Subject Code: BUAN 6337.002 – Predictive Analytics using SAS

A Group Project Report on

ZOMATO PREDICTIVE ANALYSIS

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Table of Contents

List of Figures and Tables 3
ACKNOWLEDGEMENT 4
INTRODUCTION 5
Data Description 6
Table 1: Data Description 6
Data Pre-Processing &Exploratory Data Analysis 7
Figure 1: Location of Countries 7
Figure 2: Location of Cities within India 8
Figure 3.a: Average of Aggregate Ratings for Major Cuisines 9
Figure 3.b: Average Aggregate Ratings for Major Cuisines 9
Figure 4.a: Average of votes for Major Cuisines 10
Figure 4.b: Average of votes for Major Cuisines 10
Figure 5: Average Aggregate Ratings according to number of cuisines offered by the restaurant. 11
Figure 6: Sum of Votes for Each Rating 12
Figure 7: Average Price For Each Major Cuisine 12
Model and Analysis 13
..... 15
Figure 8: Linear Regression 15
Figure 9: LASSO 17
Figure 10: Forward Selection 24
Figure 11: Backward Selection 29
Figure 11: Stepwise Selection 33
Figure 12: Logit Model 35
Figure 13:Probit Model 36
Findings and Managerial Implications 37
Table 2: Results for linear models for Votes 37
Table 3: Results for classification of ratings 37
Conclusion 38
References 39
Appendix 40
SAS Codes 40

List of Figures and Tables

Table 1: Data Description 6
Figure 1: Location of Countries 7
Figure 2: Location of Cities within India 8
Figure 3.a: Average of Aggregate Ratings for Major Cuisines 9
Figure 3.b: Average Aggregate Ratings for Major Cuisines 9
Figure 4.a: Average of votes for Major Cuisines 10
Figure 4.b: Average of votes for Major Cuisines 10
Figure 5: Average Aggregate Ratings according to number of cuisines offered by the restaurant. 11
Figure 6: Sum of Votes for Each Rating 12
Figure 7: Average Price For Each Major Cuisine 12
..... 15
Figure 8: Linear Regression 15
Figure 9: LASSO 17
Figure 10: Forward Selection 24
Figure 11: Backward Selection 29
Figure 11: Stepwise Selection 33
Figure 12: Logit Model 35
Figure 13:Probit Model 36
Table 2: Results for linear models for Votes 37
Table 3: Results for classification of ratings 37

ACKNOWLEDGEMENT

It has been a great opportunity to gain a lot of experience in real time projects, followed by the knowledge of how to design and analyse them. For that we would like to thank our professor, **Dr Shervin Tehrani,** who made it possible. We would like to acknowledge him for his efforts in providing us with useful information and for making the path clear.

INTRODUCTION

Background:

Zomato is an Indian restaurant search and discovery service founded in 2008 by Deepinder Goyal and Pankaj Chaddah. It currently operates in 24 countries. It provides information and reviews of restaurants, including images of menus where the restaurant does not have its own website and also online delivery.

In 2011, Zomato launched in Bengaluru, Pune, Chennai, Hyderabad and other cities.In September 2012, Zomato expanded overseas to the UAE, Sri Lanka, Qatar, UK, the Philippines, and South Africa.In April 2014, Zomato launched its services in Portugal, followed by launches in Canada, Lebanon and Ireland the same year. The acquisition of Seattle-based food portal Urbanspoon marked the firm's entry into the United States , Canada and Australia, and brought it into direct competition with Yelp, Zagat and OpenTable.

Objective:

The objective of our project or the research question which we were considering are as follows:

- **What factors drive the customers to vote for the restaurants on Zomato?**
- **How people rate a restaurant based on certain parameters?**

As, we can see that Zomato takes input from the customer to rate the restaurants which can be further used by other customers. So, we are using the inputs given by the data to find the factors which affect how the customers rate a restaurant.

Data Description

The data which was given to us can be summarised as follows:

- Initially we had 9,551 Restaurants and 21 attributes.
- The total number of countries were 15 in the dataset.
- 8,649 restaurants belong to India and 899 restaurants from other 14 countries of the globe
- Hence, we chose India for our major analysis of the restaurants.

Data Fields:

Variable Name	Description
Restaurant Id	Unique identifier for each restaurant in dataset
Restaurant Name	Restaurant names
Country Code	Country code in which the restaurant is situated
City	City names in which the restaurant is situated
Address	Address of the restaurant
Locality	Locality in which the restaurant is situated
Longitude	Latitude of the restaurant is situated.
Cuisines	Different types of cuisines provided by the restaurant
Average Cost for two	Average cost for two people visiting the restaurant.
Currency	Currency in which the average cost is mentioned
Has Table booking	Binary variable for table booking.
Has Online delivery	Binary variable if the restaurant has online delivery or not.
Price range	Expected price range for two people in the restaurant
Aggregate Rating	Average rating of the restaurant
Votes	Number of votes received by the votes

Table 1: Data Description

Data Pre-Processing &Exploratory Data Analysis

- The Dataset had 9551 records, out of which there were in 9 missing values in the Average Cost for Two columns and 1093 restaurants that received no votes, these rows were dropped before we began our exploratory analysis.
- The country codes were changed to the country name using the country codes file that was provided along with the dataset. The original Dataset had 75 unique cuisines which were classified into 15 primary cuisines.
- Since, India had the maximum number of restaurants (8649), it was selected for analysis and grouped into 'New Delhi' and 'Others'.
- New Delhi had 5,743 restaurants while all other remaining were in other cities of India.
- New Variables like Number of Cuisines offered by the restaurant and Major Cuisines were synthesized.

Figure 1: Location of Countries

- From Figure 1, we observe that the dataset had 15 countries, out of which New Zealand had no data. Since India had the greatest number of restaurants (8649) while all others countries combined had a 899 restaurants. As a result, India was selected for further analysis.

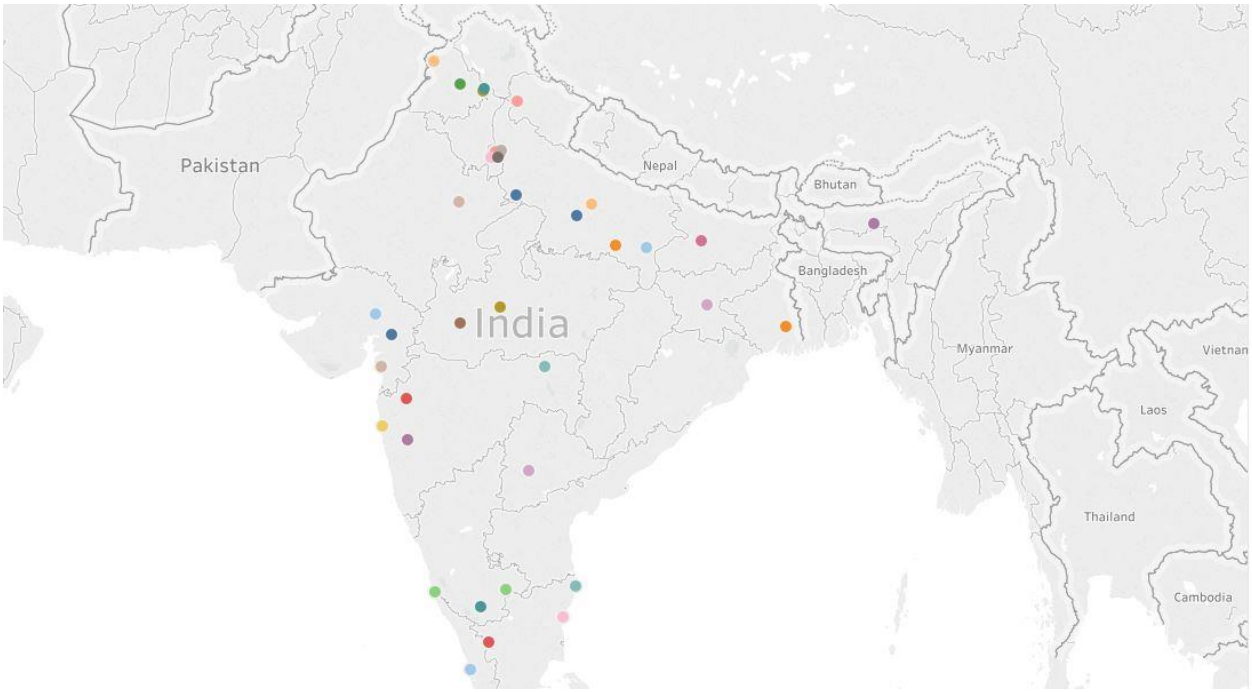

Figure 2: Location of Cities within India

- Figure 2 shows us the different location of cities within India. A total of 43 distinct cities in India were present within the dataset, however since 5,473 Restaurants were present in the capital New Delhi while the rest 3,170 were located in the other 42 cities of India, so were grouped the cities column into 'New Delhi' and 'Others'.

Figure 3.a: Average of Aggregate Ratings for Major Cuisines

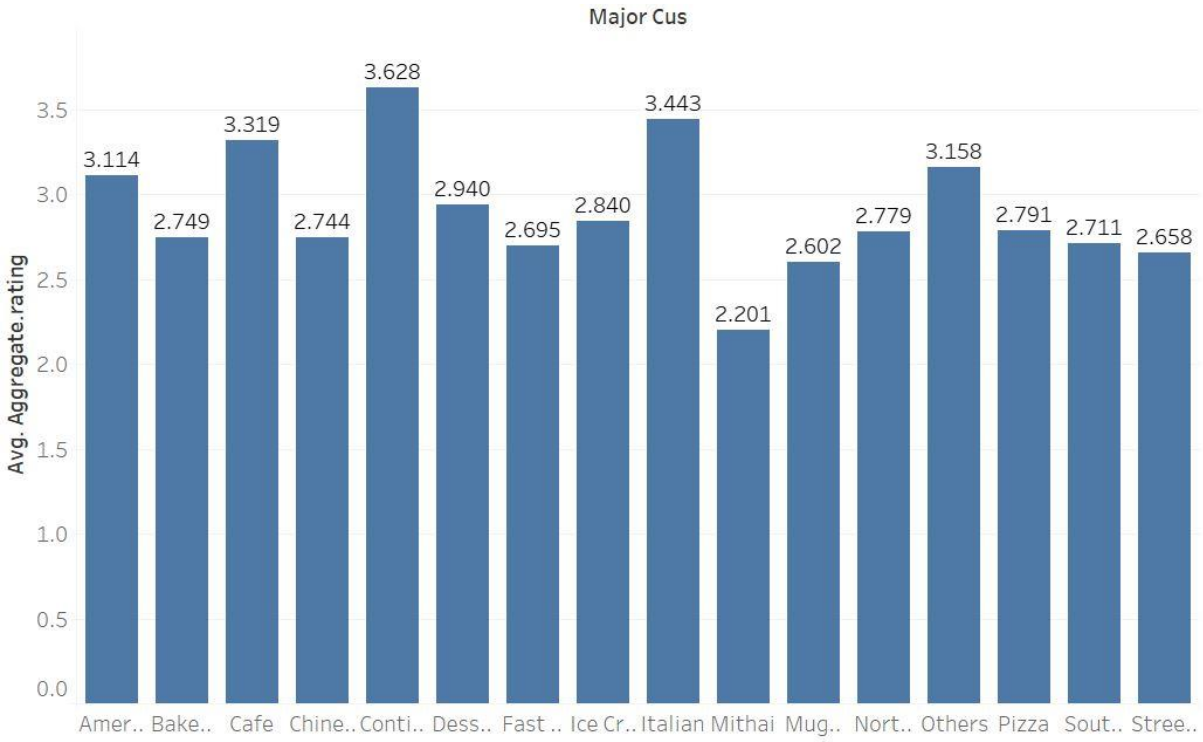

Figure 3.b: Average Aggregate Ratings for Major Cuisines

- Figure 3.a shows the average of Aggregate ratings for Major Cuisines. We see that American, Continental and Italian have higher aggregate ratings in comparison to the other cuisines which is a little surprising considering that most of the restaurants are situated in New Delhi from where the North Indian cuisine originates.

- From Figure 3.b we see that the average Aggregate ratings for Continental is 3.628 followed by Italian (3.443) and American (3.114). North Indian, the traditional food of New Delhi where the maximum restaurants are located has an average aggregate rating of 2.779.

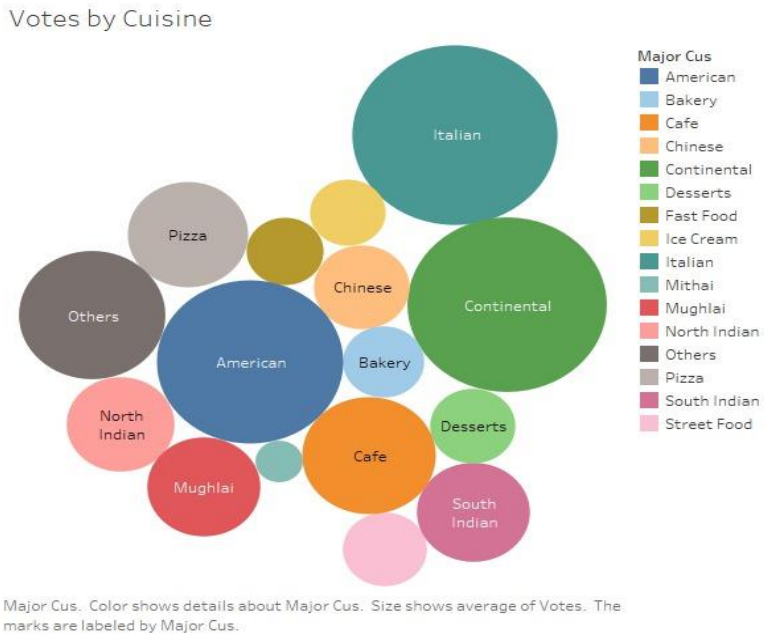

Figure 4.a: Average of votes for Major Cuisines

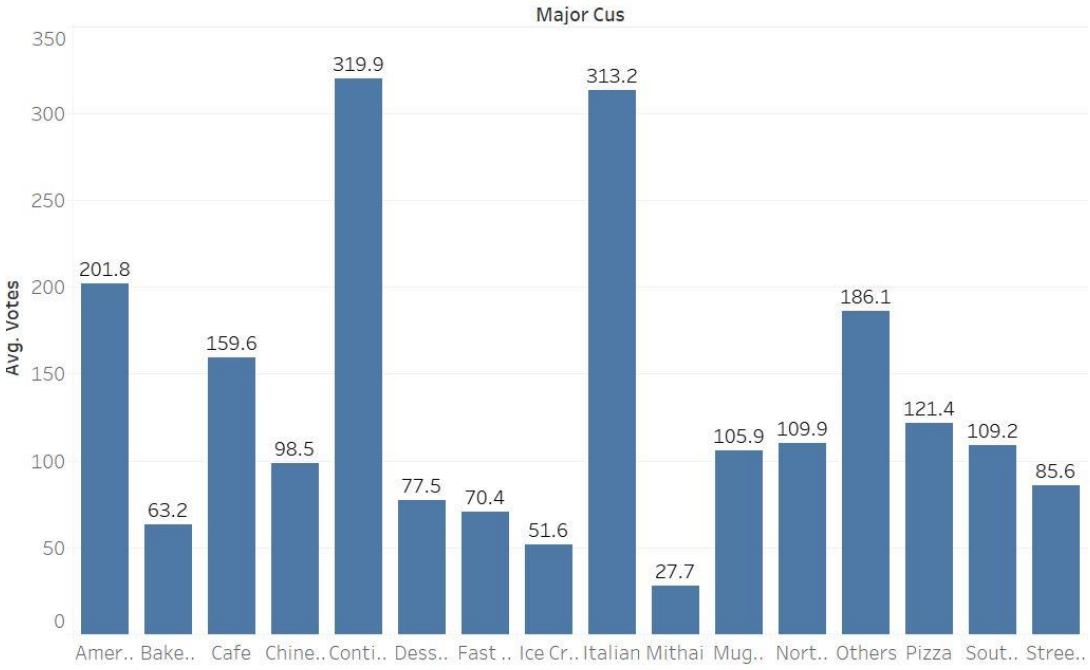

Figure 4.b: Average of votes for Major Cuisines

- Figure 4.a shows the average of Votes for Major Cuisines. We see that American, Continental and Italian have higher average votes in comparison to the other cuisines which is a little surprising considering that most of the restaurants are situated in New Delhi from where the North Indian cuisine originates.

