5-23	Food wastage vegetable	19.2 Kg	X	X
14-5-23	Food wastage vegetable	10.2 Kg	X	X
15-5-23	Food wastage vegetable	12. Kg	X	X
16-5-23	Food wastage vegetable	6 Kg	X	X
17-5-23	Food wastage vegetable	10.4 Kg	X	X
18-5-23	Food wastage vegetable	9.8 Kg	X	X
19-5-23	Food wastage vegetable	X	X	X
20-5-23	Food wastage vegetable	X	X	X

the future?



Phase 1: Demand Forecasting



Phase 2: Menu Optimization.

thank you!

ye toh badiya he yarr ! - Mukesh(Mess Bro)