Analysis of Bank Telemarketing Data

Kaushik Holla, Kaavya Gowthaman and Niyati Chopra

Understanding the Data

Client

Age

Job

Marital Status

Education

Credit in Default?

Housing Loan?

Personal Loan?

Last Contact

Mode of Communication

Call duration

Day, Month

Socio-Economic Factors

Quarterly Employment Variation Rate

Monthly Consumer Price Index

Monthly Consumer Confidence Index

Number of Employees

Euribor 3-month rate

Other

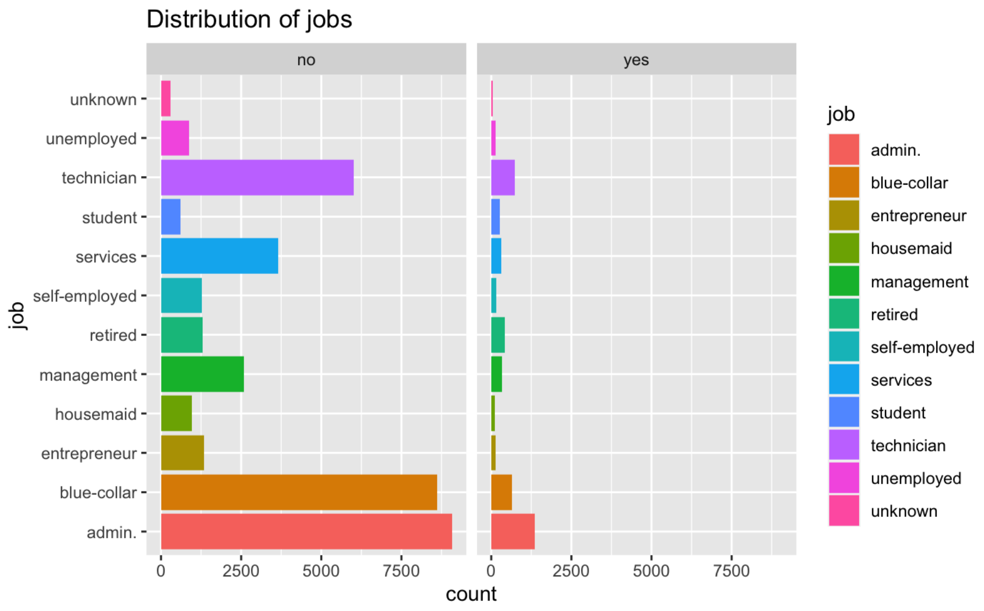
Outcome of previous campaign

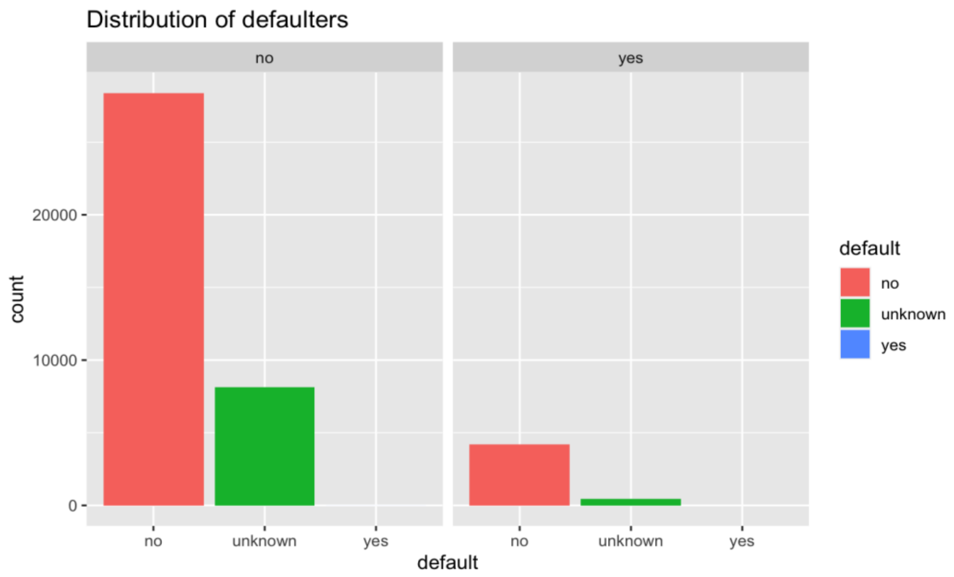
No of previous contacts in the current campaign

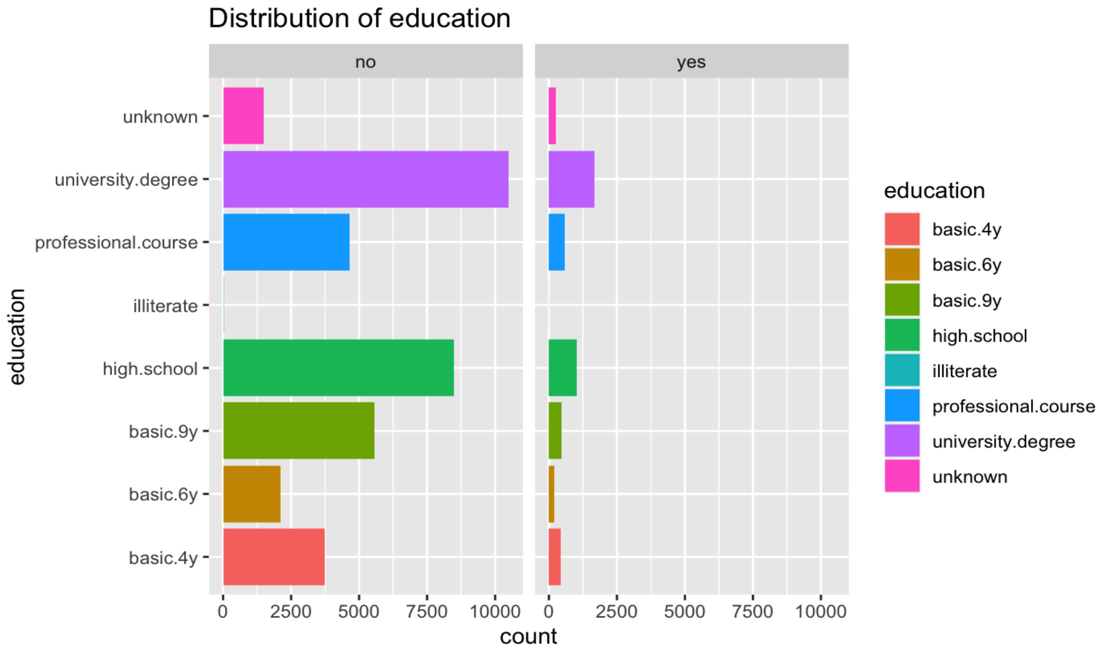
GOAL : The goal of the project is to build a classification model to predict if a client is going to subscribe to a term deposit