- From Figure 4.b we see that the average votes for Continental is 319.9 followed by Italian (313.2) and American (201.8). North Indian, the traditional food of New Delhi where the maximum restaurants are located has an average vote of 109.9.

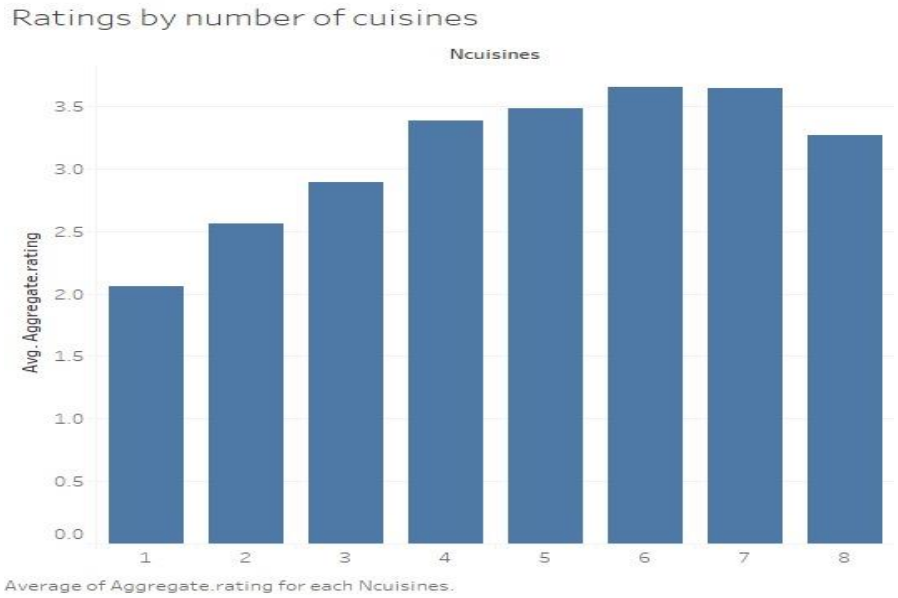

Figure 5: Average Aggregate Ratings according to number of cuisines offered by the restaurant.

- From Figure 5, we observe that the average aggregate ratings increase as the number of cuisines offered by the restaurant increase, however after 6 cuisines, the average aggregate ratings experience a drop.

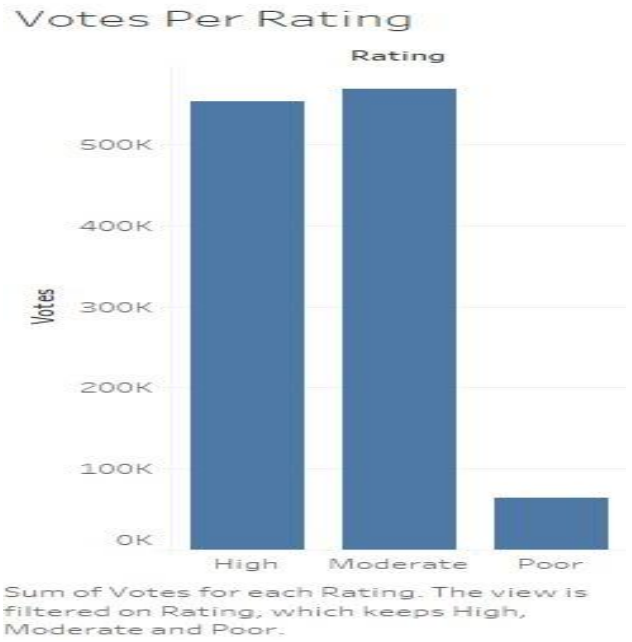

Figure 6: Sum of Votes for Each Rating

- From figure 6, we observe that High and Moderate categories have the most votes.

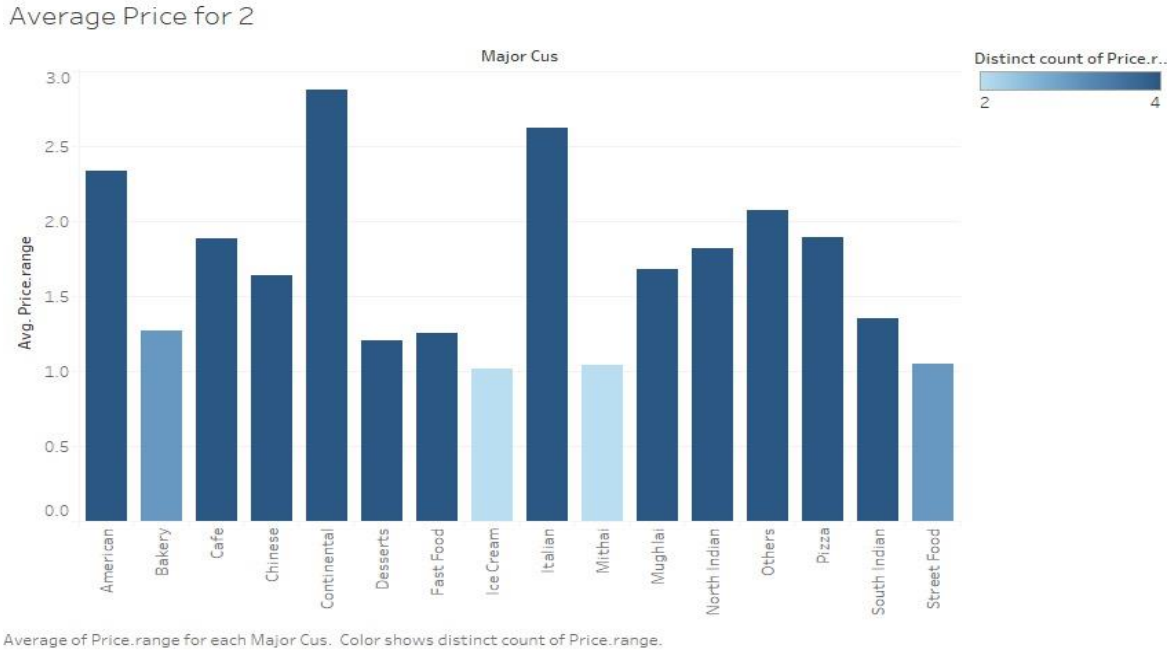

Figure 7: Average Price For Each Major Cuisine

- Figure 7 shows that the continental has the highest average price range followed by Italian and American. The colour coding shows the distinct count of the price range with the lighest being 2 and darkest being 4.

Model and Analysis

- We used Linear Regression, LASSO, Forward, Backward and stepwise selection for votes. For finding out how people rate a restaurant based on certain parameters, we used logit and probit model in SAS

Linear Regression:

The GLM Procedure

Class Level Information

Class	Levels	Values
MajorCus	16	American Bakery Cafe Chinese Continental Desserts Fast Food Ice Cream Italian Mithai Mughlai North Indian Others Pizza Street Food South Indian
City	2	New Delh Others
Has_Online_delivery	2	Yes No
Has_Table_booking	2	Yes No
Price_range	4	2 3 4 1

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	-31.8909646	B	30.2848184	-1.05	0.2924
Price_range 2	84.8017998	B	30.7082289	2.76	0.0058
Price_range 3	467.0930047	B	101.9364496	4.58	<.0001
Price_range 4	240.6158144	B	219.0375843	1.10	0.2720
Price_range 1	0.0000000	B	.	.	.
MajorCus American	-29.8175059	B	131.8689081	-0.23	0.8211
MajorCus Bakery	-14.7624795	B	34.2786299	-0.43	0.6667
MajorCus Cafe	10.8668961	B	36.1489382	0.30	0.7637
MajorCus Chinese	-14.6584027	B	34.8809085	-0.42	0.6743
MajorCus Continental	-22.9393130	B	68.2709752	-0.34	0.7369
MajorCus Desserts	38.7421217	B	49.6972769	0.78	0.4357
MajorCus Fast Food	14.3077491	B	34.3481825	0.42	0.6770
MajorCus Ice Cream	-21.8998503	B	44.8143073	-0.49	0.6251
MajorCus Italian	103.3281509	B	76.2321372	1.36	0.1753
MajorCus Mithai	-25.7370900	B	44.5025644	-0.58	0.5631
MajorCus Mughlai	30.1853464	B	56.3518354	0.54	0.5922
MajorCus North Indian	-20.1010493	B	30.9681489	-0.65	0.5163
MajorCus Others	10.4523476	B	33.5077813	0.31	0.7551
MajorCus Pizza	-10.5869522	B	58.3383736	-0.18	0.8560
MajorCus Street Food	-30.7282721	B	47.8577811	-0.64	0.5208
MajorCus South Indian	0.0000000	B	.	.	.
City New Delh	14.3725817	B	31.5973537	0.45	0.6492
City Others	0.0000000	B	.	.	.
Has_Online_delivery Yes	61.5362765	B	5.8462725	10.53	<.0001
Has_Online_delivery No	0.0000000	B	.	.	.
Has_Table_booking Yes	29.7382557	B	9.7221175	3.06	0.0022
Has_Table_booking No	0.0000000	B	.	.	.
ncuisines	62.1643127		8.0653140	7.71	<.0001
ncuisines_log	-81.0283076		17.9447150	-4.52	<.0001
MajorCus*Price_range American 2	-74.1636831	B	131.6749452	-0.56	0.5733
MajorCus*Price_range American 3	-245.5366443	B	168.5513107	-1.46	0.1452
MajorCus*Price_range American 4	287.4132026	B	260.2512606	1.10	0.2695
MajorCus*Price_range American 1	0.0000000	B	.	.	.
MajorCus*Price_range Bakery 2	-42.5101803	B	38.4336089	-1.11	0.2687
MajorCus*Price_range Bakery 3	-428.8489007	B	119.0330236	-3.60	0.0003
MajorCus*Price_range Bakery 1	0.0000000	B	.	.	.
MajorCus*Price_range Cafe 2	2.0681446	B	37.6946508	0.05	0.9562
MajorCus*Price_range Cafe 3	-272.5184685	B	106.1852194	-2.57	0.0103
MajorCus*Price_range Cafe 4	-159.1174760	B	231.5063592	-0.69	0.4919
MajorCus*Price_range Cafe 1	0.0000000	B	.	.	.
MajorCus*Price_range Chinese 2	-57.9747022	B	36.1183694	-1.61	0.1085
MajorCus*Price_range Chinese 3	-251.4000809	B	104.8203691	-2.40	0.0165
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MajorCus Street Food	-30.7282721	B	47.8577811	-0.64	0.5208
MajorCus South Indian	0.0000000	B	.	.	.
City New Delh	14.3725817	B	31.5973537	0.45	0.6492
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ncuisines	62.1643127		8.0653140	7.71	<.0001
ncuisines_log	-81.0283076		17.9447150	-4.52	<.0001
MajorCus*Price_range American 2	-74.1636831	B	131.6749452	-0.56	0.5733
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MajorCus*Price_range American 1	0.0000000	B	.	.	.
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MajorCus*Price_range Bakery 3	-428.8489007	B	119.0330236	-3.60	0.0003
MajorCus*Price_range Bakery 1	0.0000000	B	.	.	.
MajorCus*Price_range Cafe 2	2.0681446	B	37.6946508	0.05	0.9562
MajorCus*Price_range Cafe 3	-272.5184685	B	106.1852194	-2.57	0.0103
MajorCus*Price_range Cafe 4	-159.1174760	B	231.5063592	-0.69	0.4919
MajorCus*Price_range Cafe 1	0.0000000	B	.	.	.
MajorCus*Price_range Chinese 2	-57.9747022	B	36.1183694	-1.61	0.1085
MajorCus*Price_range Chinese 3	-251.4000809	B	104.8203691	-2.40	0.0165
MajorCus*Price_range Chinese 4	-133.2889062	B	223.2014744	-0.60	0.5504
MajorCus*Price_range Chinese 1	0.0000000	B	.	.	.
MajorCus*City American New Delh	-9.8243682	B	50.4831607	-0.19	0.8457
MajorCus*City American Others	0.0000000	B	.	.	.
MajorCus*City Bakery New Delh	-1.4283496	B	37.5014333	-0.04	0.9696
MajorCus*City Bakery Others	0.0000000	B	.	.	.
MajorCus*City Cafe New Delh	-17.5106656	B	37.0332509	-0.47	0.6363
MajorCus*City Cafe Others	0.0000000	B	.	.	.
MajorCus*City Chinese New Delh	-18.5603857	B	36.6504119	-0.51	0.6126
MajorCus*City Chinese Others	0.0000000	B	.	.	.
MajorCus*City Continental New Delh	-89.6803026	B	43.3052958	-2.07	0.0384
MajorCus*City Continental Others	0.0000000	B	.	.	.
MajorCus*City Desserts New Delh	-61.8169396	B	54.6548949	-1.13	0.2581
MajorCus*City Desserts Others	0.0000000	B	.	.	.
MajorCus*City Fast Food New Delh	-32.5494684	B	37.2703233	-0.87	0.3825
MajorCus*City Fast Food Others	0.0000000	B	.	.	.
MajorCus*City Ice Cream New Delh	3.5185075	B	50.7443788	0.07	0.9447
MajorCus*City Ice Cream Others	0.0000000	B	.	.	.
MajorCus*City Italian New Delh	-7.4761634	B	47.1507095	-0.16	0.8740
MajorCus*City Italian Others	0.0000000	B	.	.	.
MajorCus*City Mithai New Delh	-8.8009357	B	48.7529861	-0.18	0.8567
MajorCus*City Mithai Others	0.0000000	B	.	.	.
MajorCus*City Mughlai New Delh	-38.5949928	B	52.6380415	-0.73	0.4635
MajorCus*City Mughlai Others	0.0000000	B	.	.	.
MajorCus*City North Indian New Delh	-19.1574304	B	32.8723615	-0.58	0.5601
MajorCus*City North Indian Others	0.0000000	B	.	.	.
MajorCus*City Others New Delh	-44.8868105	B	35.0546319	-1.28	0.2004
MajorCus*City Others Others	0.0000000	B	.	.	.
MajorCus*City Pizza New Delh	-38.2789994	B	46.2889002	-0.83	0.4083
MajorCus*City Pizza Others	0.0000000	B	.	.	.
MajorCus*City Street Food New Delh	47.5395168	B	51.7920335	0.92	0.3587
MajorCus*City Street Food Others	0.0000000	B	.	.	.
MajorCus*City South Indian New Delh	0.0000000	B	.	.	.
MajorCus*City South Indian Others	0.0000000	B	.	.	.

