AYAME GOD'SWILL CLAUDE

Project 1: Predicting Catalog Demand

Step 1: Business and Data Understanding

Provide an explanation of the key decisions that need to be made. (500 word limit)

Key Decisions:

Answer these questions

1. What decisions needs to be made?

2. What data is needed to inform those decisions?

Answers: Ultimately, the company needs to decide whether or not it should send a catalog to the 250 new customers.

To make this decision, the company needs to determine how much money it can expect to earn from sending out a catalog to the new customers. It needs to predict the potential profit of sending out the catalog. The expected profit contribution must exceed $10,000, otherwise the catalog will not be sent out.

To make this prediction, we need a historical dataset (*p1-customers.xlsx*) to build a linear regression model, which will then be applied to the new dataset (*p1-mailinglist.xlsx*) and used to predict the potential profit of sending out the catalog for the 250 new customers.

From the *p1-customers.xlsx data set, we can initially assume the followings:*
Target variable: Average_Sale_Amount
Predictor variables: Name, Customer_Segment, Customer_ID, Address, State, City, Zip, Store_Number, Avg_Num_Products_Purchased, #_Years_as_Customer.

NB: Because the field **Responded_to_Last_Catalog** is only contained in the *p1-customers.xlsx* but not in the *p1-mailinglist.xlsx, it was not used* **in the linear regression model since it could not be applied to the mailing list data set.**

Step 2: Analysis, Modeling, and Validation

Provide a description of how you set up your linear regression model, what variables you used and why, and the results of the model. Visualizations are encouraged. (500 word limit)

Important: Use the p1-customers.xlsx to train your linear model.

At the minimum, answer these questions:

1. How and why did you select the predictor variables in your model? You must explain how your continuous predictor variables you've chosen have a linear relationship with the target variable. Please refer back to the "Multiple Linear Regression with Excel" lesson to help you explore your data and use scatterplots to search for linear relationships. You must include scatterplots in your answer.

2. Explain why you believe your linear model is a good model. You must justify your reasoning using the statistical results that your regression model created. For each variable you selected, please justify how each variable is a good fit for your model by using the p-values and R-squared values that your model produced.

3. What is the best linear regression equation based on the available data? Each coefficient should have no more than 2 digits after the decimal (ex: 1.28)

Important: The regression equation should be in the form:

*Y = Intercept + b1 * Variable_1 + b2 * Variable_2 + b3 * Variable_3……*

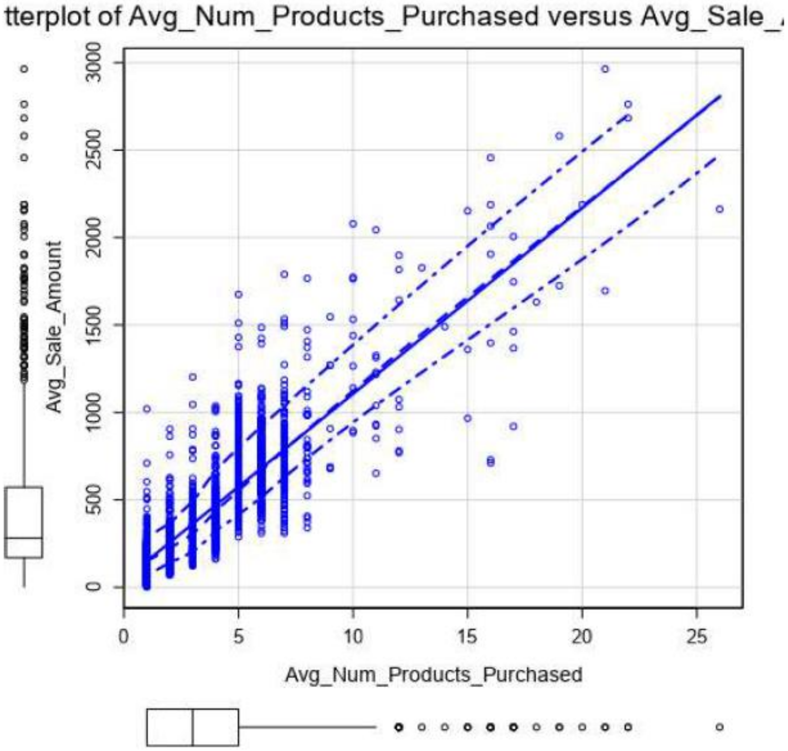
For example: Y = 482.24 + 28.83 * Loan_Status – 159 * Income + 49 (If Type: Credit Card) – 90 (If Type: Mortgage) + 0 (If Type: Cash)

Note that we **must** include the 0 coefficient for the type Cash.