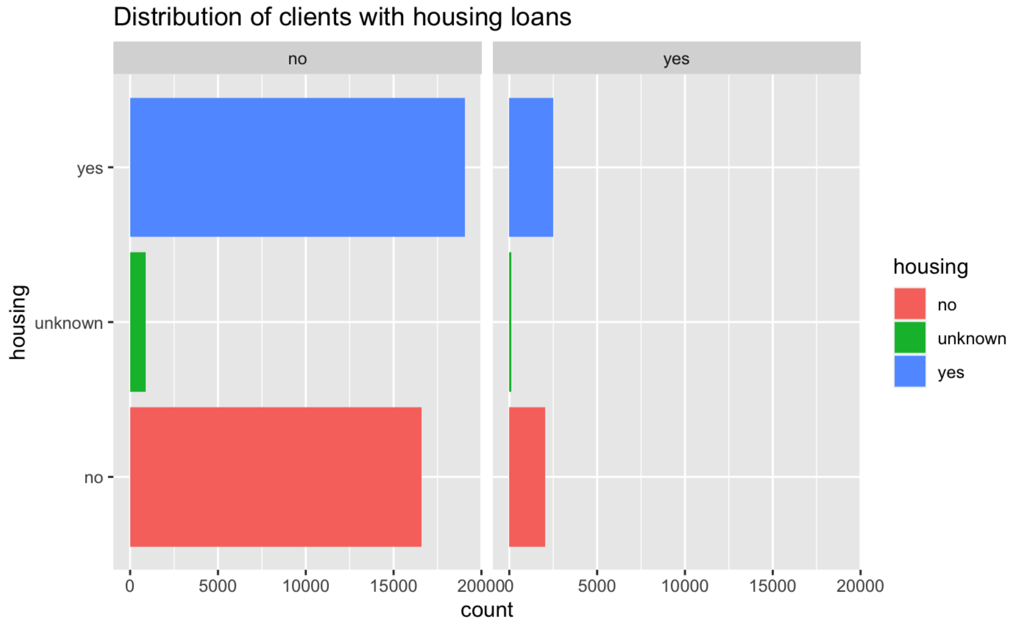
INDUSTRY RELEVANCE : The analysis is helpful in designing strategies to target prospective clients