R-Square	Coeff Var	Root MSE	Votes Mean
0.234749	177.4773	217.9460	122.8022

Figure 8: Linear Regression

- From Figure 8, we observe that price has an important effect on votes, as the price increases, the votes also increase. Votes increase by the biggest margin for price range 3.
- The votes decrease when the cuisine is North Indian. The interaction between Street Food and Price range 2 have a positive impact on votes.
- If online delivery is available, then voting is bound to increase.
- We have taken log of cuisines to show that very large number of cuisines offered by a restaurant can lead to a fall in votes. Votes with the number of cuisines offered increase up to a certain extent and then decrease.
- If table booking is available, then the votes increase.
- We also observe if that if the city is New Delhi, there is a decline in votes.
- The R-square is very low(0.23), we will use LASSO, forward , backward and best subset selection in order to better explain the variance in the model.

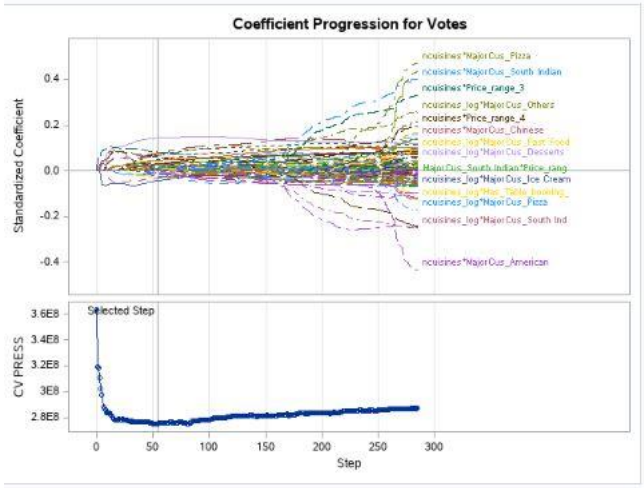
LASSO:

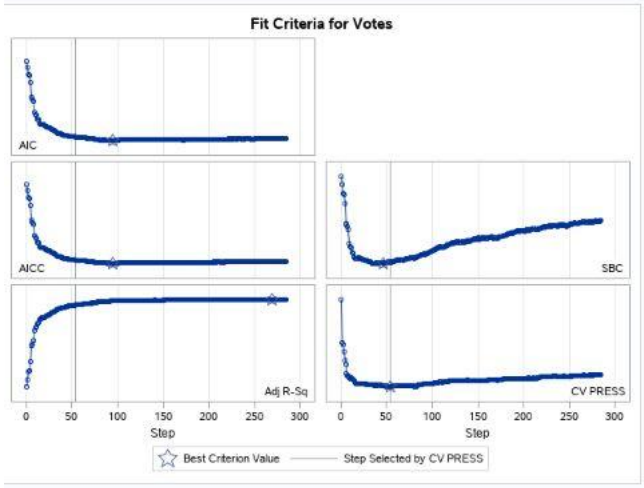
The GLMSELECT Procedure

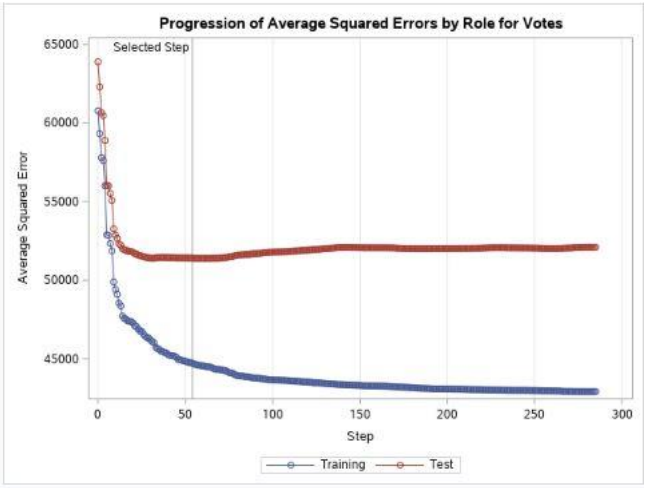
Data Set	WORK.ZOMATO_TRAINING
Test Data Set	WORK.ZOMATO_TEST
Dependent Variable	Votes
Selection Method	LASSO
Stop Criterion	None
Choose Criterion	Cross Validation
Cross Validation Method	Split
Cross Validation Fold	5
Effect Hierarchy Enforced	None

Observation Profile for Analysis Data	
Number of Observations Read	5981
Number of Observations Used	5977
Number of Observations Used for Training	5977

Observation Profile for Test Data	
Number of Observations Read	1495
Number of Observations Used	1491


Coefficient Progression for Votes
Standardized Coefficient
0.4
0.2
0.0
-0.2
-0.4
ncuisines*MajorCus_Pizza
ncuisines*MajorCus_South Indian
ncuisines*Price_range_3
ncuisines_log*MajorCus_Others
ncuisines*Price_range_4
ncuisines*MajorCus_Chinese
ncuisines_log*MajorCus_Fast Food
ncuisines_log*MajorCus_Desserts
MajorCus_South Indian*Price_rang
ncuisines_log*MajorCus_Ice Cream
ncuisines_log*Mac_Table booking_
ncuisines_log*MajorCus_Pizza
ncuisines_log*MajorCus_South Ind
ncuisines*MajorCus_American
Selected Step
CV PRESS
3.6E8
3.4E8
3.2E8
3E8
2.8E8
0
50
100
150
200
250
300
Step


Fit Criteria for Votes
AIC
AICC
SBC
Adj R-Sq
CV PRESS
0
50
100
150
200
250
300
Step
Best Criterion Value
Step Selected by CV PRESS


Progression of Average Squared Errors by Role for Votes
Selected Step
Average Squared Error
65000
60000
55000
50000
45000
0
50
100
150
200
250
300
Step
Training
Test

Root MSE	212.35091
Dependent Mean	122.69834
R-Square	0.2641
Adj R-Sq	0.2582
AIC	70080
AICC	70081
SBC	64429
ASE (Train)	44723
ASE (Test)	51405
CV PRESS	275021172

Parameter Estimates		
Parameter	DF	Estimate
Intercept	1	86.641759
Price_range_1	1	-21.796978
Price_range_3	1	5.993878
MajorCus_American*Price_range_4	1	188.685505
MajorCus_Bakery*Price_range_3	1	-85.601654
MajorCus_Cafe*Price_range_2	1	10.453361
MajorCus_Cafe*Price_range_3	1	-2.712683
MajorCus_Continental*Price_range_3	1	25.066307
MajorCus_Continental*Price_range_4	1	65.997969
MajorCus_Desserts*Price_range_3	1	-37.190825
MajorCus_Italian*Price_range_3	1	80.608659
MajorCus_Italian*Price_range_4	1	-18.532092
MajorCus_North Indian*Price_range_1	1	-5.066000
MajorCus_North Indian*Price_range_2	1	-19.620385
MajorCus_North Indian*Price_range_4	1	2.228266
MajorCus_Others*Price_range_2	1	26.018843
MajorCus_Pizza*Price_range_3	1	178.182507
MajorCus_South Indian*Price_range_3	1	182.418641
MajorCus_Street Food*Price_range_2	1	75.003782
City_Others*Price_range_3	1	5.429686
MajorCus_Continental*City_Others	1	20.452054
MajorCus_Others*City_Others	1	6.462069
MajorCus_Street Food*City_New Delh	1	3.274310
Has_Online_delivery_No	1	-6.787581
Has_Online_delivery_No*Price_range_1	1	-16.436438
Has_Online_delivery_No*Price_range_3	1	60.398286
Has_Online_delivery_Yes*Price_range_4	1	236.479368
MajorCus_Cafe*Has_Online_delivery_Yes	1	27.183810
MajorCus_Chinese*Has_Online_delivery_No	1	-1.506727
MajorCus_Continental*Has_Online_delivery_Yes	1	25.867679
MajorCus_Italian*Has_Online_delivery_No	1	40.363956
MajorCus_Pizza*Has_Online_delivery_Yes	1	25.273445
MajorCus_South Indian*Has_Online_delivery_Yes	1	42.138325
MajorCus_Street Food*Has_Online_delivery_Yes	1	24.979651
Has_Table_booking_No*Price_range_3	1	69.353512
Has_Table_booking_No*Price_range_4	1	92.413816
MajorCus_American*Has_Table_booking_Yes	1	72.605654
MajorCus_Italian*Has_Table_booking_Yes	1	87.338286
MajorCus_Others*Has_Table_booking_Yes	1	46.014390
City_Others*Has_Table_booking_Yes	1	50.467180
Has_Online_delivery_Yes*Has_Table_booking_Yes	1	155.438988
ncuisines*Price_range_1	1	-5.424482
ncuisines*Price_range_3	1	18.679749
ncuisines*Price_range_4	1	25.475098
ncuisines*Has_Online_delivery_Yes	1	5.005358
ncuisines_log*MajorCus_Cafe	1	31.118553
ncuisines_log*MajorCus_Continental	1	33.243635
ncuisines_log*MajorCus_North Indian	1	-5.914380
ncuisines*ncuisines_	1	8.836236

Figure 9: LASSO

- From the model, we can see that the LASSO has done the selection steps 285 times to find the best effects on votes.
- The R -square value has improved to 0.26 in comparison to the Linear regression Model.
- The AIC is 70080
- In LASSO, people tend to vote for high priced restaurant, the result is same as linear regression but for North Indian, Italian and dessert, high priced restaurants tend to get less votes than lower priced range restaurant.
- If online delivery is available, then voting is bound to increase.
- The R-square is still very low(0.26), we will use forward , backward and best subset selection in order to better explain the variance in the model.

Forward Selection:

The GLMSELECT Procedure

Data Set	WORK.ZOMATO_TRAINING
Test Data Set	WORK.ZOMATO_TEST
Dependent Variable	Votes
Selection Method	Forward
Select Criterion	C(p)
Stop Criterion	C(p)
Effect Hierarchy Enforced	Single

Observation Profile for Analysis Data	
Number of Observations Read	5981
Number of Observations Used	5977
Number of Observations Used for Training	5977

Observation Profile for Test Data	
Number of Observations Read	1495
Number of Observations Used	1491

Class Level Information			
Class	Levels		Values
MajorCus	16		American Bakery Cafe Chinese Continental Desserts Fast Food Ice Cream Italian Mithai Mughlai North Indian Others Pizza South Indian Street Food
City	2	*	New Delh Others
Has_Online_delivery	2	*	No Yes
Has_Table_booking	2	*	No Yes
Price_range	4	*	1 2 3 4
* Associated Parameters Split			

The GLMSELECT Procedure

Forward Selection Summary

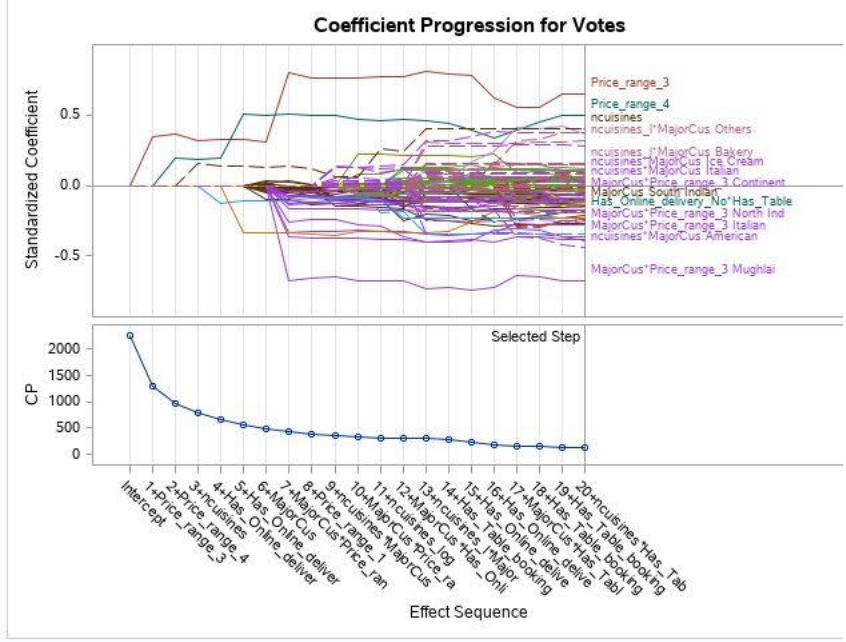
Step	Effect Entered	Number Effects In	Number Parms In	CP	ASE	Test ASE
0	Intercept	1	1	2268.1663	60777.4876	63888.5477
1	Price_range_3	2	2	1290.0690	53551.1566	56036.5642
2	Price_range_4	3	3	972.7389	51196.7111	53753.5413
3	ncuisines	4	4	784.2051	49791.8915	52076.0479
4	Has_Online_delivery_No	5	5	654.3176	48819.4746	51169.0496
5	Has_Online_delivery_No*Price_range_4	6	6	557.4723	48090.6813	51032.4411
6	MajorCus	7	21	477.1219	47277.0589	50700.3594
7	MajorCus*Price_range_3	8	33	434.9069	46788.8507	51109.1370
8	Price_range_1	9	34	395.3641	46482.5524	50864.2913
9	ncuisines*MajorCus	10	49	365.2565	46039.3749	50944.4075
10	MajorCus*Price_range_4	11	59	338.8403	45697.1449	51695.0727
11	ncuisines_log	12	60	319.8738	45542.5574	51690.0032
12	MajorCus*Has_Online_delivery_No	13	75	304.0348	45204.5829	51698.5739
13	ncuisines_l*MajorCus	14	90	296.0837	44924.7662	51464.0778
14	Has_Table_booking_Yes	15	91	290.3098	44867.4485	51672.3542
15	Has_Online_delivery_No*Has_Table_booking_Yes	16	92	222.7983	44354.9356	51979.6712
16	Has_Online_delivery_No*Price_range_3	17	93	181.9226	44038.8097	52770.4916
17	MajorCus*Has_Table_booking_Yes	18	103	161.0346	43737.3389	52803.6626
18	Has_Table_booking_Yes*Price_range_4	19	104	154.3013	43672.9481	52671.4303
19	Has_Table_booking_Yes*Price_range_3	20	105	136.8499	43529.5313	52285.3952
20	ncuisines*Has_Table_booking_Yes	21	106	134.4076*	43496.7780	52193.2116