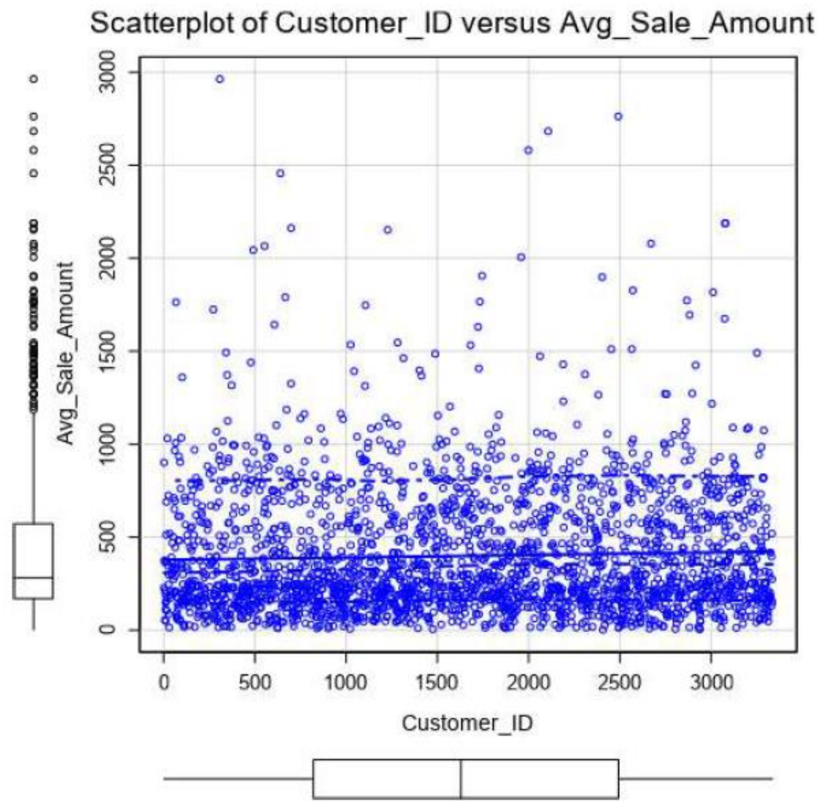
Note: For students using software other than Alteryx, if you decide to use Customer Segment as one of your predictor variables, please set the base case to Credit Card Only.

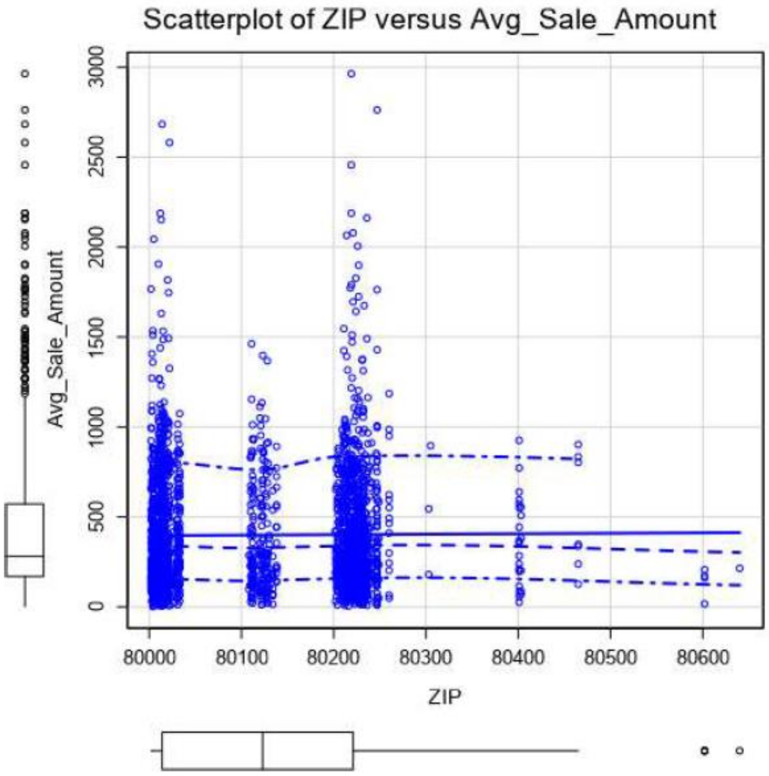
Answers: Customer_ID, Zip, Store_Number, Avg_Num_Products_Purchased, #_Years_as_Customer are all numeric variables. Hence, scatterplot was used to check their usefulness in predicting the target variable. The followings were discovered:

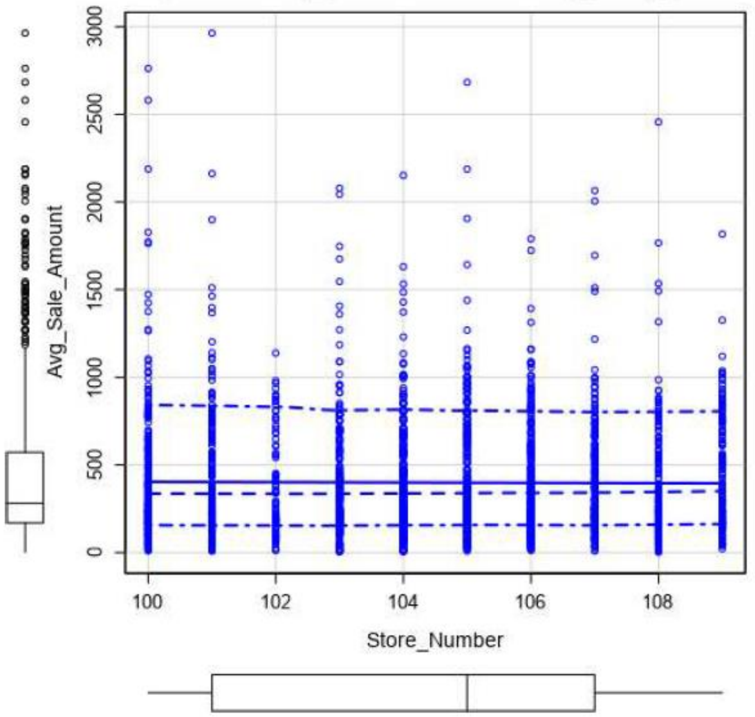
- The scatterplot of the predictor variable Avg_Num_Products_Purchased versus the target variable Average_Sale_Amount shows a sloped line. More so, the linear regression trial shows a p-value of 2.2e-16 (which is far less than 0.05) and with three stars to the right Hence, a strong linear relationship exists between the predictor variable Avg_Num_Products_Purchased and the target variable and will be used in the model.



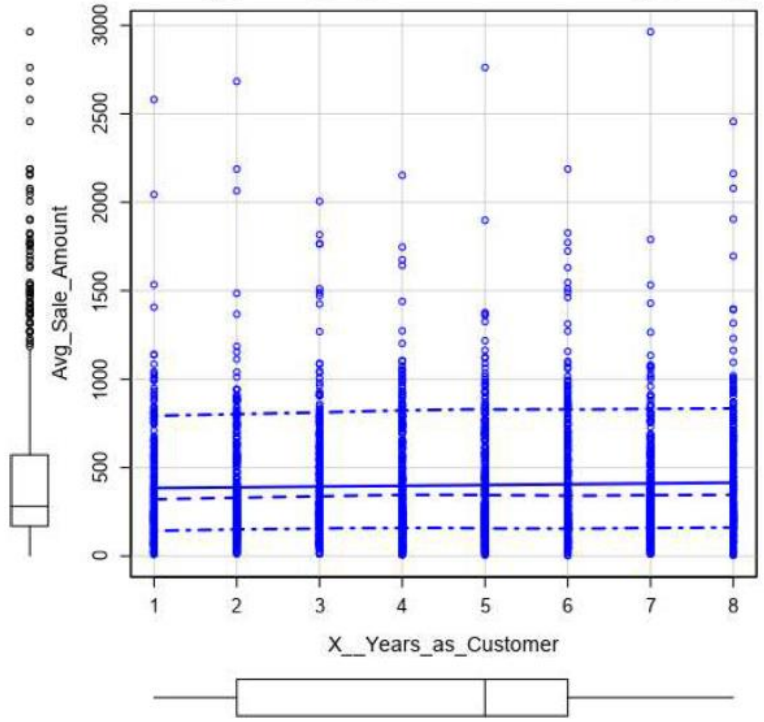
- The scatterplot for the rest of the numeric variables (Customer_ID, Zip, Store_Number, #_Years_as_Customer) versus the target variable Average_Sale_Amount show no slope. Hence, no linear relationship exists between these variables and the target variable. More so, investigations carried out by plugging these variables into the linear regression tool gave p-values greater than 0.05 with no stars to the right. As such, they are not good predictor variables for the target variable and will not be included in the model.