Exploratory Data Analysis: Client Data

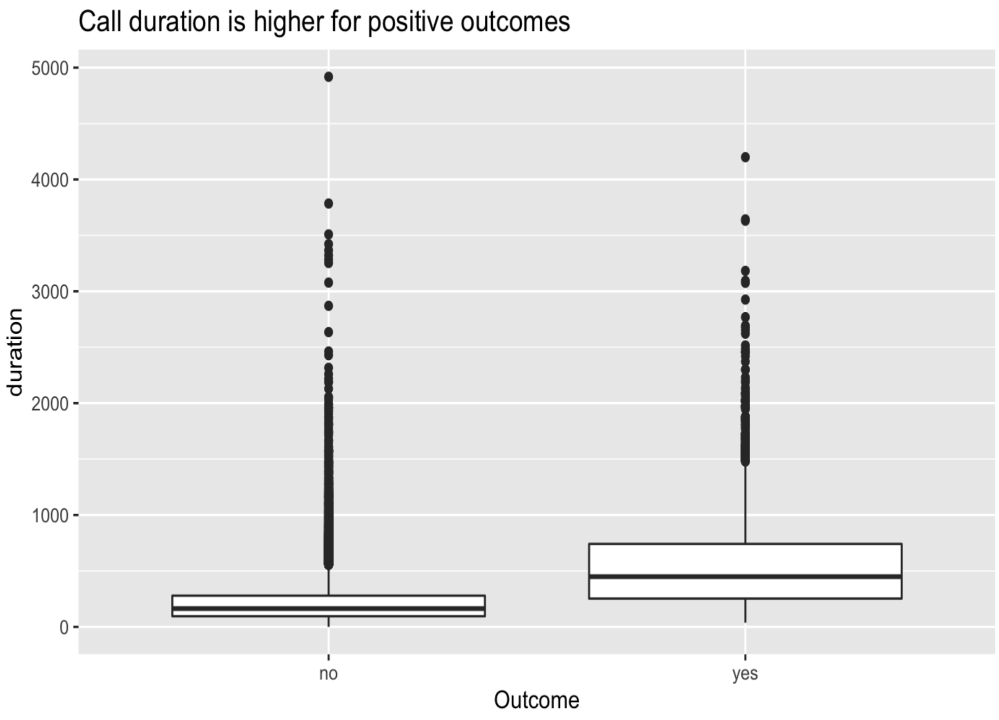


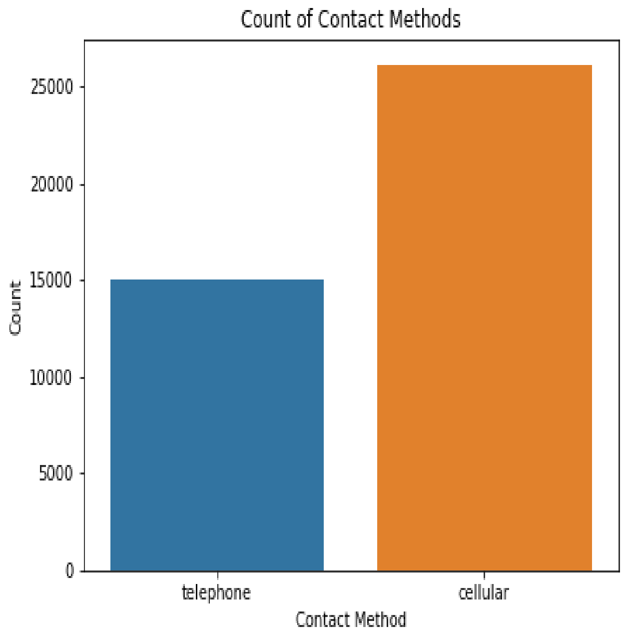


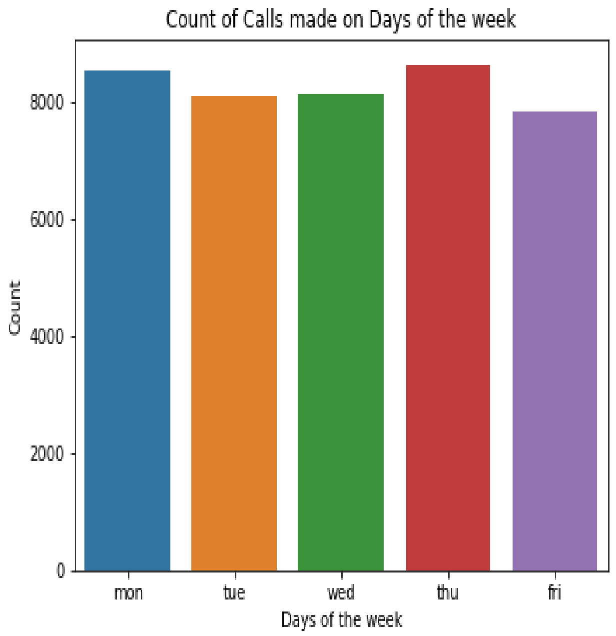




Exploratory Data Analysis: Last Contact Data

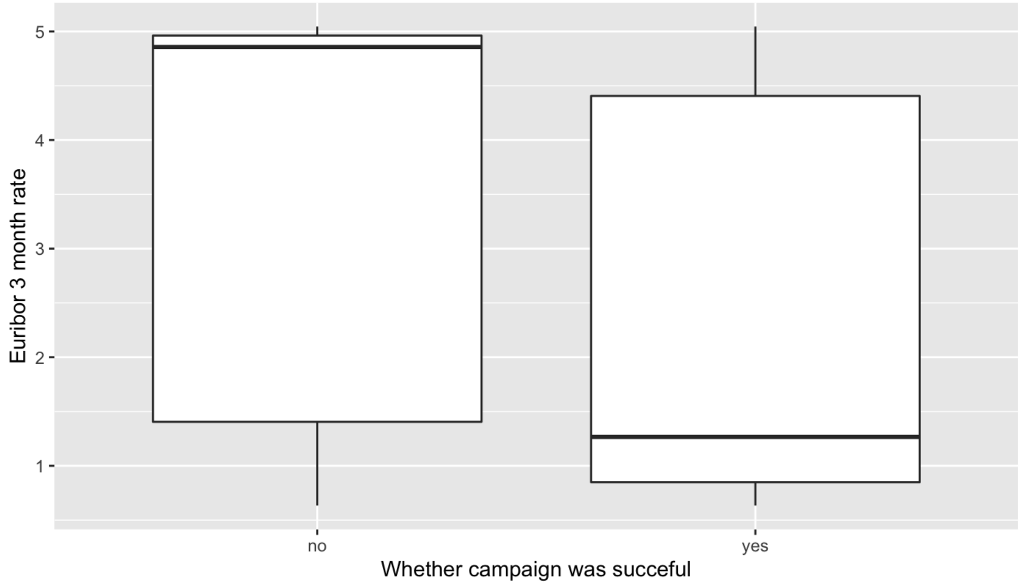




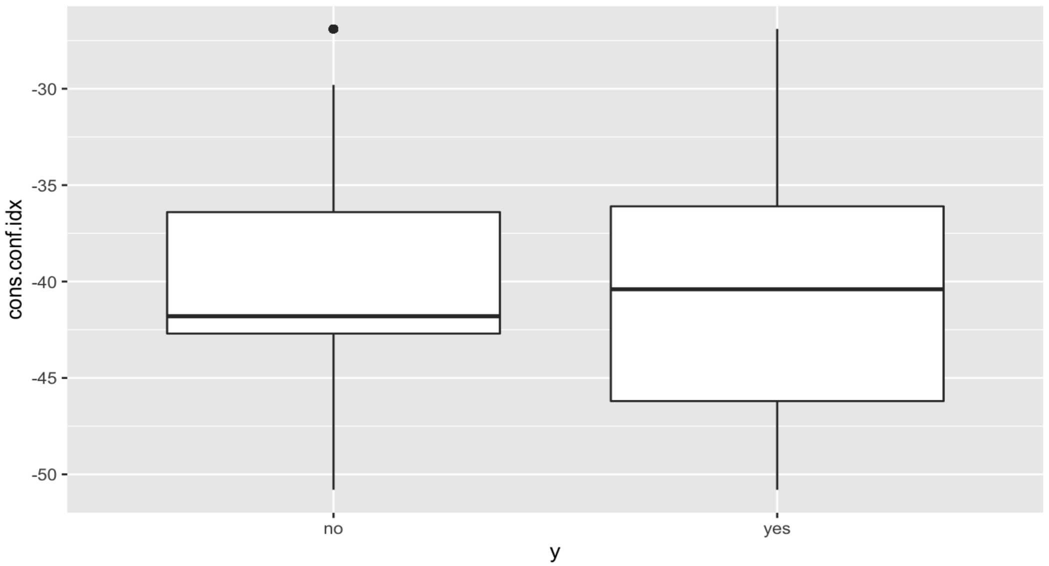


Exploratory Data Analysis: Socio-Economic Factors