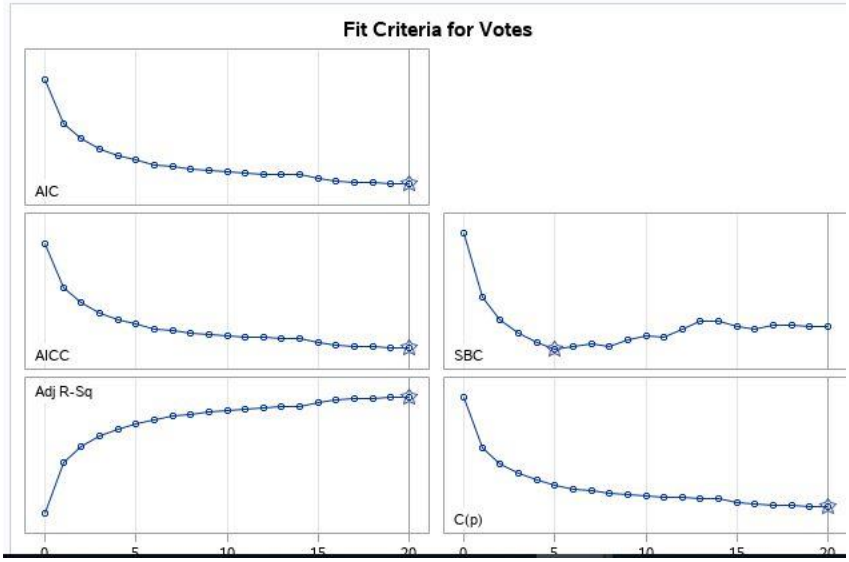
* Optimal Value of Criterion

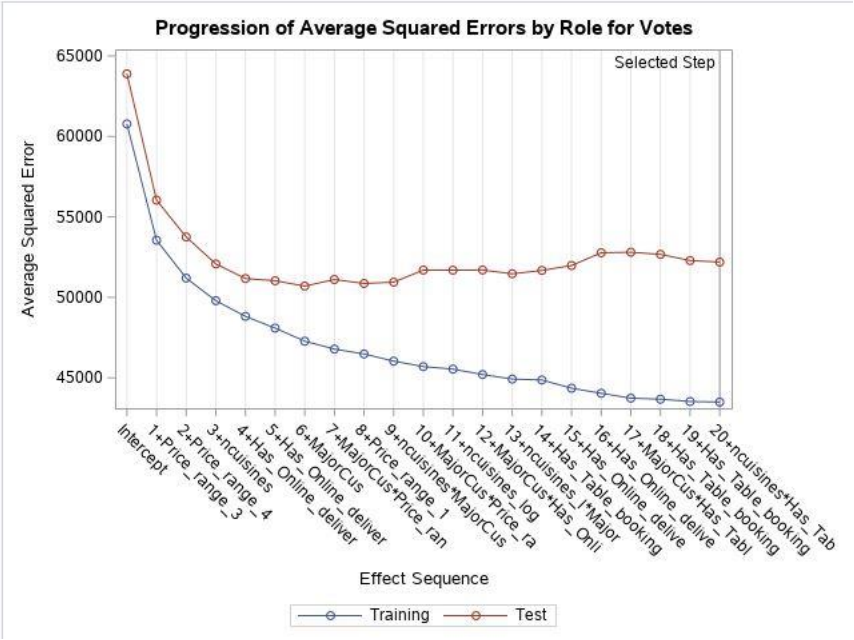
Selection stopped at a local minimum of the C(p) criterion.

Stop Details

Candidate For	Effect	Candidate C(p)		Compare C(p)
Entry	City_Others	134.9338	>	134.4076


Coefficient Progression for Votes
Standardized Coefficient
0.5
0.0
-0.5
Price_range_3
Price_range_4
ncuisines
ncuisines_I*MajorCus Others
ncuisines_I*MajorCus Bakery
ncuisines*MajorCus Ice Cream
ncuisines*MajorCus Italian
MajorCus*Price_range_3 Continent
MajorCus South Indian
Has_Online_delivery_No*Has_Table
MajorCus*Price_range_3 North Ind
MajorCus*Price_range_3 Italian
ncuisines*MajorCus American
MajorCus*Price_range_3 Mughlai
Selected Step
CP
2000
1500
1000
500
0
Intercept
1+Price_range_3
2+Price_range_4
3+ncuisines
4+Has_Online_deliver
5+Has_Online_deliver
6+MajorCus
7+MajorCus*Price_ran
8+Price_range_1
9+ncuisines*MajorCus
10+MajorCus*Price_ra
11+ncuisines_log
12+MajorCus*Price_ra
13+ncuisines*Has_Onli
14+Has_Table_booking
15+Has_Online_delive
16+Has_Online_delive
17+MajorCus*Has_Tabl
18+Has_Table_booking
19+Has_Table_booking
20+ncuisines*Has_Tab
Effect Sequence


Fit Criteria for Votes
AIC
AICC
SBC
Adj R-Sq
C(p)
0
5
10
15
20


Progression of Average Squared Errors by Role for Votes
Selected Step
Average Squared Error
65000
60000
55000
50000
45000
Intercept
1+Price_range_3
2+Price_range_4
3+ncuisines
4+Has_Online_deliver
5+Has_Online_deliver
6+MajorCus
7+MajorCus+Price_ran
8+Price_range_1
9+ncuisines*MajorCus
10+MajorCus+Price_ra
11+ncuisines_log
12+MajorCus+Has_Onli
13+ncuisines_I*Major
14+Has_Table_booking
15+Has_Online_delive
16+Has_Online_delive
17+MajorCus+Has_Tabl
18+Has_Table_booking
19+Has_Table_booking
20+ncuisines+Has_Tab
Effect Sequence
Training
Test

Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	148.908561	86.369471	1.72	0.0847
Price_range_1	1	-51.469530	7.455290	-6.90	<.0001
Price_range_3	1	462.667554	120.787976	3.83	0.0001
Price_range_4	1	575.155524	137.409975	4.19	<.0001
MajorCus American	1	-34.941508	120.744719	-0.29	0.7723
MajorCus Bakery	1	-60.971982	98.613747	-0.62	0.5364
MajorCus Cafe	1	-94.942178	94.711492	-1.00	0.3162
MajorCus Chinese	1	-123.414327	94.071024	-1.31	0.1896
MajorCus Continental	1	-123.537602	99.525869	-1.24	0.2146
MajorCus Desserts	1	8.372418	130.242222	0.06	0.9487
MajorCus Fast Food	1	-0.220602	100.198128	-0.00	0.9982
MajorCus Ice Cream	1	-207.563848	160.890573	-1.29	0.1971
MajorCus Italian	1	-143.034921	103.284192	-1.38	0.1661
MajorCus Mithai	1	36.769054	139.842556	0.26	0.7926
MajorCus Mughlai	1	15.325153	135.408035	0.11	0.9099
MajorCus North Indian	1	-112.959012	87.485357	-1.29	0.1967
MajorCus Others	1	-11.919086	90.507624	-0.13	0.8952
MajorCus Pizza	1	-424.058172	180.945891	-2.34	0.0191
MajorCus South Indian	1	-178.080639	115.411435	-1.54	0.1229
MajorCus Street Food	0	0	.	.	.
MajorCus*Price_range_3 American	1	-409.964851	139.883556	-2.93	0.0034
MajorCus*Price_range_3 Bakery	1	-597.949402	141.131915	-4.24	<.0001
MajorCus*Price_range_3 Cafe	1	-452.941516	122.998395	-3.68	0.0002
MajorCus*Price_range_3 Chinese	1	-310.630857	122.828685	-2.53	0.0115
MajorCus*Price_range_3 Continental	1	-145.534779	126.758772	-1.15	0.2510
MajorCus*Price_range_3 Desserts	1	-593.121265	181.211040	-3.27	0.0011
MajorCus*Price_range_3 Fast Food	1	-155.290889	154.998377	-1.00	0.3164
MajorCus*Price_range_3 Italian	1	-277.568200	127.123975	-2.18	0.0290
MajorCus*Price_range_3 Mughlai	1	-469.840636	138.487028	-3.39	0.0007
MajorCus*Price_range_3 North Indian	1	-296.326852	119.779325	-2.47	0.0134
MajorCus*Price_range_3 Others	1	-361.131460	121.458542	-2.97	0.0030
MajorCus*Price_range_3 Pizza	1	-147.683988	152.259133	-0.97	0.3321
MajorCus*Price_range_3 South Indian	0	0	.	.	.
MajorCus*Price_range_4 American	1	104.769057	167.743588	0.62	0.5323
MajorCus*Price_range_4 Cafe	1	-278.286232	158.193488	-1.76	0.0786
MajorCus*Price_range_4 Chinese	1	-71.224748	140.894873	-0.51	0.6132
MajorCus*Price_range_4 Continental	1	179.706350	140.434608	1.28	0.2007
MajorCus*Price_range_4 Desserts	1	-354.557168	250.267125	-1.42	0.1566
MajorCus*Price_range_4 Fast Food	1	18.082585	248.938203	0.07	0.9421
MajorCus*Price_range_4 Italian	1	-330.845932	146.564131	-2.26	0.0240
MajorCus*Price_range_4 Mughlai	1	-220.730609	166.343173	-1.33	0.1846
MajorCus*Price_range_4 North Indian	1	-19.507774	132.897806	-0.15	0.8833
MajorCus*Price_range_4 Others	1	-135.389527	134.477246	-1.01	0.3141
MajorCus*Price_range_4 Pizza	0	0	.	.	.
Has_Online_delivery_No	1	-120.577516	49.877767	-2.42	0.0157

Root MSE	210.43314
Dependent Mean	122.69834
R-Square	0.2843
Adj R-Sq	0.2715
AIC	70028
AICC	70032
BIC	64054
C(p)	134.40761
SBC	64759
ASE (Train)	43497
ASE (Test)	52193

Has_Online_delivery_No*Price_range_3	1	98.426136	23.107017	4.26	<.0001
Has_Online_delivery_No*Price_range_4	1	-281.894279	47.919472	-5.88	<.0001
MajorCus*Has_Online_delivery_No American	1	116.220545	70.171624	1.66	0.0977
MajorCus*Has_Online_delivery_No Bakery	1	82.862289	55.251756	1.50	0.1337
MajorCus*Has_Online_delivery_No Cafe	1	48.239802	55.234630	0.87	0.3825
MajorCus*Has_Online_delivery_No Chinese	1	73.272378	53.902550	1.36	0.1741
MajorCus*Has_Online_delivery_No Continental	1	-50.697334	63.724719	-0.80	0.4263
MajorCus*Has_Online_delivery_No Desserts	1	55.823947	71.168112	0.78	0.4328
MajorCus*Has_Online_delivery_No Fast Food	1	111.254470	54.201717	2.05	0.0402
MajorCus*Has_Online_delivery_No Ice Cream	1	80.006922	64.207867	1.25	0.2128
MajorCus*Has_Online_delivery_No Italian	1	209.635250	65.767575	3.19	0.0014
MajorCus*Has_Online_delivery_No Mithai	1	-11.111247	105.540663	-0.11	0.9162
MajorCus*Has_Online_delivery_No Mughlai	1	79.500593	66.048807	1.20	0.2288
MajorCus*Has_Online_delivery_No North Indian	1	92.088094	51.099334	1.80	0.0716
MajorCus*Has_Online_delivery_No Others	1	72.698899	53.118801	1.37	0.1712
MajorCus*Has_Online_delivery_No Pizza	1	9.245537	63.788507	0.14	0.8848
MajorCus*Has_Online_delivery_No South Indian	1	5.404988	63.576868	0.09	0.9323
MajorCus*Has_Online_delivery_No Street Food	0	0	.	.	.
Has_Table_booking_Yes	1	259.671543	110.173821	2.36	0.0185
Has_Table_booking_Yes*Price_range_3	1	-111.501094	24.542621	-4.54	<.0001
Has_Table_booking_Yes*Price_range_4	1	-164.590254	35.800736	-4.60	<.0001
MajorCus*Has_Table_booking_Yes American	1	117.995357	135.603949	0.87	0.3843
MajorCus*Has_Table_booking_Yes Cafe	1	-90.841520	115.969650	-0.78	0.4335
MajorCus*Has_Table_booking_Yes Chinese	1	-130.978115	112.198881	-1.17	0.2431
MajorCus*Has_Table_booking_Yes Continental	1	-191.872678	114.782412	-1.67	0.0947
MajorCus*Has_Table_booking_Yes Fast Food	1	-231.256082	168.207277	-1.37	0.1692
MajorCus*Has_Table_booking_Yes Italian	1	93.225705	117.199925	0.80	0.4264
MajorCus*Has_Table_booking_Yes Mughlai	1	-88.412261	133.722112	-0.66	0.5085
MajorCus*Has_Table_booking_Yes North Indian	1	-117.805400	109.230570	-1.08	0.2809
MajorCus*Has_Table_booking_Yes Others	1	0.923707	111.500381	0.01	0.9934
MajorCus*Has_Table_booking_Yes Pizza	1	-187.872143	148.761005	-1.26	0.2067
MajorCus*Has_Table_booking_Yes South Indian	0	0	.	.	.
Has_Online_delivery_No*Has_Table_booking_Yes	1	-173.150359	23.563666	-7.35	<.0001
ncuisines	1	90.073886	71.386071	1.26	0.2071
ncuisines*MajorCus American	1	-237.014465	143.722607	-1.65	0.0992
ncuisines*MajorCus Bakery	1	-86.470197	84.578137	-1.02	0.3066
ncuisines*MajorCus Cafe	1	10.883700	79.743676	0.14	0.8914
ncuisines*MajorCus Chinese	1	5.994808	80.322571	0.07	0.9405
ncuisines*MajorCus Continental	1	-31.844404	82.164091	-0.39	0.6983
ncuisines*MajorCus Desserts	1	-94.534697	114.716119	-0.82	0.4099
ncuisines*MajorCus Fast Food	1	-125.782629	87.777264	-1.43	0.1519
ncuisines*MajorCus Ice Cream	1	87.067353	156.466183	0.56	0.5779
ncuisines*MajorCus Italian	1	12.126001	87.796611	0.14	0.8902
ncuisines*MajorCus Mithai	1	-75.156883	84.941947	-0.88	0.3763
ncuisines*MajorCus Mughlai	1	-132.334413	128.983326	-1.03	0.3049
ncuisines*MajorCus North Indian	1	-20.744881	72.690245	-0.29	0.7754
ncuisines*MajorCus Others	1	-119.066103	75.972107	-1.57	0.1171
ncuisines*MajorCus Pizza	1	295.967536	178.116661	1.66	0.0966