Scatterplot of Customer_ID versus Avg_Sale_Amount
Avg_Sale_Amount
0
500
1000
1500
2000
2500
3000
Customer_ID
0
500
1000
1500
2000
2500
3000


Scatterplot of ZIP versus Avg_Sale_Amount
Avg_Sale_Amount
0
500
1000
1500
2000
2500
3000
ZIP
80000
80100
80200
80300
80400
80500
80600



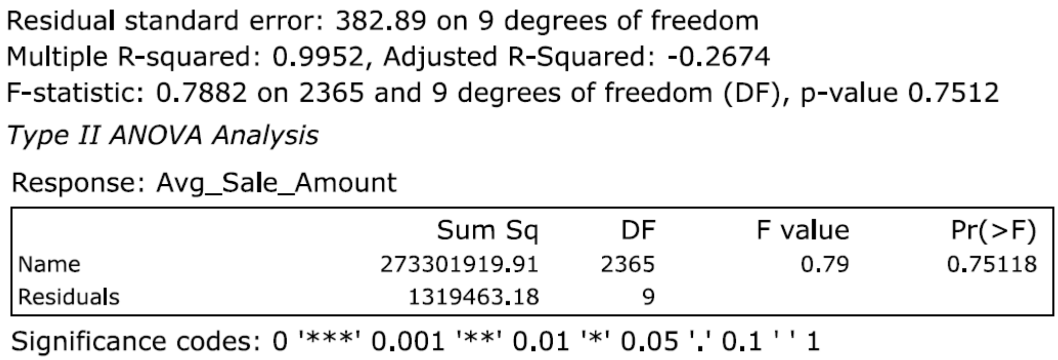
Scatterplot of Store_Number versus Avg_Sale_Amount



Scatterplot of X__Years_as_Customer versus Avg_Sale_Amc

As for the categorical variables Name, Customer_Segment, Address, State and City, the linear regression tool in Alteryx was used as a trial-and-error measure to determine which is/are statistically significant, one after the other, and the following results were obtained:

- For Name, the p-value is 0.7512 (which is greater than 0.05) and with no stars. Hence it is not statistically significant.



Residual standard error: 382.89 on 9 degrees of freedom
Multiple R-squared: 0.9952, Adjusted R-Squared: -0.2674
F-statistic: 0.7882 on 2365 and 9 degrees of freedom (DF), p-value 0.7512

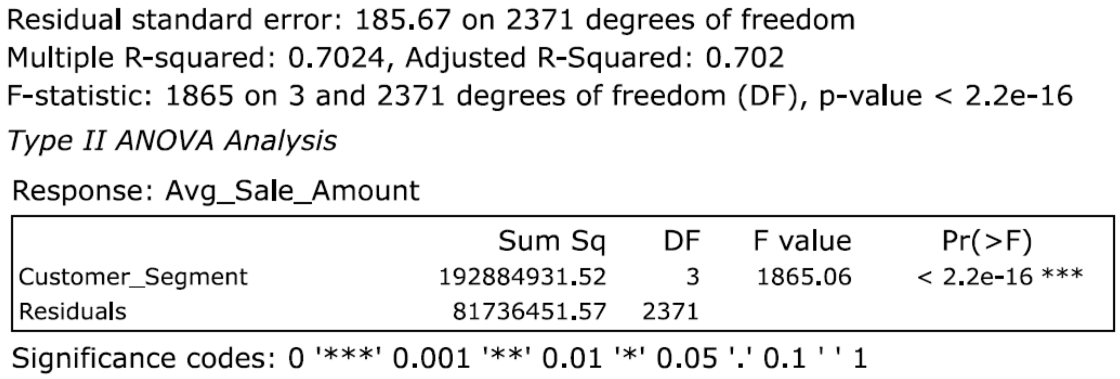
Type II ANOVA Analysis

Response: Avg_Sale_Amount

	Sum Sq	DF	F value	Pr(>F)
Name	273301919.91	2365	0.79	0.75118
Residuals	1319463.18	9		