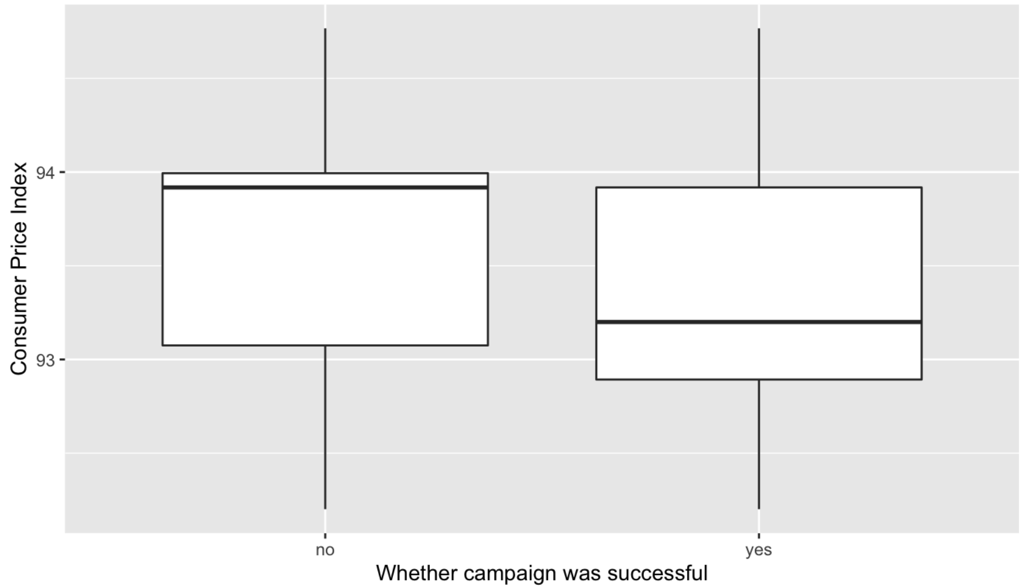
Outcome is highly dependent on Euribor 3 month rate



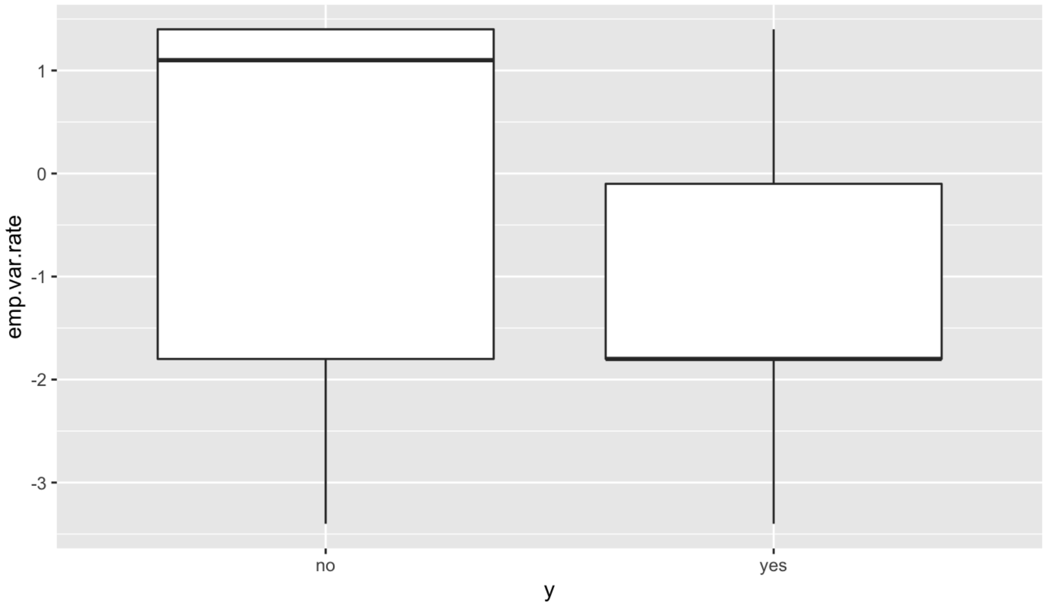
Outcome might be dependent on Consumer confidence index



Outcome is dependent on Consumer price index



Outcome is highly dependent on Employment Variation Rate



Conclusions drawn from EDA

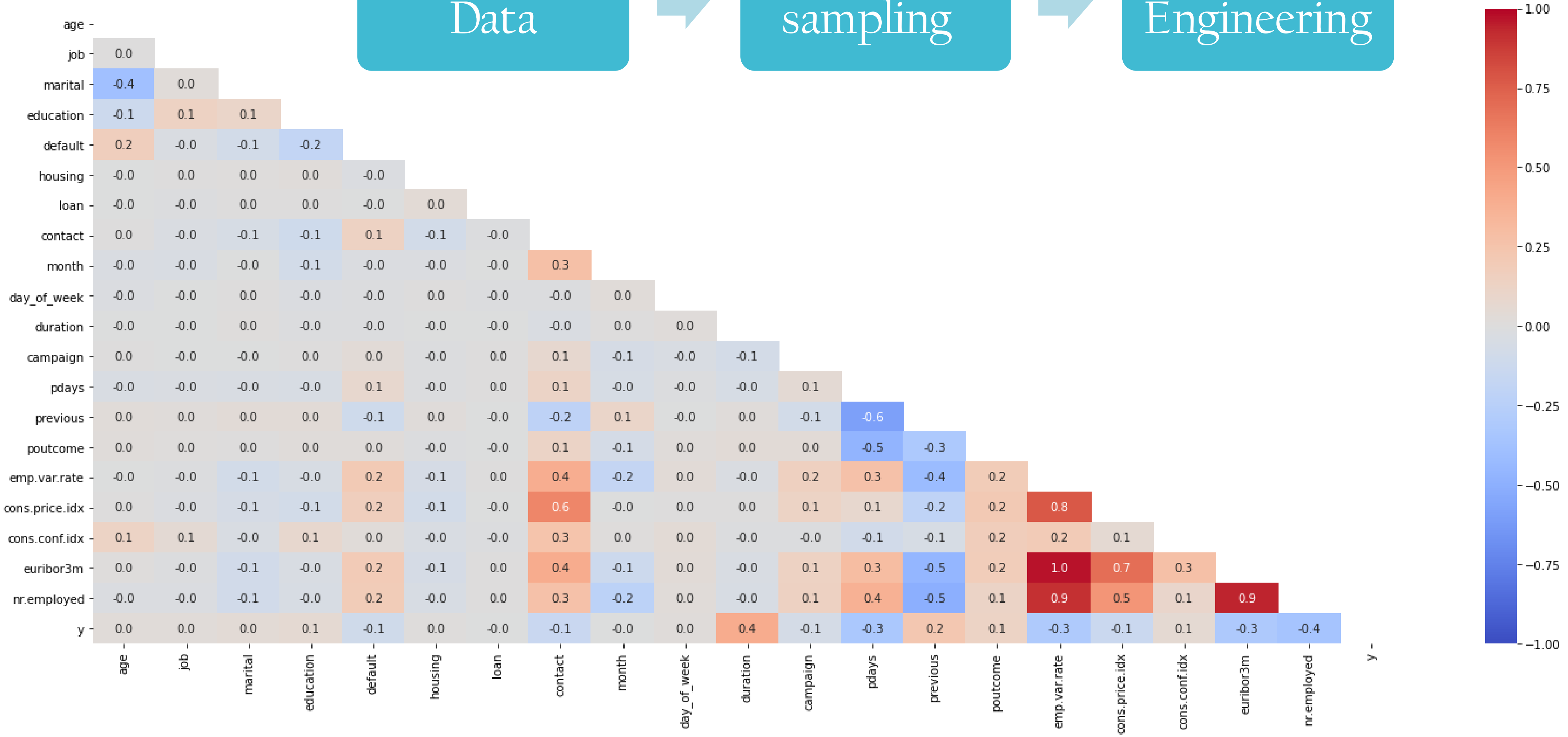
- Socio-economic factors highly influence the outcome. There might be possible correlation between these variables that needs to be checked.
- Client Data like education, job, marital status etc. does not influence the outcome.
- Call duration influences the outcome. The duration is higher for people who subscribed to the term deposit.