ncuisines*MajorCus Pizza	1	295.967536	178.116661	1.66	0.0966
ncuisines*MajorCus South Indian	1	190.131386	101.359847	1.88	0.0607
ncuisines*MajorCus Street Food	0	0	.	.	.
ncuisines*Has_Table_booking_Yes	1	15.866124	7.545983	2.10	0.0355
ncuisines_log	1	-167.819061	144.864725	-1.16	0.2467
ncuisines_l*MajorCus American	1	595.821520	367.852579	1.62	0.1053
ncuisines_l*MajorCus Bakery	1	223.812126	169.745315	1.32	0.1874
ncuisines_l*MajorCus Cafe	1	64.314986	163.992189	0.39	0.6949
ncuisines_l*MajorCus Chinese	1	-2.888581	162.561672	-0.02	0.9858
ncuisines_l*MajorCus Continental	1	186.247197	187.449901	0.99	0.3205
ncuisines_l*MajorCus Desserts	1	193.340529	225.807407	0.86	0.3919
ncuisines_l*MajorCus Fast Food	1	230.266982	172.417802	1.34	0.1818
ncuisines_l*MajorCus Ice Cream	1	-95.588233	279.322147	-0.34	0.7322
ncuisines_l*MajorCus Italian	1	-31.152932	196.665145	-0.16	0.8741
ncuisines_l*MajorCus Mithai	1	150.894698	180.904213	0.83	0.4043
ncuisines_l*MajorCus Mughlai	1	285.628694	244.005949	1.17	0.2418
ncuisines_l*MajorCus North Indian	1	28.648057	148.321063	0.19	0.8468
ncuisines_l*MajorCus Others	1	288.306559	155.547866	1.85	0.0639
ncuisines_l*MajorCus Pizza	1	-275.567786	308.043414	-0.89	0.3711
ncuisines_l*MajorCus South Indian	1	-376.706208	201.378628	-1.87	0.0614
ncuisines_l*MajorCus Street Food	0	0	.	.	.

Figure 10: Forward Selection

- We observe that the R-square improves to 0.28 in the case of Forward Selection which is better than both linear regression and LASSO.
- The AIC is 70028 which is lower than that of LASSO, so a better fit than LASSO can be implied.
- In Forward selection also shows when the level of price increase, the possibility of getting votes increase.
- If online delivery is available, then voting is bound to increase but people tend to not give votes for price range 3 and 4 if they provide online delivery. This is different from using LASSO.
- The R-square is still very low(0.28), we will use backward and best subset selection in order to better explain the variance in the model.

Backward Selection:

The GLMSELECT Procedure

Data Set	WORK.ZOMATO_TRAINING
Test Data Set	WORK.ZOMATO_TEST
Dependent Variable	Votes
Selection Method	Backward
Select Criterion	C(p)
Stop Criterion	C(p)
Effect Hierarchy Enforced	Single

Observation Profile for Analysis Data	
Number of Observations Read	5981
Number of Observations Used	5977
Number of Observations Used for Training	5977

Observation Profile for Test Data	
Number of Observations Read	1495
Number of Observations Used	1491

Class Level Information			
Class	Levels		Values
MajorCus	16		American Bakery Cafe Chinese Continental Desserts Fast Food Ice Cream Italian Mithai Mughlai North Indian Others Pizza South Indian Street Food
City	2	*	New Delh Others
Has_Online_delivery	2	*	No Yes
Has_Table_booking	2	*	No Yes
Price_range	4	*	1 2 3 4
* Associated Parameters Split			

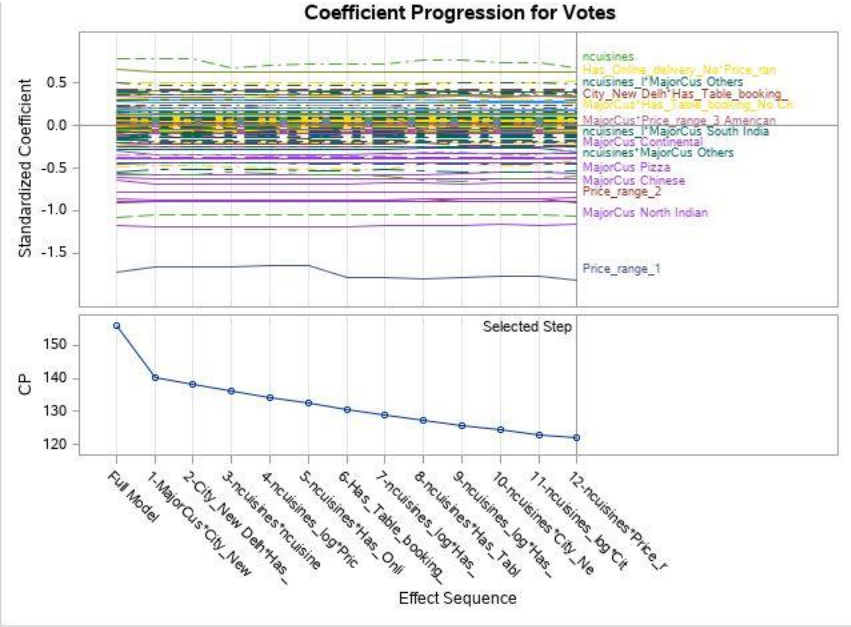
Dimensions	
Number of Effects	29
Number of Effects after Splits	83
Number of Parameters	265

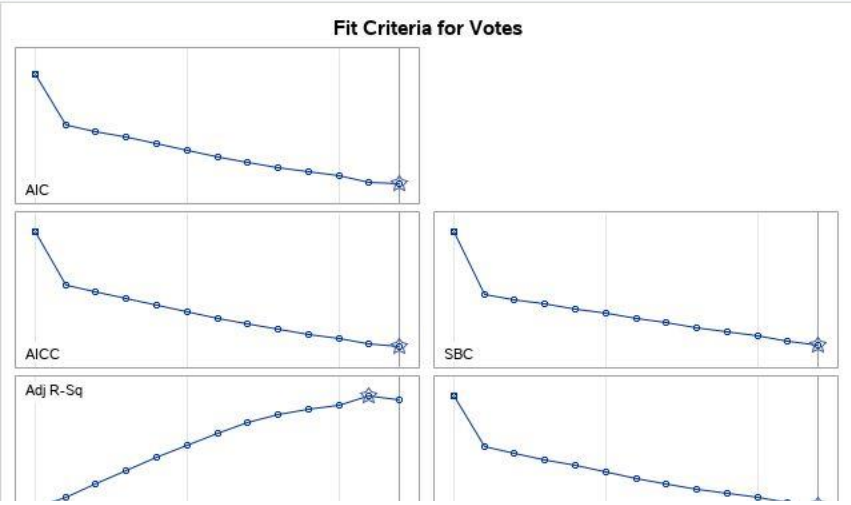
The GLMSELECT Procedure

Backward Selection Summary

Step	Effect Removed	Number Effects In	Number Parms In	CP	ASE	Test ASE
0		83	156	156.0000	42918.6727	52096.7243
	ncuisines_log*Has_Table_booking_Yes	82	156	156.0000	42918.6727	52096.7243
	ncuisines_log*Has_Online_delivery_Yes	81	156	156.0000	42918.6727	52096.7243
	ncuisines_log*City_Others	80	156	156.0000	42918.6727	52096.7243
	ncuisines_log*Price_range_4	79	156	156.0000	42918.6727	52096.7243
	ncuisines*Has_Table_booking_Yes	78	156	156.0000	42918.6727	52096.7243
	ncuisines*Has_Online_delivery_Yes	77	156	156.0000	42918.6727	52096.7243
	ncuisines*City_Others	76	156	156.0000	42918.6727	52096.7243
	ncuisines*Price_range_4	75	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_Yes*Has_Table_booking_Yes	74	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_Yes*Has_Table_booking_No	73	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_No*Has_Table_booking_Yes	72	156	156.0000	42918.6727	52096.7243
	City_Others*Has_Table_booking_Yes	71	156	156.0000	42918.6727	52096.7243
	City_Others*Has_Table_booking_No	70	156	156.0000	42918.6727	52096.7243
	City_New Delh*Has_Table_booking_Yes	69	156	156.0000	42918.6727	52096.7243
	MajorCus*Has_Table_booking_Yes	68	156	156.0000	42918.6727	52096.7243
	Has_Table_booking_Yes*Price_range_4	67	156	156.0000	42918.6727	52096.7243
	Has_Table_booking_Yes*Price_range_3	66	156	156.0000	42918.6727	52096.7243
	Has_Table_booking_Yes*Price_range_2	65	156	156.0000	42918.6727	52096.7243
	Has_Table_booking_Yes*Price_range_1	64	156	156.0000	42918.6727	52096.7243
	Has_Table_booking_No*Price_range_4	63	156	156.0000	42918.6727	52096.7243
	Has_Table_booking_Yes	62	156	156.0000	42918.6727	52096.7243
	City_Others*Has_Online_delivery_Yes	61	156	156.0000	42918.6727	52096.7243
	City_Others*Has_Online_delivery_No	60	156	156.0000	42918.6727	52096.7243
	City_New Delh*Has_Online_delivery_Yes	59	156	156.0000	42918.6727	52096.7243
	MajorCus*Has_Online_delivery_Yes	58	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_Yes*Price_range_4	57	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_Yes*Price_range_3	56	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_Yes*Price_range_2	55	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_Yes*Price_range_1	54	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_No*Price_range_4	53	156	156.0000	42918.6727	52096.7243
	Has_Online_delivery_Yes	52	156	156.0000	42918.6727	52096.7243
	MajorCus*City_Others	51	156	156.0000	42918.6727	52096.7243
	City_Others*Price_range_4	50	156	156.0000	42918.6727	52096.7243
	City_Others*Price_range_3	49	156	156.0000	42918.6727	52096.7243
	City_Others*Price_range_2	48	156	156.0000	42918.6727	52096.7243
	City_Others*Price_range_1	47	156	156.0000	42918.6727	52096.7243
	City_New Delh*Price_range_4	46	156	156.0000	42918.6727	52096.7243
	City_Others	45	156	156.0000	42918.6727	52096.7243
	MajorCus*Price_range_4	44	156	156.0000	42918.6727	52096.7243
	Price_range_4	43	156	156.0000	42918.6727	52096.7243
1	MajorCus*City_New Delh	42	141	140.2432	43023.6688	52008.8531
2	City_New Delh*Has_Online_delivery_No	41	140	138.2524	43023.7570	52011.6061
3	ncuisines*ncuisines_	40	139	136.2741	43023.9166	52017.4190
4	ncuisines_log*Price_range_3	39	138	134.2964	43024.0615	52030.5943
5	ncuisines*Has_Online_delivery_No	38	137	132.3767	43024.6735	52038.2368
6	Has_Table_booking_No*Price_range_1	37	136	130.4909	43025.5149	52044.4257
7	ncuisines_log*Has_Online_delivery_No	36	135	128.7845	43027.6798	52000.2609
8	ncuisines*Has_Table_booking_No	35	134	127.1451	43030.3390	52020.0310
9	ncuisines_log*Has_Table_booking_No	34	133	125.7667	43034.9219	52031.0073
10	ncuisines*City_New Delh	33	132	124.4513	43039.9692	52004.6855
11	ncuisines_log*City_New Delh	32	131	122.7695	43042.3154	52027.2965
12	ncuisines*Price_range_3	31	130	122.1191*	43052.2658	51916.2206

* Optimal Value of Criterion


Coefficient Progression for Votes
Standardized Coefficient
0.5
0.0
-0.5
-1.0
-1.5
ncuisines
Has_Online_delivery_No*Price_ran
ncuisines_l*MajorCus_Others
City_New Delh*Has_Table_booking_
MajorCus*Has_Table_booking_No Ch
MajorCus*Price_range_3 American
ncuisines_l*MajorCus_South India
MajorCus*Continental
ncuisines*MajorCus_Others
MajorCus_Pizza
MajorCus_Chinese
Price_range_2
MajorCus_North Indian
Price_range_1
Selected Step
CP
150
140
130
120
Full Model
1-MajorCus*City_New
2-City_New Delh*Has_
3-ncuisines*ncuisine
4-ncuisines_log*Pric
5-ncuisines*Has_Onli
6-Has_Table_booking_
7-ncuisines_log*Has_
8-ncuisines*Has_Tabl
9-ncuisines_log*Has_
10-ncuisines*City_Ne
11-ncuisines_log*Cit
12-ncuisines*Price_r
Effect Sequence