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- For Customer_Segment, the p-value is 2.2e-16 (which is far less than 0.05) and with three stars to the right. Hence it is very much statistically significant.



Residual standard error: 185.67 on 2371 degrees of freedom
Multiple R-squared: 0.7024, Adjusted R-Squared: 0.702
F-statistic: 1865 on 3 and 2371 degrees of freedom (DF), p-value < 2.2e-16

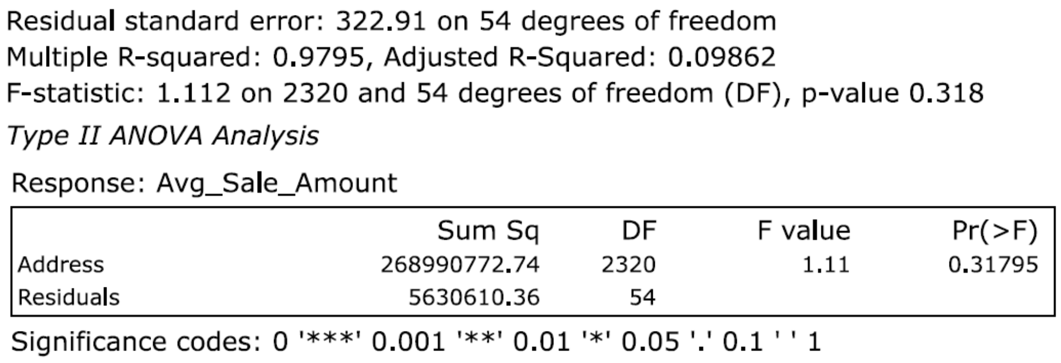
Type II ANOVA Analysis

Response: Avg_Sale_Amount

	Sum Sq	DF	F value	Pr(>F)
Customer_Segment	192884931.52	3	1865.06	< 2.2e-16 ***
Residuals	81736451.57	2371		

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- For Address, the p-value is 0.318 with no stars, which is greater than 0.05. Hence it is not statistically significant.



Residual standard error: 322.91 on 54 degrees of freedom
Multiple R-squared: 0.9795, Adjusted R-Squared: 0.09862
F-statistic: 1.112 on 2320 and 54 degrees of freedom (DF), p-value 0.318

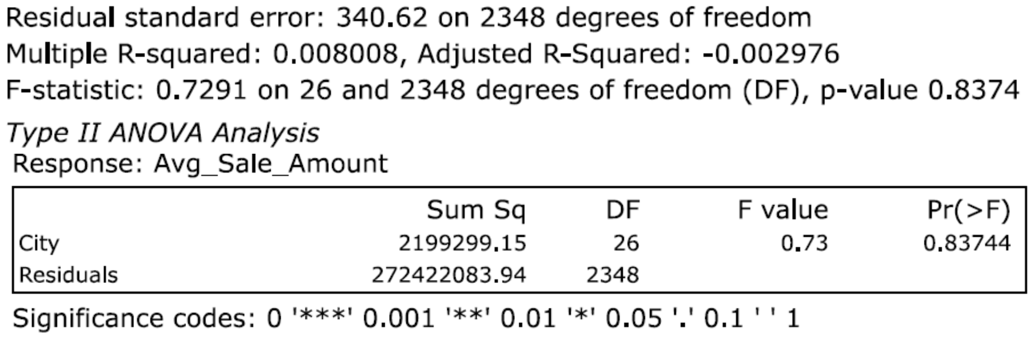
Type II ANOVA Analysis

Response: Avg_Sale_Amount

	Sum Sq	DF	F value	Pr(>F)
Address	268990772.74	2320	1.11	0.31795
Residuals	5630610.36	54		

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- For City, the p-value is 0.8374 with no stars, which is greater than 0.05. Hence it is not statistically significant.