Feature Engineering

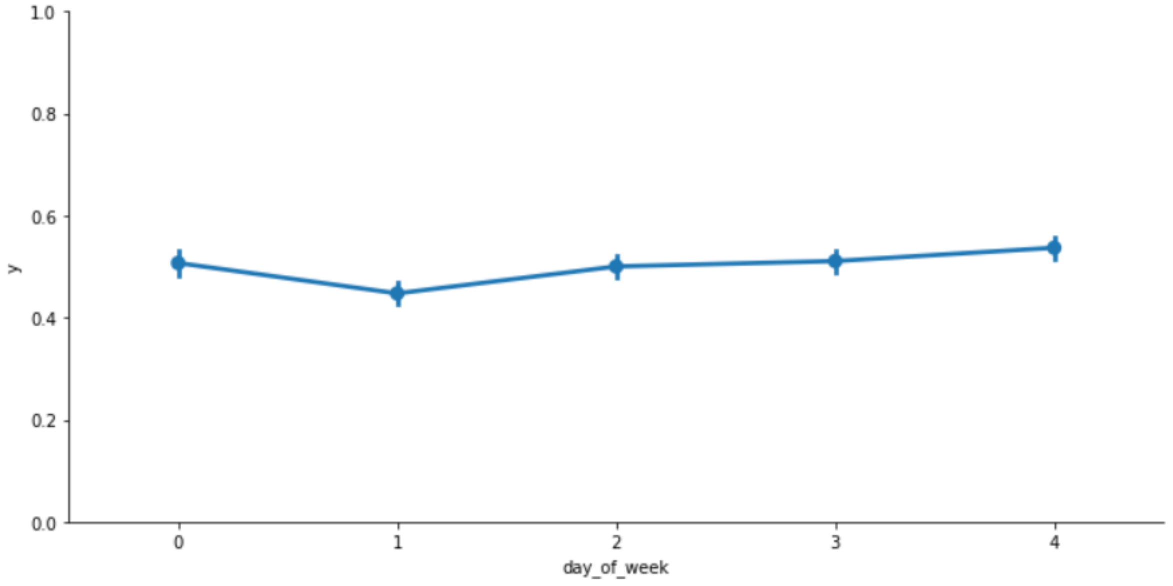
Imbalanced Data

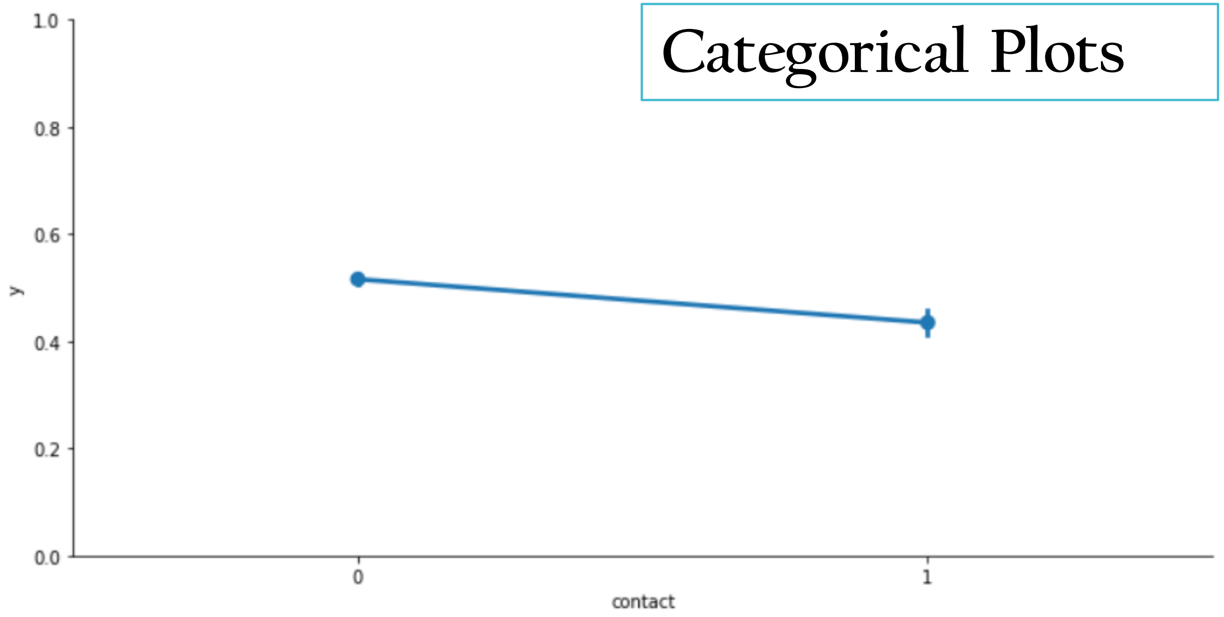
Under-sampling

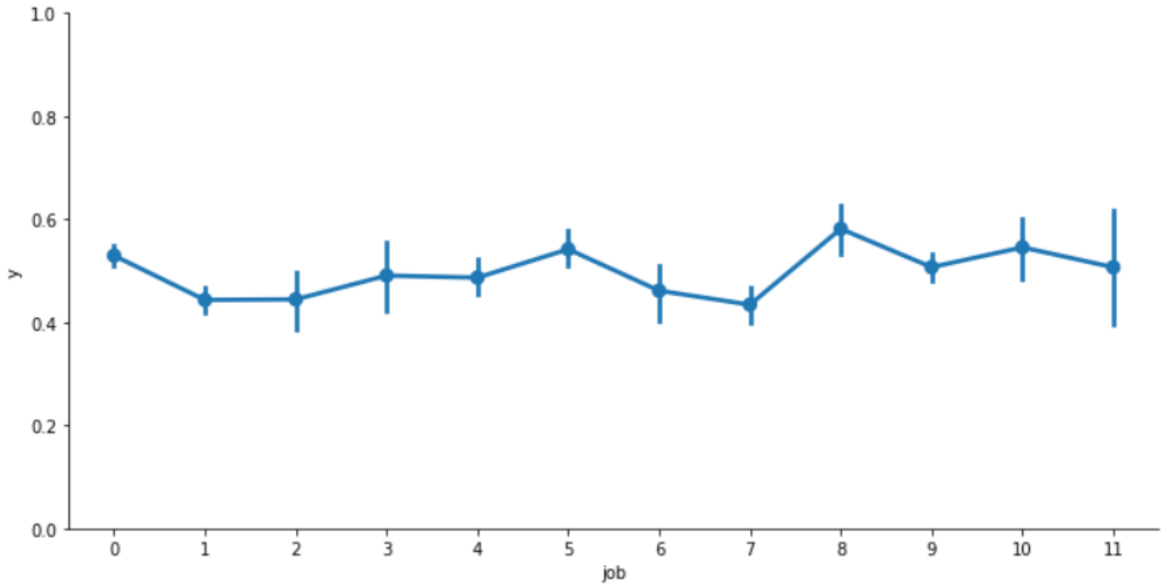
Feature Engineering

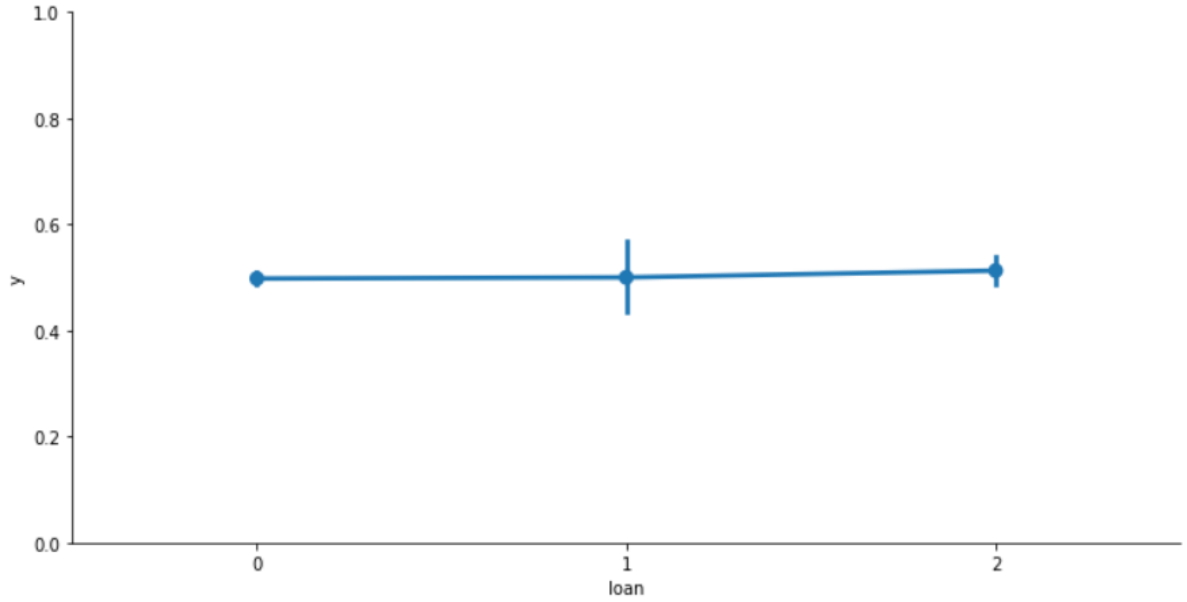


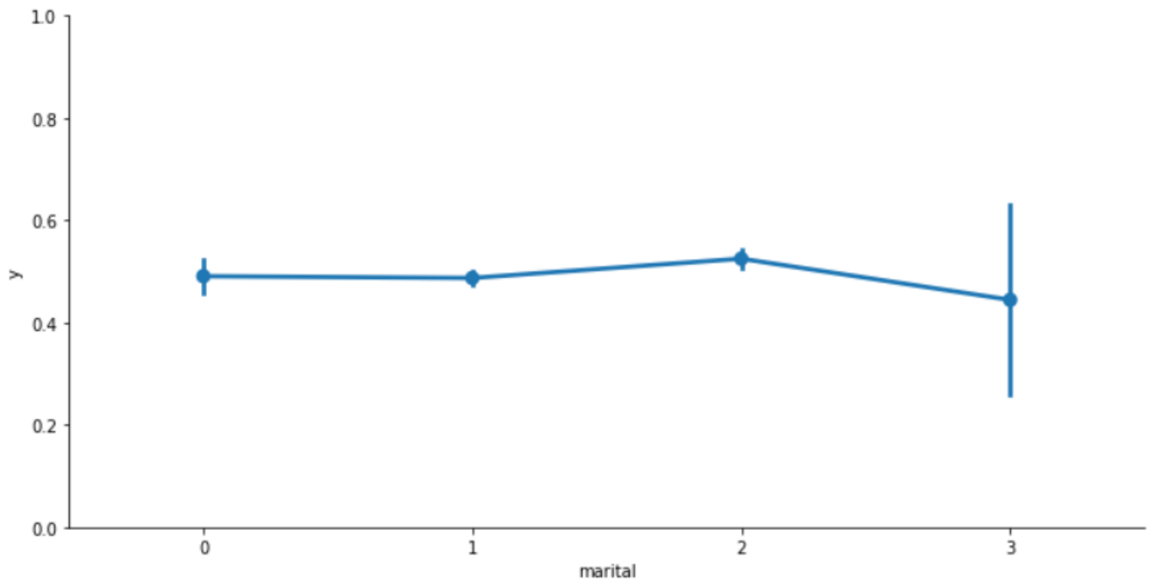
Categorical Plots

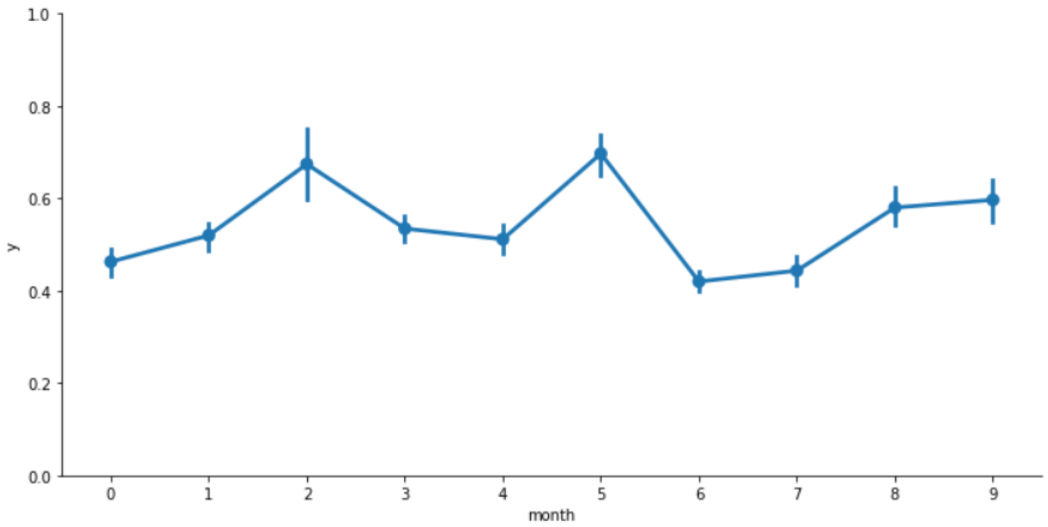


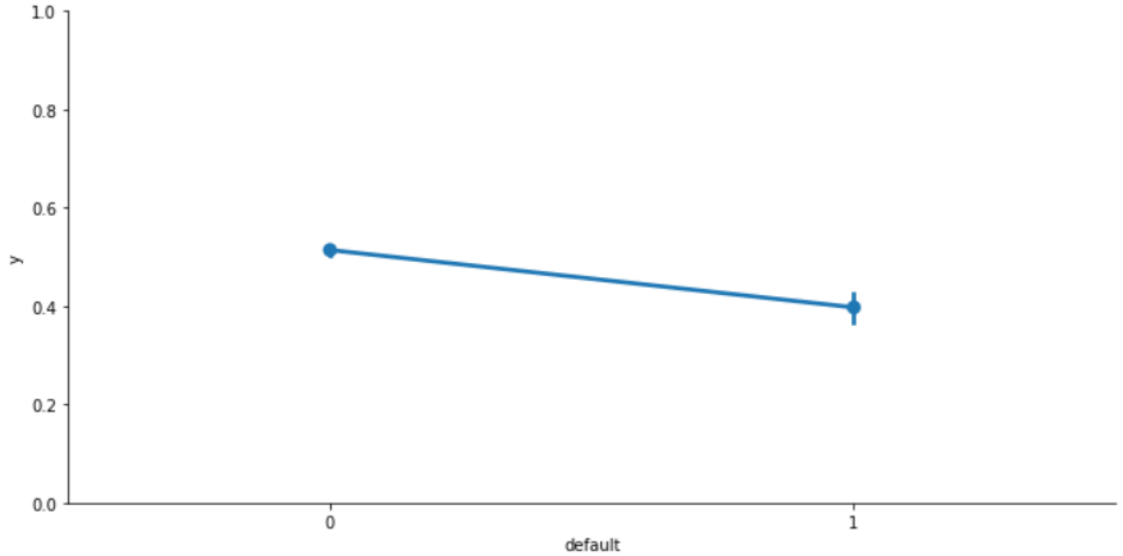


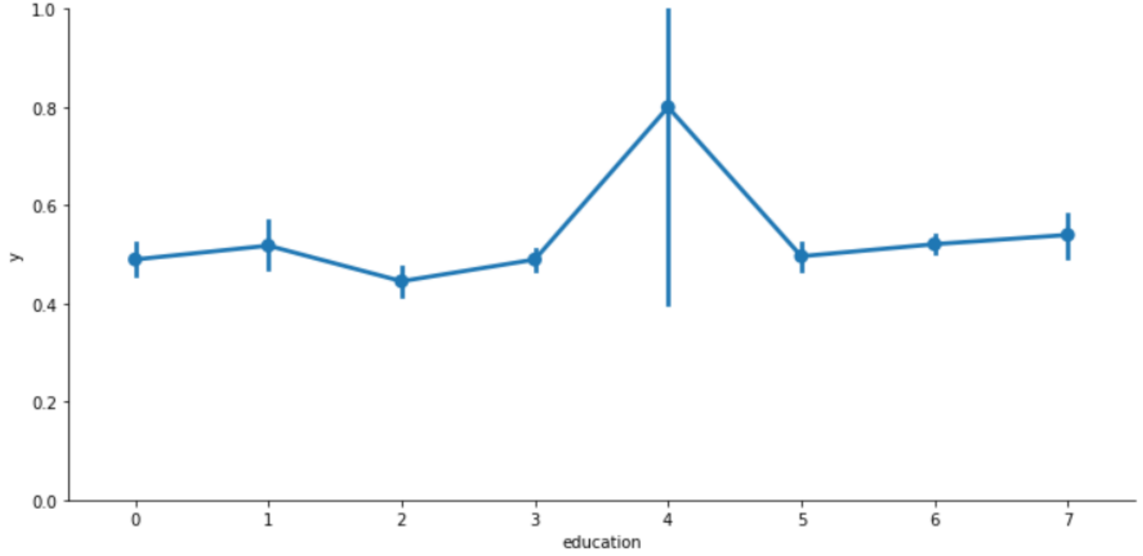





1.0
0.8
0.6
0.4
0.2
0.0
y
0
1
2
3
marital


1.0
0.8
0.6
0.4
0.2
0.0
y
0
1
2
3
4
5
6
7
8
9
month


1.0
0.8
0.6
0.4
0.2
0.0
y
0
1
default


1.0
0.8
0.6
0.4
0.2
0.0
y
0
1
2
3
4
5
6
7
education

Statistical Significance Test:

We performed Statistical significance test for every feature with the output to see if a feature is statistically significant with output.

Feature	P-Value