Fit Criteria for Votes
AIC
AICC
SBC
Adj R-Sq

Root MSE	209.78435
Dependent Mean	122.69634
R-Square	0.2916
Adj R-Sq	0.2760
AIC	70015
AICC	70021
BIC	64044
C(p)	122.11905
SBC	64906
ASE (Train)	43052
ASE (Test)	51916

Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1155.239388	237.312267	4.87	<.0001
Price_range_1	1	-900.383744	222.085324	-4.05	<.0001
Price_range_2	1	-465.403226	203.853596	-2.28	0.0225
Price_range_3	1	-221.406420	164.647288	-1.34	0.1788
MajorCus American	1	-171.231965	257.697019	-0.66	0.5064
MajorCus Bakery	1	-841.330120	189.685305	-4.44	<.0001
MajorCus Cafe	1	-864.901884	259.509662	-3.33	0.0009
MajorCus Chinese	1	-665.697057	242.800579	-2.74	0.0061
MajorCus Continental	1	-472.213723	241.893346	-1.95	0.0510
MajorCus Desserts	1	-765.294113	329.245317	-2.32	0.0201
MajorCus Fast Food	1	-517.402588	345.638715	-1.50	0.1345
MajorCus Ice Cream	1	-369.650611	268.331030	-1.38	0.1684
MajorCus Italian	1	-721.427435	246.278440	-2.93	0.0034
MajorCus Mithai	1	-103.218332	197.617574	-0.52	0.6015
MajorCus Mughlai	1	-632.623096	278.422668	-2.27	0.0231
MajorCus North Indian	1	-600.489661	235.763406	-2.55	0.0109
MajorCus Others	1	-516.490483	237.537067	-2.17	0.0297
MajorCus Pizza	1	-972.917783	283.431049	-3.43	0.0006
MajorCus South Indian	1	-350.864920	140.795285	-2.49	0.0127
MajorCus Street Food	0	0	.	.	.
MajorCus*Price_range_1 American	1	422.705036	353.430979	1.20	0.2317
MajorCus*Price_range_1 Bakery	1	786.078384	162.989483	4.82	<.0001
MajorCus*Price_range_1 Cafe	1	719.294592	235.535997	3.05	0.0023
MajorCus*Price_range_1 Chinese	1	470.134114	222.065368	2.12	0.0343
MajorCus*Price_range_1 Continental	1	210.074876	229.117145	0.92	0.3592
MajorCus*Price_range_1 Desserts	1	789.948105	304.690132	2.59	0.0095
MajorCus*Price_range_1 Fast Food	1	341.429551	302.234465	1.13	0.2587
MajorCus*Price_range_1 Ice Cream	1	161.466085	227.496814	0.71	0.4778
MajorCus*Price_range_1 Italian	1	808.777116	234.784600	3.44	0.0006
MajorCus*Price_range_1 Mithai	1	154.709134	117.084218	1.32	0.1864
MajorCus*Price_range_1 Mughlai	1	564.435939	240.133172	2.35	0.0188
MajorCus*Price_range_1 North Indian	1	409.874159	216.704482	1.89	0.0586
MajorCus*Price_range_1 Others	1	516.205336	218.421303	2.36	0.0181
MajorCus*Price_range_1 Pizza	1	303.434383	176.682752	1.72	0.0860
MajorCus*Price_range_1 South Indian	1	165.672169	86.806928	1.91	0.0564
MajorCus*Price_range_1 Street Food	0	0	.	.	.
MajorCus*Price_range_2 American	1	81.934843	226.959940	0.36	0.7181
MajorCus*Price_range_2 Bakery	1	594.371485	144.302345	4.12	<.0001
MajorCus*Price_range_2 Cafe	1	543.593608	221.659926	2.45	0.0142
MajorCus*Price_range_2 Chinese	1	266.260394	207.742512	1.28	0.2000
MajorCus*Price_range_2 Continental	1	47.492669	207.975292	0.23	0.8194
MajorCus*Price_range_2 Desserts	1	704.338472	299.424483	2.35	0.0187
MajorCus*Price_range_2 Fast Food	1	149.045756	292.904051	0.51	0.6109
MajorCus*Price_range_2 Ice Cream	0	0	.	.	.
MajorCus*Price_range_2 Italian	1	498.989612	213.085690	2.34	0.0192
MajorCus*Price_range_2 Mithai	0	0	.	.	.
MajorCus*Price_range_2 Mughlai	1	411.461645	225.929575	1.82	0.0686
MajorCus*Price_range_2 North Indian	1	212.182163	201.978659	1.05	0.2935
MajorCus*Price_range_2 Others	1	377.790037	204.105252	1.85	0.0642
MajorCus*Price_range_2 Pizza	1	141.522181	153.269943	0.92	0.3559
MajorCus*Price_range_2 South Indian	0	0	.	.	.
MajorCus*Price_range_2 Street Food	0	0	.	.	.
MajorCus*Price_range_3 American	1	-304.214866	183.523510	-1.66	0.0974
MajorCus*Price_range_3 Bakery	0	0	.	.	.
MajorCus*Price_range_3 Cafe	1	89.354106	187.388664	0.48	0.6335
MajorCus*Price_range_3 Chinese	1	-24.115218	169.469303	-0.14	0.8888
MajorCus*Price_range_3 Continental	1	-114.660782	166.085331	-0.69	0.4900
MajorCus*Price_range_3 Desserts	1	20.488322	299.420819	0.07	0.9454
MajorCus*Price_range_3 Fast Food	1	-28.927303	263.649930	-0.10	0.9188
MajorCus*Price_range_3 Italian	1	254.293449	170.530072	1.49	0.1360
MajorCus*Price_range_3 Mughlai	1	-60.184050	190.523848	-0.32	0.7521
MajorCus*Price_range_3 North Indian	1	-67.911949	162.314724	-0.42	0.6757
MajorCus*Price_range_3 Others	1	-4.596252	163.562931	-0.03	0.9776
MajorCus*Price_range_3 Pizza	0	0	.	.	.
MajorCus*Price_range_3 South Indian	0	0	.	.	.
City_New Delh	1	-6.539940	29.394176	-0.22	0.8239
City_New Delh*Price_range_1	1	-105.965474	33.804319	-3.14	0.0017
City_New Delh*Price_range_2	1	-111.455320	33.100786	-3.37	0.0008
City_New Delh*Price_range_3	1	-66.635238	32.704021	-2.04	0.0416
Has_Online_delivery_No	1	-562.221935	67.441517	-8.34	<.0001
Has_Online_delivery_No*Price_range_1	1	263.080549	49.956950	5.27	<.0001
Has_Online_delivery_No*Price_range_2	1	263.485243	48.343671	5.45	<.0001
Has_Online_delivery_No*Price_range_3	1	371.771055	45.985639	8.08	<.0001
MajorCus*Has_Online_delivery_No American	1	105.119601	71.569068	1.47	0.1419
MajorCus*Has_Online_delivery_No Bakery	1	76.172233	55.254000	1.38	0.1681
MajorCus*Has_Online_delivery_No Cafe	1	41.975471	56.003831	0.75	0.4536
MajorCus*Has_Online_delivery_No Chinese	1	67.179058	54.445555	1.23	0.2173
MajorCus*Has_Online_delivery_No Continental	1	-58.652778	64.358809	-0.91	0.3622
MajorCus*Has_Online_delivery_No Desserts	1	42.308948	71.195375	0.59	0.5524
MajorCus*Has_Online_delivery_No Fast Food	1	104.110861	54.491227	1.91	0.0561
MajorCus*Has_Online_delivery_No Ice Cream	1	74.982791	64.317403	1.17	0.2437
MajorCus*Has_Online_delivery_No Italian	1	191.557917	67.761547	2.83	0.0047
MajorCus*Has_Online_delivery_No Mithai	1	-22.236979	105.762149	-0.21	0.8335
MajorCus*Has_Online_delivery_No Mughlai	1	76.131257	67.435324	1.13	0.2590
MajorCus*Has_Online_delivery_No North Indian	1	83.221045	51.906671	1.60	0.1089
MajorCus*Has_Online_delivery_No Others	1	84.357059	54.107784	1.56	0.1190
MajorCus*Has_Online_delivery_No Pizza	1	6.578733	65.578964	0.10	0.9201
MajorCus*Has_Online_delivery_No South Indian	1	7.661612	65.090331	0.12	0.9063
MajorCus*Has_Online_delivery_No Street Food	0	0	.	.	.
Has_Table_booking_No	1	-160.983592	115.566659	-1.39	0.1637
Has_Table_booking_No*Price_range_2	1	-200.913907	37.744996	-5.32	<.0001
Has_Table_booking_No*Price_range_3	1	-74.697271	35.177300	-2.12	0.0338
MajorCus*Has_Table_booking_No American	1	-133.138286	136.453236	-0.98	0.3293
MajorCus*Has_Table_booking_No Bakery	0	0	.	.	.
MajorCus*Has_Table_booking_No Cafe	1	69.891362	116.046886	0.60	0.5482
MajorCus*Has_Table_booking_No Chinese	1	106.367308	112.542644	0.95	0.3446
MajorCus*Has_Table_booking_No Continental	1	156.847358	114.914220	1.36	0.1723
MajorCus*Has_Table_booking_No Desserts	0	0	.	.	.
MajorCus*Has_Table_booking_No Fast Food	1	187.229525	168.356524	1.11	0.2661
MajorCus*Has_Table_booking_No Ice Cream	0	0	.	.	.
MajorCus*Has_Table_booking_No Italian	1	-109.737010	117.361716	-0.94	0.3498
MajorCus*Has_Table_booking_No Mithai	0	0	.	.	.
MajorCus*Has_Table_booking_No Mughlai	1	73.431450	133.776917	0.55	0.5831
MajorCus*Has_Table_booking_No North Indian	1	96.108975	109.442175	0.88	0.3799
MajorCus*Has_Table_booking_No Others	1	-15.974299	111.698675	-0.14	0.8863
MajorCus*Has_Table_booking_No Pizza	1	226.761323	148.799640	1.52	0.1276
MajorCus*Has_Table_booking_No South Indian	0	0	.	.	.
MajorCus*Has_Table_booking_No Street Food	0	0	.	.	.
City_New Delh*Has_Table_booking_No	1	115.670339	22.284755	5.19	<.0001
Has_Online_delivery_No*Has_Table_booking_No	1	184.272560	23.873526	7.72	<.0001

City_New Delhi*Has_Table_booking_No	1	115.670339	22.284755	5.19	<.0001
Has_Online_delivery_No*Has_Table_booking_No	1	184.272560	23.873526	7.72	<.0001
ncuisines	1	149.616302	76.370216	1.96	0.0501
ncuisines*Price_range_1	1	-67.247650	29.746625	-2.26	0.0238
ncuisines*Price_range_2	1	-75.092995	24.294409	-3.09	0.0020
ncuisines*MajorCus American	1	-283.826464	156.952667	-1.81	0.0706
ncuisines*MajorCus Bakery	1	-78.533544	84.481429	-0.93	0.3526
ncuisines*MajorCus Cafe	1	0.547760	81.726469	0.01	0.9947
ncuisines*MajorCus Chinese	1	-12.942245	81.336428	-0.16	0.8736
ncuisines*MajorCus Continental	1	-57.860042	84.957488	-0.68	0.4959
ncuisines*MajorCus Desserts	1	-107.552318	115.020376	-0.94	0.3498
ncuisines*MajorCus Fast Food	1	-124.860521	87.781695	-1.42	0.1550
ncuisines*MajorCus Ice Cream	1	96.696122	156.378358	0.62	0.5364
ncuisines*MajorCus Italian	1	-10.535483	90.393064	-0.12	0.9072
ncuisines*MajorCus Mithai	1	-76.257636	87.373909	-0.87	0.3828
ncuisines*MajorCus Mughlai	1	-121.831428	130.194003	-0.94	0.3494
ncuisines*MajorCus North Indian	1	-21.905310	74.355909	-0.29	0.7683
ncuisines*MajorCus Others	1	-138.687088	77.395255	-1.79	0.0732
ncuisines*MajorCus Pizza	1	315.042319	180.392721	1.75	0.0808
ncuisines*MajorCus South Indian	1	198.408998	101.187166	1.96	0.0499
ncuisines*MajorCus Street Food	0	0	.	.	.
ncuisines_log	1	-293.103562	157.537380	-1.86	0.0629
ncuisines_log*Price_range_1	1	122.588217	65.854927	1.86	0.0627
ncuisines_log*Price_range_2	1	154.470484	59.725435	2.59	0.0097
ncuisines_l*MajorCus American	1	753.850174	414.889157	1.82	0.0693
ncuisines_l*MajorCus Bakery	1	222.934087	169.586609	1.31	0.1887
ncuisines_l*MajorCus Cafe	1	94.415685	168.006968	0.56	0.5742
ncuisines_l*MajorCus Chinese	1	46.925081	164.147056	0.29	0.7750
ncuisines_l*MajorCus Continental	1	259.096109	193.195535	1.34	0.1799
ncuisines_l*MajorCus Desserts	1	225.903372	226.035655	1.00	0.3176
ncuisines_l*MajorCus Fast Food	1	243.663444	172.568372	1.41	0.1580
ncuisines_l*MajorCus Ice Cream	1	-97.111930	279.278910	-0.35	0.7281
ncuisines_l*MajorCus Italian	1	45.642127	203.156252	0.22	0.8222
ncuisines_l*MajorCus Mithai	1	166.866831	183.028001	0.91	0.3620
ncuisines_l*MajorCus Mughlai	1	261.219658	248.496568	1.05	0.2932
ncuisines_l*MajorCus North Indian	1	47.990320	151.246944	0.32	0.7510
ncuisines_l*MajorCus Others	1	339.930757	158.167734	2.15	0.0317
ncuisines_l*MajorCus Pizza	1	-309.716546	313.545110	-0.99	0.3233
ncuisines_l*MajorCus South Indian	1	-383.309991	200.969190	-1.91	0.0565
ncuisines_l*MajorCus Street Food	0	0	.	.	.

Figure 11: Backward Selection

- In case of backward selection, we observe that the R square is 0.27 which is lower than that of forward selection.
- The AIC of backward selection is better than forward and LASSO with a value of 70015 which implies a better fit.
- In Backward selection, price range 4 restaurant have higher possibility of getting votes.
- If online delivery is available, then voting is bound to increase.
- The R-square is lower than forward selection (0.28), we will use stepwise selection and best subset selection in order to better explain the variance in the model.

