# Project 1: Predicting Catalog Demand

Complete each section. When you are ready, save your file as a PDF document and submit it here: https://classroom.udacity.com/nanodegrees/nd008/parts/c0b53068-1239-4f01-82bf-24886872f48e/project

## 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?

The final decision is to implement the catalogue project. By exercising catalog mailing activity it is predicted to generate net project profit at $22,435.62. It is above minimum profit contribution of $10.000 set by the management

2. What data is needed to inform those decisions?

In order to inform this decision, we need the existing data of customers and the information about the 250 mailing list that we targeted.

For existing customer , we would need Average Sale amount of the existing customers as the target variable
We also need customer segment, Average number of product purchased, #years as a customer as predictor variable

For the mailing list, we require the same variable as the existing customer, which are customer segment, average number of product purchased, # years as customer as a predictor variable, to later on predicting the average sale amount per customer

## 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 (see supplementary text) in your model? You must explain how your continuous predictor variables you've chosen have a linear relationship with the target variable. Please refer to this lesson to help you explore your data and use scatterplots to search for linear relationships. You must include scatterplots in your answer.

In order to find out what variables that relates with the variable “Average Sale Amount” itself. I conducted multiple regression analysis from customers dataset, trying to predict the average sale amount using many of the predictor variables,

We also found that “customer segment”, “whether customer responded to last catalogue”, and “average number of product purchased” are significant. For the variable “customer responded to last catalogue”, we don’t have the information whether the mailing list were sent catalogue before. I tried to combine the data by joining customer ID of the customer list and the mailing list, and found no match. This can be happen because of all mailing list never received any catalogue, OR, the customer list we received didn’t include the mailing list. Since I don’t know for sure the information whether the mailing list were sent a catalogue before, so I decided to exclude the “customer responded to last catalogue”.

After I did the regression, from the initial prediction report below, we can see that the variable of “store number” are not significant, so we will exclude in the next regression

While Probability ( t- value) of variable “X years as customer” are not that significant, the probability was still near 0.05, which is 0.05264, so I decided to input that variable also for the regression analysis

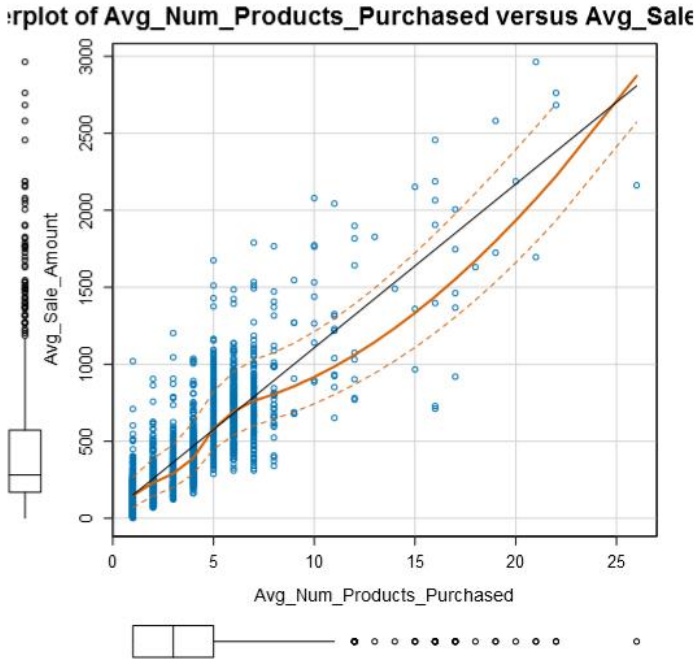
As summary, predictor that I selected in the end were

1. “Customer segment”,
2. “Average number of product purchased” ,m
3. “X years” as customer

Excluded variable were:

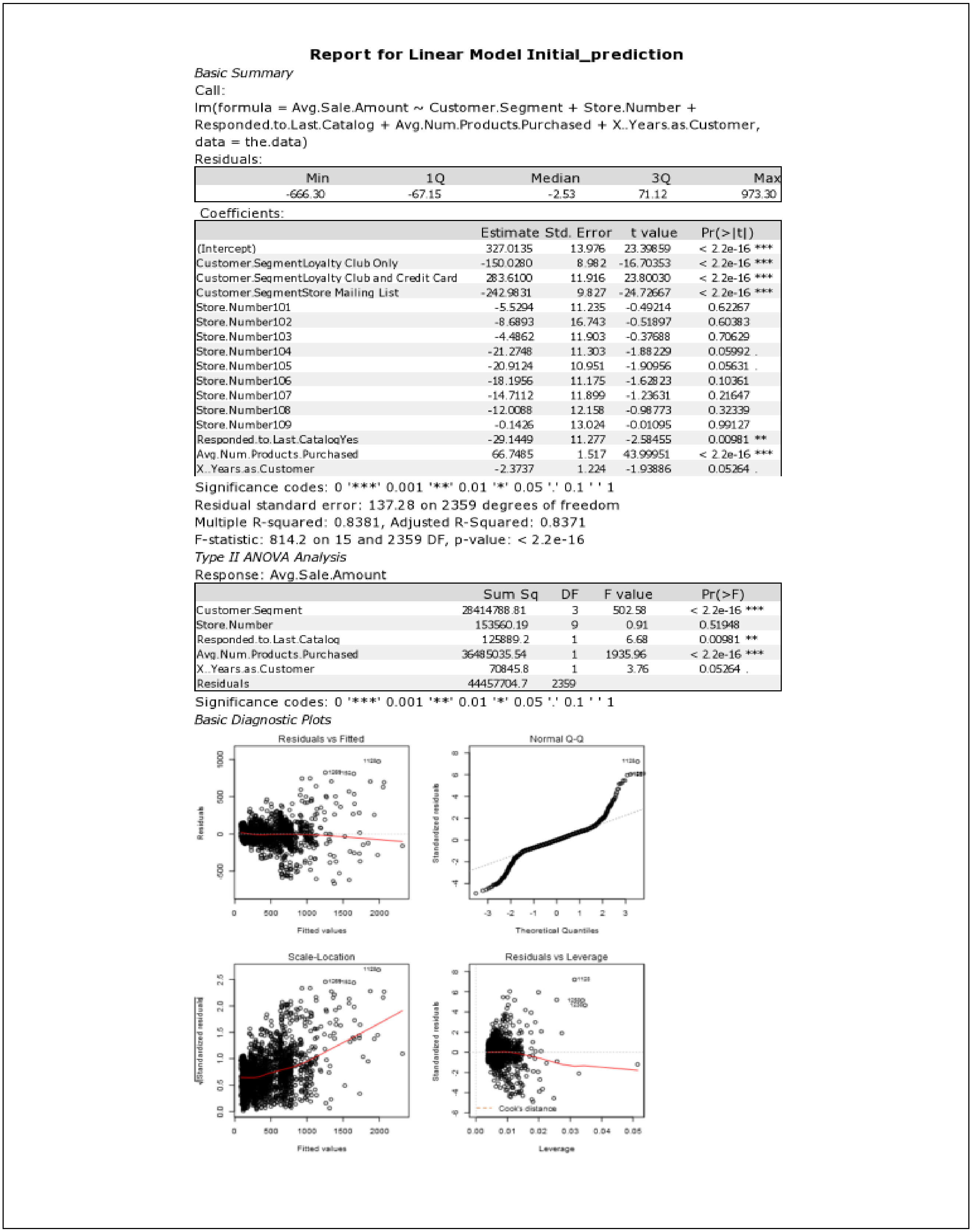
1. “responded to last catalogue”
2. “Store number”

From the above selected variable, the only continuous variable that we can plot to average sales variable was “average number of product purchased”. Beside the significance, we can see the relationship between average sale and average number of purchased product from this scatter plot



The scatter plot shows the positive correlation between average number of product to average sale. The higher the average number of product purchased, leads to higher average sale in general.

The predictor “customer segment” was a categorical variable, which cannot  descripted using scatter plot, and number of years as a customer was a discrete variable that has less significance so we cannot see the variable relationship well using the scatter plot also, but both significance can be shown from initial prediction regression analysis report.