Residual standard error: 340.62 on 2348 degrees of freedom
Multiple R-squared: 0.008008, Adjusted R-Squared: -0.002976
F-statistic: 0.7291 on 26 and 2348 degrees of freedom (DF), p-value 0.8374

Type II ANOVA Analysis
Response: Avg_Sale_Amount

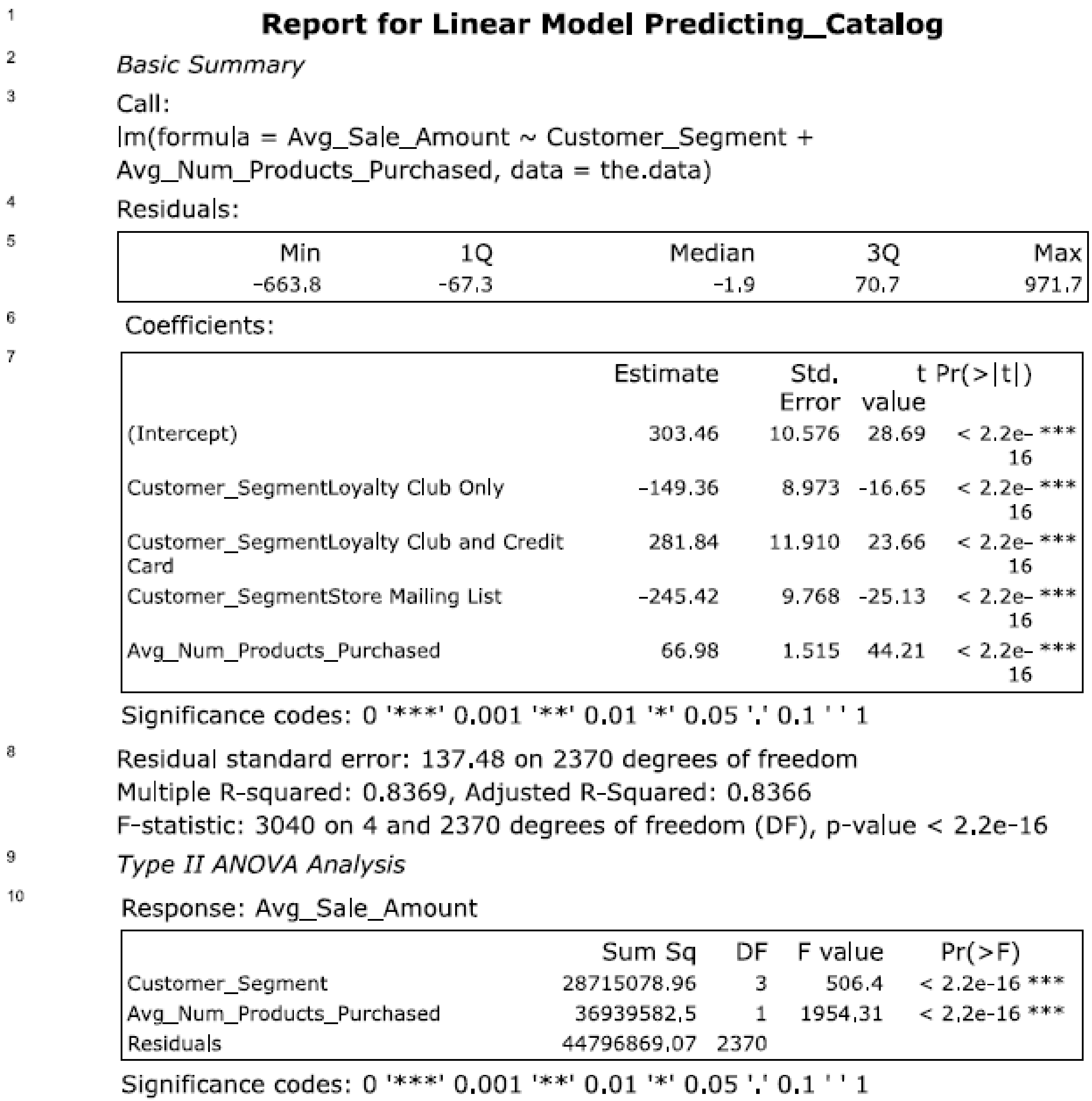
	Sum Sq	DF	F value	Pr(>F)
City	2199299.15	26	0.73	0.83744
Residuals	272422083.94	2348		

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- The variable State could not run in Alteryx, and looking at the fact that there is no variation in its values both in the historical data set and the dataset to be predicted, we can safely conclude that it is not statistically significant.