Stepwise Selection:

The GLMSELECT Procedure

Data Set	WORK.ZOMATO_TRAINING
Test Data Set	WORK.ZOMATO_TEST
Dependent Variable	Votes
Selection Method	Backward
Select Criterion	C(p)
Stop Criterion	C(p)
Effect Hierarchy Enforced	Single

Observation Profile for Analysis Data	
Number of Observations Read	5981
Number of Observations Used	5977
Number of Observations Used for Training	5977

Observation Profile for Test Data	
Number of Observations Read	1495
Number of Observations Used	1491

Class Level Information			
Class	Levels		Values
MajorCus	16		American Bakery Cafe Chinese Continental Desserts Fast Food Ice Cream Italian Mithai Mughlai North Indian Others Pizza South Indian Street Food
City	2	*	New Delh Others
Has_Online_delivery	2	*	No Yes
Has_Table_booking	2	*	No Yes
Price_range	4	*	1 2 3 4
* Associated Parameters Split			

Dimensions	
Number of Effects	29
Number of Effects after Splits	83
Number of Parameters	265

Stepwise Selection Summary

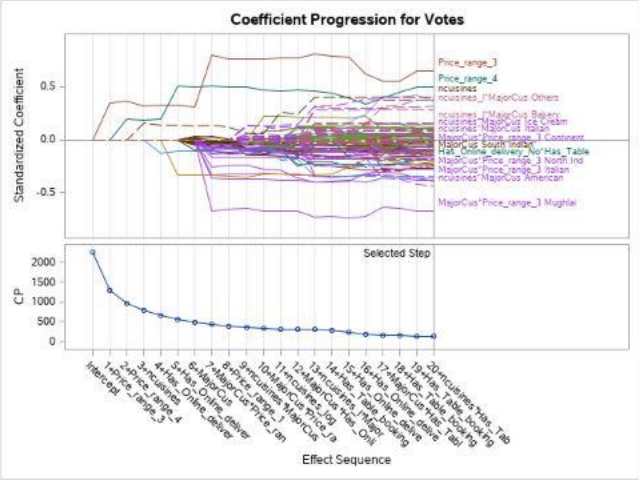
Step	Effect Entered	Effect Removed	Number Effects In	Number Parms In	CP	ASE	Test ASE
0	Intercept		1	1	2268.1663	60777.4876	63888.5477
1	Price_range_3		2	2	1290.0690	53551.1566	56036.5642
2	Price_range_4		3	3	972.7389	51196.7111	53753.5413
3	ncuisines		4	4	784.2051	49791.8915	52076.0479
4	Has_Online_delivery_No		5	5	654.3176	48819.4746	51169.0496
5	Has_Online_delivery_No*Price_range_4		6	6	557.4723	48090.6813	51032.4411
6	MajorCus		7	21	477.1219	47277.0589	50700.3594
7	MajorCus*Price_range_3		8	33	434.9089	46788.8507	51109.1370
8	Price_range_1		9	34	395.3641	46482.5524	50864.2913
9	ncuisines*MajorCus		10	49	365.2565	46039.3749	50944.4075
10	MajorCus*Price_range_4		11	59	338.8403	45697.1449	51695.0727
11	ncuisines_log		12	60	319.6738	45542.5574	51690.0032
12	MajorCus*Has_Online_delivery_No		13	75	304.0348	45204.5829	51696.5739
13	ncuisines_l*MajorCus		14	90	296.0837	44924.7662	51464.0778
14	Has_Table_booking_Yes		15	91	290.3098	44867.4485	51672.3542
15	Has_Online_delivery_No*Has_Table_booking_Yes		16	92	222.7983	44354.9356	51979.6712
16	Has_Online_delivery_No*Price_range_3		17	93	181.9226	44038.8097	52770.4916
17	MajorCus*Has_Table_booking_Yes		18	103	161.0346	43737.3389	52803.6626
18	Has_Table_booking_Yes*Price_range_4		19	104	154.3013	43672.9481	52671.4303
19	Has_Table_booking_Yes*Price_range_3		20	105	136.8499	43529.5313	52285.3952
20	ncuisines*Has_Table_booking_Yes		21	106	134.4076*	43496.7780	52193.2116

* Optimal Value of Criterion

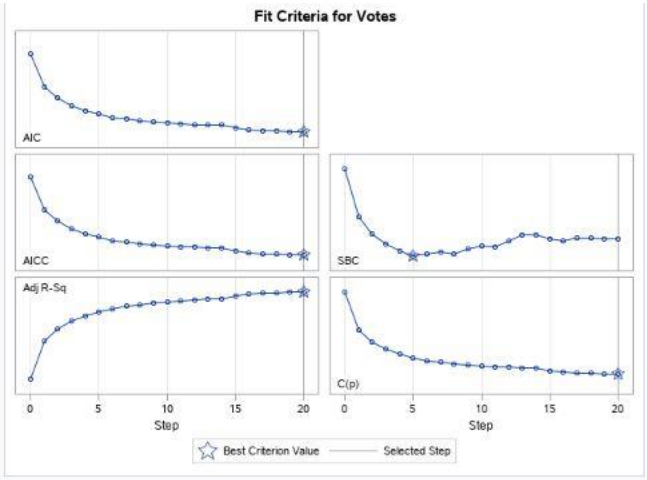
Selection stopped at a local minimum of the C(p) criterion.

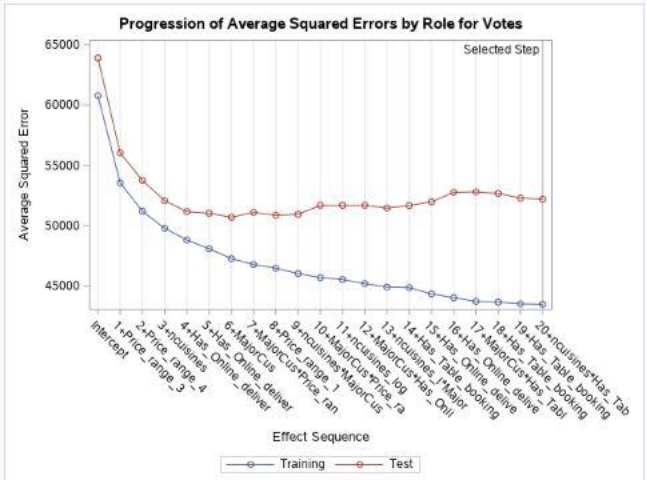
Stop Details

Candidate For	Effect	Candidate C(p)		Compare C(p)
Entry	City_Others	134.9338	>	134.4076
Removal	ncuisines*Has_Table_booking_Yes	138.8499	>	134.4076



Dependent Mean	122.69634
R-Square	0.2643
Adj R-Sq	0.2715
AIC	70028
AICC	70032
BIC	64054
C(p)	134.40761
SBC	64759
ASE (Train)	43497
ASE (Test)	52193





Parameter Estimates					
Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	148.908561	86.369471	1.72	0.0847
Price_range_1	1	-51.469530	7.455290	-6.90	<.0001
Price_range_3	1	462.667554	120.787976	3.83	0.0001
Price_range_4	1	575.155524	137.409975	4.19	<.0001
MajorCus American	1	-34.941508	120.744719	-0.29	0.7723
MajorCus Bakery	1	-60.971982	98.613747	-0.62	0.5364
MajorCus Cafe	1	-94.942178	94.711492	-1.00	0.3162
MajorCus Chinese	1	-123.414327	94.071024	-1.31	0.1896
MajorCus Continental	1	-123.537602	99.525689	-1.24	0.2146
MajorCus Desserts	1	8.372418	130.242222	0.06	0.9487
MajorCus Fast Food	1	-0.220602	100.198128	-0.00	0.9982
MajorCus Ice Cream	1	-207.563648	160.890573	-1.29	0.1971
MajorCus Italian	1	-143.034921	103.284192	-1.38	0.1661
MajorCus Mithai	1	36.769054	139.842556	0.26	0.7926
MajorCus Mughlai	1	15.325153	135.408035	0.11	0.9099
MajorCus North Indian	1	-112.959012	87.485357	-1.29	0.1967
MajorCus Others	1	-11.919086	90.507624	-0.13	0.8952
MajorCus Pizza	1	-424.058172	180.945891	-2.34	0.0191
MajorCus South Indian	1	-178.080639	115.411435	-1.54	0.1229
MajorCus Street Food	0	0	.	.	.
MajorCus*Price_range_3 American	1	-409.964851	139.883556	-2.93	0.0034
MajorCus*Price_range_3 Bakery	1	-597.949402	141.131915	-4.24	<.0001
MajorCus*Price_range_3 Cafe	1	-452.941516	122.996395	-3.68	0.0002
MajorCus*Price_range_3 Chinese	1	-310.630857	122.826685	-2.53	0.0115
MajorCus*Price_range_3 Continental	1	-145.534779	126.756772	-1.15	0.2510
MajorCus*Price_range_3 Desserts	1	-593.121265	181.211040	-3.27	0.0011
MajorCus*Price_range_3 Fast Food	1	-155.290889	154.996377	-1.00	0.3164
MajorCus*Price_range_3 Italian	1	-277.568200	127.123975	-2.18	0.0290
MajorCus*Price_range_3 Mughlai	1	-469.840636	138.487028	-3.39	0.0007
MajorCus*Price_range_3 North Indian	1	-296.326852	119.779325	-2.47	0.0134
MajorCus*Price_range_3 Others	1	-361.131460	121.456542	-2.97	0.0030
MajorCus*Price_range_3 Pizza	1	-147.683988	152.259133	-0.97	0.3321
MajorCus*Price_range_3 South Indian	0	0	.	.	.
MajorCus*Price_range_4 American	1	104.769057	167.743588	0.62	0.5323
MajorCus*Price_range_4 Cafe	1	-278.286232	158.193488	-1.76	0.0788
MajorCus*Price_range_4 Chinese	1	-71.224748	140.894873	-0.51	0.6132
MajorCus*Price_range_4 Continental	1	179.706350	140.434608	1.28	0.2007
MajorCus*Price_range_4 Desserts	1	-354.557168	250.267125	-1.42	0.1566
MajorCus*Price_range_4 Fast Food	1	18.082585	248.936203	0.07	0.9421
MajorCus*Price_range_4 Italian	1	-330.845932	146.564131	-2.26	0.0240
MajorCus*Price_range_4 Mughlai	1	-220.730609	166.343173	-1.33	0.1846
MajorCus*Price_range_4 North Indian	1	-19.507774	132.897606	-0.15	0.8833
MajorCus*Price_range_4 Others	1	-135.389527	134.477246	-1.01	0.3141
MajorCus*Price_range_4 Pizza	0	0	.	.	.
Has_Online_delivery_No	1	-120.577516	49.877767	-2.42	0.0157
Has_Online_delivery_No*Price_range_3	1	98.426136	23.107017	4.26	<.0001
Has_Online_delivery_No*Price_range_4	1	-261.894279	47.919472	-5.88	<.0001
MajorCus*Has_Online_delivery_No American	1	116.220545	70.171624	1.66	0.0977
MajorCus*Has_Online_delivery_No Bakery	1	82.862289	55.251756	1.50	0.1337
MajorCus*Has_Online_delivery_No Cafe	1	48.239602	55.234630	0.87	0.3825
MajorCus*Has_Online_delivery_No Chinese	1	73.272378	53.902550	1.36	0.1741

MajorCus*Has_Online_delivery_No Chinese	1	73.272378	53.902550	1.36	0.1741
MajorCus*Has_Online_delivery_No Continental	1	-50.697334	63.724719	-0.80	0.4263
MajorCus*Has_Online_delivery_No Desserts	1	55.823947	71.168112	0.78	0.4328
MajorCus*Has_Online_delivery_No Fast Food	1	111.254470	54.201717	2.05	0.0402
MajorCus*Has_Online_delivery_No Ice Cream	1	80.006922	64.207867	1.25	0.2128
MajorCus*Has_Online_delivery_No Italian	1	209.635250	65.767575	3.19	0.0014
MajorCus*Has_Online_delivery_No Mithai	1	-11.111247	105.540663	-0.11	0.9162
MajorCus*Has_Online_delivery_No Mughlai	1	79.500593	66.046807	1.20	0.2288
MajorCus*Has_Online_delivery_No North Indian	1	92.088094	51.099334	1.80	0.0716
MajorCus*Has_Online_delivery_No Others	1	72.696899	53.118601	1.37	0.1712
MajorCus*Has_Online_delivery_No Pizza	1	9.245537	63.786507	0.14	0.8848
MajorCus*Has_Online_delivery_No South Indian	1	5.404988	63.576868	0.09	0.9323
MajorCus*Has_Online_delivery_No Street Food	0	0	.	.	.
Has_Table_booking_Yes	1	259.671543	110.173621	2.36	0.0185
Has_Table_booking_Yes*Price_range_3	1	-111.501094	24.542621	-4.54	<.0001
Has_Table_booking_Yes*Price_range_4	1	-164.590254	35.800736	-4.60	<.0001
MajorCus*Has_Table_booking_Yes American	1	117.995357	135.603949	0.87	0.3843
MajorCus*Has_Table_booking_Yes Cafe	1	-90.841520	115.969650	-0.78	0.4335
MajorCus*Has_Table_booking_Yes Chinese	1	-130.978115	112.196881	-1.17	0.2431
MajorCus*Has_Table_booking_Yes Continental	1	-191.872678	114.782412	-1.67	0.0947
MajorCus*Has_Table_booking_Yes Fast Food	1	-231.256082	168.207277	-1.37	0.1692
MajorCus*Has_Table_booking_Yes Italian	1	93.225705	117.199925	0.80	0.4264
MajorCus*Has_Table_booking_Yes Mughlai	1	-88.412261	133.722112	-0.66	0.5085
MajorCus*Has_Table_booking_Yes North Indian	1	-117.805400	109.230570	-1.08	0.2809
MajorCus*Has_Table_booking_Yes Others	1	0.923707	111.500381	0.01	0.9934
MajorCus*Has_Table_booking_Yes Pizza	1	-187.872143	148.761005	-1.26	0.2067
MajorCus*Has_Table_booking_Yes South Indian	0	0	.	.	.
Has_Online_delivery_No*Has_Table_booking_Yes	1	-173.150359	23.563666	-7.35	<.0001
ncuisines	1	90.073886	71.386071	1.26	0.2071
ncuisines*MajorCus American	1	-237.014485	143.722607	-1.65	0.0992
ncuisines*MajorCus Bakery	1	-86.470197	84.578137	-1.02	0.3066
ncuisines*MajorCus Cafe	1	10.883700	79.743676	0.14	0.8914
ncuisines*MajorCus Chinese	1	5.994808	80.322571	0.07	0.9405
ncuisines*MajorCus Continental	1	-31.844404	82.164091	-0.39	0.6983
ncuisines*MajorCus Desserts	1	-94.534697	114.716119	-0.82	0.4099
ncuisines*MajorCus Fast Food	1	-125.782629	87.777264	-1.43	0.1519
ncuisines*MajorCus Ice Cream	1	67.067353	156.466183	0.56	0.5779
ncuisines*MajorCus Italian	1	12.126001	87.796611	0.14	0.8902
ncuisines*MajorCus Mithai	1	-75.156883	84.941947	-0.88	0.3783
ncuisines*MajorCus Mughlai	1	-132.334413	128.983326	-1.03	0.3049
ncuisines*MajorCus North Indian	1	-20.744881	72.690245	-0.29	0.7754
ncuisines*MajorCus Others	1	-119.086103	75.972107	-1.57	0.1171
ncuisines*MajorCus Pizza	1	295.967536	178.116661	1.66	0.0966
ncuisines*MajorCus South Indian	1	190.131386	101.359647	1.88	0.0607
ncuisines*MajorCus Street Food	0	0	.	.	.
ncuisines*Has_Table_booking_Yes	1	15.866124	7.545983	2.10	0.0355
ncuisines_log	1	-167.819061	144.864725	-1.16	0.2467
ncuisines_l*MajorCus American	1	595.821520	367.852579	1.62	0.1053
ncuisines_l*MajorCus Bakery	1	223.812126	169.745315	1.32	0.1874
ncuisines_l*MajorCus Cafe	1	64.314966	163.992189	0.39	0.6949
ncuisines_l*MajorCus Chinese	1	-2.886581	162.561672	-0.02	0.9858
ncuisines_l*MajorCus Continental	1	186.247197	187.449901	0.99	0.3205
ncuisines_l*MajorCus Desserts	1	193.340529	225.807407	0.86	0.3919
ncuisines_l*MajorCus Fast Food	1	230.266982	172.417802	1.34	0.1818
ncuisines_l*MajorCus Ice Cream	1	-95.586233	279.322147	-0.34	0.7322
ncuisines_l*MajorCus Italian	1	-31.152932	196.665145	-0.16	0.8741
ncuisines_l*MajorCus Mithai	1	150.894698	180.904213	0.83	0.4043
ncuisines_l*MajorCus Mughlai	1	285.628694	244.005949	1.17	0.2418
ncuisines_l*MajorCus North Indian	1	28.648057	148.321083	0.19	0.8468
ncuisines_l*MajorCus Others	1	268.306559	155.547666	1.85	0.0639
ncuisines_l*MajorCus Pizza	1	-275.567786	308.043414	-0.89	0.3711
ncuisines_l*MajorCus South Indian	1	-376.706208	201.378628	-1.87	0.0614
ncuisines_l*MajorCus Street Food	0	0	.	.	.