### Report for Linear Model Initial_prediction

*Basic Summary*

Call:

```
lm(formula = Avg.Sale.Amount ~ Customer.Segment + Store.Number +
Responded.to.Last.Catalog + Avg.Num.Products.Purchased + X..Years.as.Customer,
data = the.data)
```

Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -666.30 | -67.15 | -2.53 | 71.12 | 973.30 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 327.0135 | 13.976 | 23.39859 | < 2.2e-16 *** |
| Customer.SegmentLoyalty Club Only | -150.0280 | 8.982 | -16.70353 | < 2.2e-16 *** |
| Customer.SegmentLoyalty Club and Credit Card | 283.6100 | 11.916 | 23.80030 | < 2.2e-16 *** |
| Customer.SegmentStore Mailing List | -242.9831 | 9.827 | -24.72667 | < 2.2e-16 *** |
| Store.Number101 | -5.5294 | 11.235 | -0.49214 | 0.62267 |
| Store.Number102 | -8.6893 | 16.743 | -0.51897 | 0.60383 |
| Store.Number103 | -4.4862 | 11.903 | -0.37688 | 0.70629 |
| Store.Number104 | -21.2748 | 11.303 | -1.88229 | 0.05992 . |
| Store.Number105 | -20.9124 | 10.951 | -1.90956 | 0.05631 . |
| Store.Number106 | -18.1956 | 11.175 | -1.62823 | 0.10361 |
| Store.Number107 | -14.7112 | 11.899 | -1.23631 | 0.21647 |
| Store.Number108 | -12.0088 | 12.158 | -0.98773 | 0.32339 |
| Store.Number109 | -0.1426 | 13.024 | -0.01095 | 0.99127 |
| Responded.to.Last.CatalogYes | -29.1449 | 11.277 | -2.58455 | 0.00981 ** |
| Avg.Num.Products.Purchased | 66.7485 | 1.517 | 43.99951 | < 2.2e-16 *** |
| X..Years.as.Customer | -2.3737 | 1.224 | -1.93886 | 0.05264 . |

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

Residual standard error: 137.28 on 2359 degrees of freedom

Multiple R-squared: 0.8381, Adjusted R-Squared: 0.8371

F-statistic: 814.2 on 15 and 2359 DF, p-value: < 2.2e-16

*Type II ANOVA Analysis*

Response: Avg.Sale.Amount

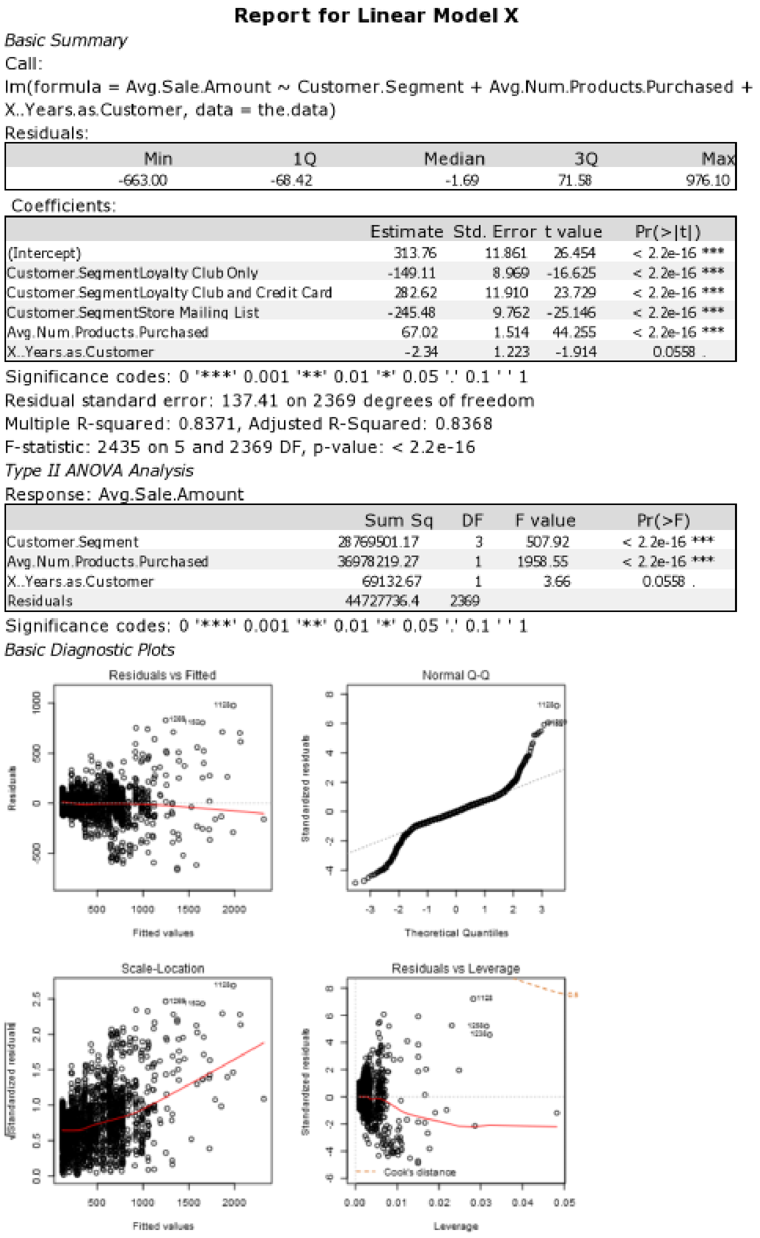
| | Sum Sq | DF | F value | Pr(>F) |
|---|---|---|---|---|
| Customer.Segment | 28414788.81 | 3 | 502.58 | < 2.2e-16 *** |
| Store.Number | 153560.19 | 9 | 0.91 | 0.51948 |
| Responded.to.Last.Catalog | 125889.2 | 1 | 6.68 | 0.00981 ** |
| Avg.Num.Products.Purchased | 36485035.54 | 1 | 1935.96 | < 2.2e-16 *** |
| X..Years.as.Customer | 70845.8 | 1 | 3.76 | 0.05264 . |
| Residuals | 44457704.7 | 2359 | | |