Conclusively, the only two statistically significant predictor variables that were used to build the model are: Avg_Num_Products_Purchased and Customer_Segment.

Fixing in and running the linear regression tool in Alteryx using these two predictor variables, the following regression formula (or model) was obtained:
Average_Sale_Amount = 303.46 + 66.98(Avg_Num_Products_Purchased)
– 149.36(Customer_SegmentLoyalty Club Only)
+ 281.84(Customer_SegmentLoyalty Club and Credit Card)
– 245.42(Customer_SegmentStore Mailing List)
+ 0 (Customer_SegmentCredit Card Only).



1 **Report for Linear Model Predicting_Catalog**

2 *Basic Summary*

3 Call:
lm(formula = Avg_Sale_Amount ~ Customer_Segment + Avg_Num_Products_Purchased, data = the.data)

4 Residuals:

5

Min	1Q	Median	3Q	Max
-663.8	-67.3	-1.9	70.7	971.7

6 Coefficients:

7

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	303.46	10.576	28.69	< 2.2e-16 ***
Customer_SegmentLoyalty Club Only	-149.36	8.973	-16.65	< 2.2e-16 ***
Customer_SegmentLoyalty Club and Credit Card	281.84	11.910	23.66	< 2.2e-16 ***
Customer_SegmentStore Mailing List	-245.42	9.768	-25.13	< 2.2e-16 ***
Avg_Num_Products_Purchased	66.98	1.515	44.21	< 2.2e-16 ***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

8 Residual standard error: 137.48 on 2370 degrees of freedom
Multiple R-squared: 0.8369, Adjusted R-Squared: 0.8366
F-statistic: 3040 on 4 and 2370 degrees of freedom (DF), p-value < 2.2e-16

9 *Type II ANOVA Analysis*

10 Response: Avg_Sale_Amount

	Sum Sq	DF	F value	Pr(>F)
Customer_Segment	28715078.96	3	506.4	< 2.2e-16 ***
Avg_Num_Products_Purchased	36939582.5	1	1954.31	< 2.2e-16 ***
Residuals	44796869.07	2370		

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Looking at the statistical results from the model, it can be seen that the p-values of all the predictor variables used to build the model are all 2.2e-16 (which is far less than 0.05) and all with significance codes ***. Hence, the predictor variables are all statistically significant, and we can leave them all in. The Multiple R-squared is 0.8369 and the Adjusted R-Squared is 0.8366 (which are all close to 1). All of these indicates a very strong model with which a Data Analyst should be confident of making reliable predictions.

Step 3: Presentation/Visualization

Use your model results to provide a recommendation. (500 word limit)

At the minimum, answer these questions:

1. What is your recommendation? Should the company send the catalog to these 250 customers?

2. How did you come up with your recommendation? (Please explain your process so reviewers can give you feedback on your process)

3. What is the expected profit from the new catalog (assuming the catalog is sent to these 250 customers)?

- **Answers:** Using a score tool, I was able to get the predicted sales amount per customer.
- Next, using a scatter plot tool, I observed the correlation between the score (or predicted sales amount) versus the Avg_Num_Products_Purchased (the best numeric variable in the model), and I noticed a very strong positive correlation.
- Then using a formula tool, I computed the expected revenue per customer as Expected_Revenue = [Score_Yes] × [Score].
- Next, I used a summarize tool to sum up all the expected revenues for all 250 customers. This gave $47,224.8713.
- Finally, using another formula tool, I calculated the final profit that can be accrued from sending a catalog to the 250 customers as follows:

  Profit = (Sum_Expected_Revenue × 50% average gross margin) – (6.50 costs of printing and distributing per catalog × 250 customers)

  = $ 21987.4356865455

Since the company will only send out the catalog if the expected profit exceeds $10 000, and the trusted model here is predicting a profit more than twice this amount, I would recommend that the company sends out the catalog to the 250 new customers.