Figure 11: Stepwise Selection

- The stepwise selection has R square value of 0.27 which is higher than that of LASSO however lower than the Forward selection.
- In terms of fit, the AIC is 70028 which is equivalent to the forward selection model.
- The price range result showing the same pattern as before, when the price range is low especially in range 1, the possibility of getting votes is low.
- If online delivery is available, then voting is bound to increase.
- Forward selection has the highest R square for now.

Logit Model:

The LOGISTIC Procedure

Model Information		
Data Set	WORK.ZOMATO_SAMPLED	
Response Variable	rating	
Number of Response Levels	3	
Weight Variable	Selected	Selection Indicator
Model	generalized logit	
Optimization Technique	Newton-Raphson	

Number of Observations Read	7476
Number of Observations Used	5977
Sum of Weights Read	5981
Sum of Weights Used	5977

Response Profile			
Ordered Value	rating	Total Frequency	Total Weight
1	High	597	597.0000
2	Moderate	3364	3364.0000
3	Poor	2016	2016.0000

Logits modeled use rating='Poor' as the reference category.

Analysis Variable : Match
Mean
0.6481605

Frequency Percent Row Pct Col Pct	Table of rating by I_rating			
	I_rating(Into: rating)			
rating	High	Moderate	Poor	Total
High	35 2.34 23.03 68.63	116 7.76 76.32 12.06	1 0.07 0.66 0.21	152 10.17
Moderate	15 1.00 1.68 29.41	665 44.48 74.55 69.13	212 14.18 23.77 43.98	892 59.67
Poor	1 0.07 0.22 1.96	181 12.11 40.13 18.81	269 17.99 59.65 55.81	451 30.17
Total	51 3.41	962 64.35	482 32.24	1495 100.00

Figure 12: Logit Model

- From the confusion Matrix in Figure 12 we observe that High is correctly predicted 23.03% times, Moderate is correctly predicted 74.55% times while poor is predicted correctly 59.5% times.
- The overall accuracy of the model is 64.81%.

Probit Model:

The LOGISTIC Procedure

Model Information		
Data Set	WORK.ZOMATO_SAMPLED	
Response Variable	rating	
Number of Response Levels	3	
Weight Variable	Selected	Selection Indicator
Model	cumulative probit	
Optimization Technique	Fisher's scoring	

Number of Observations Read	7476
Number of Observations Used	5977
Sum of Weights Read	5981
Sum of Weights Used	5977

Response Profile			
Ordered Value	rating	Total Frequency	Total Weight
1	High	597	597.0000
2	Moderate	3364	3364.0000
3	Poor	2016	2016.0000

Probabilities modeled are cumulated over the lower Ordered Values.

Analysis Variable : Match
Mean
0.6234114

Frequency
Percent
Row Pct
Col Pct

Table of rating by I_rating				
	I_rating(Into: rating)			
rating	High	Moderate	Poor	Total
High	35 2.34 23.03 58.33	117 7.83 76.97 10.66	0 0.00 0.00 0.00	152 10.17
Moderate	24 1.61 2.69 40.00	714 47.76 80.04 65.03	154 10.30 17.26 45.70	892 59.67
Poor	1 0.07 0.22 1.67	267 17.86 59.20 24.32	183 12.24 40.58 54.30	451 30.17
Total	60 4.01	1098 73.44	337 22.54	1495 100.00

Figure 13:Probit Model

- From the confusion Matrix in Figure 13 we observe that High is correctly predicted 23.03% times, Moderate is correctly predicted 80.04% times while poor is predicted correctly 40.58.% times.
- The overall accuracy of the model is 62.34%.

Findings and Managerial Implications

Model	R-Sq	AIC
Linear Regression	**0.23**	**-**
LASSO	**0.26**	**70080**
Forward	**0.28**	**70028**
Backward	**0.27**	**70015**
Stepwise	**0.27**	**70028**

Table 2: Results for linear models for Votes

Model	%correct High	%correct Moderate	%correct Low	Overall Accuracy
Logit	23.03	74.55	59.65	64.8%
Probit	23.03	80.04	40.58	62.32%

Table 3: Results for classification of ratings

Based on the descriptive analysis, opening a Italian or continental restaurants would get more votes and higher rating compare to other cuisine. Italian and continental restaurants are fall at price range 4 restaurants.

Moreover, Forward selection is the best model among the five models. Based on Forward selection model, if the restaurants wants to get more voting. First, the higher priced restaurants, the possibility of getting votes is higher. Second, online delivery service will increase the possibility of getting more votes, but not work on the price rang 4 restaurants. If The luxury restaurants focus on getting more votes, they do not need to spend money on provide online delivery. Third, providing table booking increase the possibility of getting more votes but this also not work on restaurant in price range 3 and 4. This result shows if the restaurants are in lower price range, they should provide table booking in order to increase the possibility of getting more votes.

In Summary, based on the dataset, open a Italian or continental restaurants would have the highest possibility of getting higher rating and more votes and since they are high price range restaurants, the owners do not need to spend money on providing delivery service and table booking.

Conclusion

90 % of the people buying decisions are based on online review. Having many good ratings is a big opportunity to drive more traffic to your business (Vermaat, 2018). Only have good rating is not enough to attract more customers, you have to have huge quantity reviews to make people believe in restaurant consistency.

From Zomato dataset, we found out the price range affect the possibility for people to rate the restaurant. Restaurants owners should adjust their service based on their food price to get more rating. For the price range 1, people do not bother or feel obligate to rate the restaurants but for the restaurant people spend a lot of money on, they expect more than price range 1 restaurants so they feel more obligate to rate the restaurants. However, they can provide online delivery and table booking to increase the possibility of getting more reviews. Second, we found out in price range 4 restaurants, people do not care about if they have online delivery. Customer service and restaurant atmosphere are a huge factors for people paying more money, people do not order take out at luxury restaurants which lead to the result luxury restaurants do not need to hire people to do delivery.

There are a lot of factors affect restaurants rating and the motivation to rate. The dataset does not include many other factors. According to Wakefield (2004) who identify five important factors for restaurants which are customers interaction, technological investments, capacity, quality of physical facilities. Satisfied customer service increases the possibility of rating them online (Vermaat, 2018).in the future dataset, these factors can be added in the survey to come up with a better outcome.

References

1. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani(2009). An Introduction to Statistical Learning. Springer

2. Zomato Restaurants Data retrieved from https://www.kaggle.com/shrutimehta/zomato-restaurants-data

3. Budhwar, K. (2004). Understand the sucess factors for indepedent restaurants in Delhi.
4. Vermaat, D. (2018). 11 tips to encourage customers to leave reviews for your business online. Retrieved from loopyloyalty: https://blog.loopyloyalty.com
5. Wakefield, K. (2004). Research Reveals Five Most Important Success Factors For Pizza. Retrieved from Pizza marketing Quarterly.

Appendix

SAS Codes

```
LIBNAME PRO 'C:\Users\vdr180000\Desktop';

/* This imports the csv dataset into SAS. */
PROC IMPORT OUT= zomato_in
        DATAFILE= "C:\Users\vdr180000\Desktop\zomato_in.csv"
        DBMS=CSV REPLACE;
    GETNAMES=YES;
    DATAROW=2;
RUN;
/* generating the working dataset in Work library */
data zomato;
 set zomato_in;
run;

/* Defining log */
data zomato;
 set zomato_in;
 ncuisines_log=log(ncuisines);
run;

/*splitting*/
proc surveyselect data=zomato out=zomato_sampled outall samprate=0.8 seed=2;
run;
data zomato_training zomato_test;
set zomato_sampled;
if selected then output zomato_training; /* Tell SAS that only keep the 80% selected one in
sample. The rest
will be in test data */
else output zomato_test;
run;

/*linear regression*/
ods graphics on;
proc glm data =zomato_sampled ;
class MajorCus(ref='South Indian') City(ref='Others') Has_Online_delivery(ref='No')
Has_Table_booking(ref='No') Price_range(ref='1');
 model votes = price_range MajorCus City Has_Online_delivery Has_Table_booking ncuisines
ncuisines_log price_range*Majorcus MajorCus*City /solution;
run;
```

```
ods graphics off;

/*ASE in train vs. test data */
/* Stepwise with LASSO regression with AIC as criteria */
proc glmselect data=zomato_training testdata=zomato_test seed = 2  plots=all;
class MajorCus City(split) Has_Online_delivery(split) Has_Table_booking(split)
Price_range(split);
model Votes=
Price_range|MajorCus|City|Has_Online_delivery|Has_Table_booking|ncuisines|ncuisines_log
@2
  /selection=lasso(choose=cv stop=none) hierarchy=single cvmethod=split(5) showpvalues;
 performance buildsscp=incremental;
run;

/*ASE in train vs. test data */
/* Selection with forard,backward and stepwise */
proc glmselect data=zomato_training testdata=zomato_test seed = 2  plots=all;
class MajorCus City(split) Has_Online_delivery(split) Has_Table_booking(split)
Price_range(split);
model Votes=
Price_range|MajorCus|City|Has_Online_delivery|Has_Table_booking|ncuisines|ncuisines_log
@2
  /selection=forward(select=cp) hierarchy=single showpvalues;
 performance buildsscp=incremental;
run;

proc glmselect data=zomato_training testdata=zomato_test seed = 2  plots=all;
class MajorCus City(split) Has_Online_delivery(split) Has_Table_booking(split)
Price_range(split);
model Votes=
Price_range|MajorCus|City|Has_Online_delivery|Has_Table_booking|ncuisines|ncuisines_log
@2
  /selection=backward(select=cp) hierarchy=single showpvalues;
 performance buildsscp=incremental;
run;

proc glmselect data=zomato_training testdata=zomato_test seed = 2  plots=all;
class MajorCus City(split) Has_Online_delivery(split) Has_Table_booking(split)
Price_range(split);
model Votes=
Price_range|MajorCus|City|Has_Online_delivery|Has_Table_booking|ncuisines|ncuisines_log
@2
  /selection=stepwise(select=cp) hierarchy=single showpvalues;
 performance buildsscp=incremental;
```

```
run;

/*logistic regression*/
proc logistic data=zomato_sampled;
class MajorCus(ref='South Indian') City(ref='Others') Has_Online_delivery(ref='No')
Has_Table_booking(ref='No') Price_range(ref='1');
model rating(event='High') = Price_range City MajorCus Has_Online_delivery
Has_Table_booking ncuisines ncuisines_log Votes/ link=glogit;
weight selected;
output out=preds predprobs=individual;/*only training sample is used for estimation, since
selected = 0 for test sample */
score data=zomato_test out=zomatoPred;
run;
proc freq data=zomatoPred;
      table rating*I_rating / out=CellCounts;
      run;
     data CellCounts;
      set CellCounts;
      Match=0;
      if rating=I_rating then Match=1;
      run;
     proc means data=CellCounts mean;
      freq count;
      var Match;
      run;

/*probit model*/
proc logistic data=zomato_sampled;
class MajorCus(ref='South Indian') City(ref='Others') Has_Online_delivery(ref='No')
Has_Table_booking(ref='No') Price_range(ref='1');
model rating(event='High') = Price_range City MajorCus Has_Online_delivery
Has_Table_booking ncuisines ncuisines_log Votes/ link=probit;
weight selected;
output out=preds1 predprobs=individual;/*only training sample is used for estimation, since
selected = 0 for test sample */
score data=zomato_test out=zomatoPred1;
run;
proc freq data=zomatoPred1;
      table rating*I_rating / out=CellCounts1;
      run;
     data CellCounts1;
      set CellCounts1;
      Match=0;
      if rating=I_rating then Match=1;
```

```
 run;
proc means data=CellCounts1 mean;
 freq count;
 var Match;
 run;
```