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

*Basic Diagnostic Plots*

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.

This is the new linear regression



**Report for Linear Model X**

*Basic Summary*

Call:

lm(formula = Avg.Sale.Amount ~ Customer.Segment + Avg.Num.Products.Purchased +
X..Years.as.Customer, data = the.data)

Residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -663.00 | -68.42 | -1.69 | 71.58 | 976.10 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 313.76 | 11.861 | 26.454 | < 2.2e-16 *** |
| Customer.SegmentLoyalty Club Only | -149.11 | 8.969 | -16.625 | < 2.2e-16 *** |
| Customer.SegmentLoyalty Club and Credit Card | 282.62 | 11.910 | 23.729 | < 2.2e-16 *** |
| Customer.SegmentStore Mailing List | -245.48 | 9.762 | -25.146 | < 2.2e-16 *** |
| Avg.Num.Products.Purchased | 67.02 | 1.514 | 44.255 | < 2.2e-16 *** |
| X..Years.as.Customer | -2.34 | 1.223 | -1.914 | 0.0558 . |

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

Residual standard error: 137.41 on 2369 degrees of freedom

Multiple R-squared: 0.8371, Adjusted R-Squared: 0.8368

F-statistic: 2435 on 5 and 2369 DF, p-value: < 2.2e-16

*Type II ANOVA Analysis*

Response: Avg.Sale.Amount

| | Sum Sq | DF | F value | Pr(>F) |
|---|---|---|---|---|
| Customer.Segment | 28769501.17 | 3 | 507.92 | < 2.2e-16 *** |
| Avg.Num.Products.Purchased | 36978219.27 | 1 | 1958.55 | < 2.2e-16 *** |
| X..Years.as.Customer | 69132.67 | 1 | 3.66 | 0.0558 . |
| Residuals | 44727736.4 | 2369 | | |

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

*Basic Diagnostic Plots*

This regression is a good model because all the variable has low p-value , all below 0.05, except X years as customer which is still around 0.05. And the R-square of the model is 0.8371, which is good, but can be better if it’s get around 0.9. but as long as its above 0.7 is still useable

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 = 313.76* + (*67.02 * Avg Num Product Purchased )* – (*2.34* # year as customer*)
– (149.11 if Customer Segment: Loyalty Club only) + (282.62 If Customer Segment : Loyalty Card and Credit Card) – (245.48 If Customer Segment: Store Mailing List)

## 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?

The Recommendation is to 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)

First:
I change the variable type into appropriate types using auto-field and select tools

Second :
I checked the cleanliness of the data using field summary tools

Third:
I made multiple regression analysis using many predictor variables, and check the ones that have significant p-value. I used the customers list to create the model

Fourth:
I use score tools to find the predicted average sale amount of the 250 customers using the model I made, and applied that model to mailing list data

Fifth:

then I multiply all the predicted avg sales with the yes score

Sixth: I sum all the result, and found sum of predicted overall sales were $ 48121.24

Seventh: I Multiply by 50% for profit contribution, and minus it with the cost (250 * 6.50 = $1625)

The result were $ 48,121.24 * 50% - (250*6.50) = $22.435.62

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

The expected profit was $22.435.62

## Before you Submit

Please check your answers against the requirements of the project dictated by the rubric here. Reviewers will use this rubric to grade your project.