Age	0.551
Job	0.495
Marital	0.00604
Education	0.000896
Default	2.47e-13
Housing	0.719
Loan	0.319
Contact	6.08e-10
Month	0.839
Day of Week	0.000613
Duration	4.38e-19
Campaign	0.466
pdays	2.25e-66
previous	2.04e-19
poutcome	1.37e-56
Emp.var.rate	1.09e-10
Cons.price.idx	8.1e-05
Cons.conf.idx	1.83e-05
Euribor3m	1.24e-19
Nr.employed	3.27e-38

Conclusion After Feature Engineering

- **Duration, pdays, emp.var.rate, euribor3m and nr.employed** have good correlation with output therefore they might form a very good features compared to others.
- There is high correlation between the socio-economic variables.
- From categorical plot we can see that when value of **poutcome(Previous campaign outcome)** is success, there is 72.5% positive outcome.
- **Age, housing, month and campaign** have p-value greater than 0.05 therefore we can eliminate them as they fail to reject null hypothesis.

Models and Evaluation Metrics

Models Implemented:

Logistic Regression
Support Vector Classifier
K Nearest Neighbours
Random Forest Classifier

		True Class	
		Positive	Negative
Predicted Class	Positive	TP	FP
	Negative	FN	TN

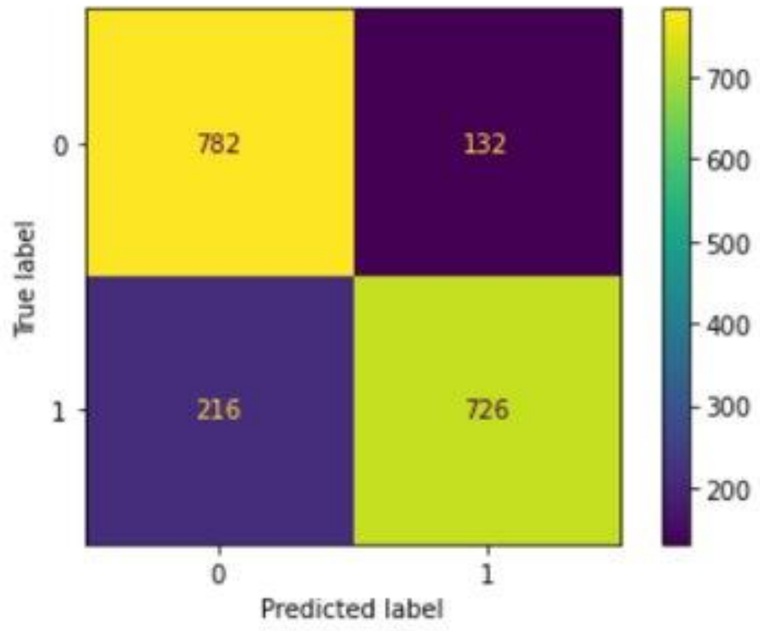
Since the problem we are trying to solve is a classification problem, we generated a confusion matrix to calculate F1 score to compare models

$$\text{F1 Score} = \frac{2 \times (\text{Precision} \times \text{Recall})}{\text{Precision} + \text{Recall}}$$

Logistic Regression

The accuracy for this model is: 81.25%

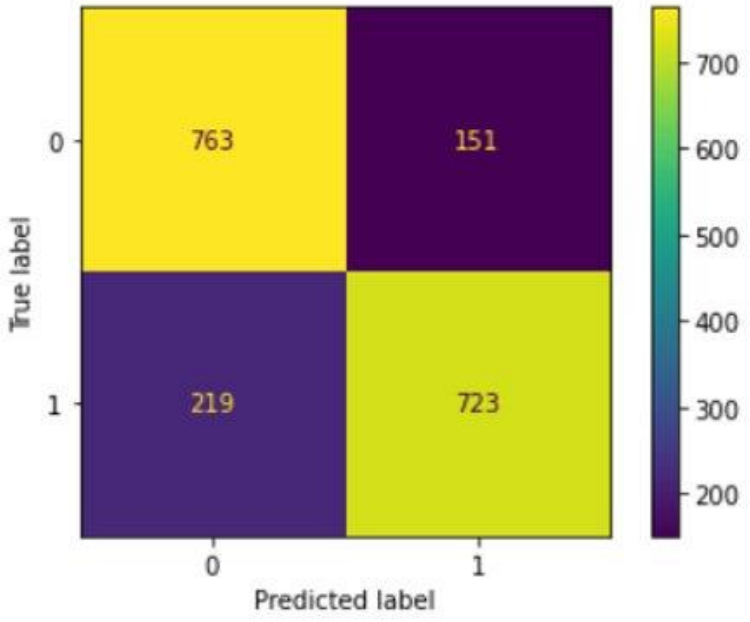
	precision	recall	f1-score	support
0	0.78	0.86	0.82	914
1	0.85	0.77	0.81	942



Support Vector Classifier

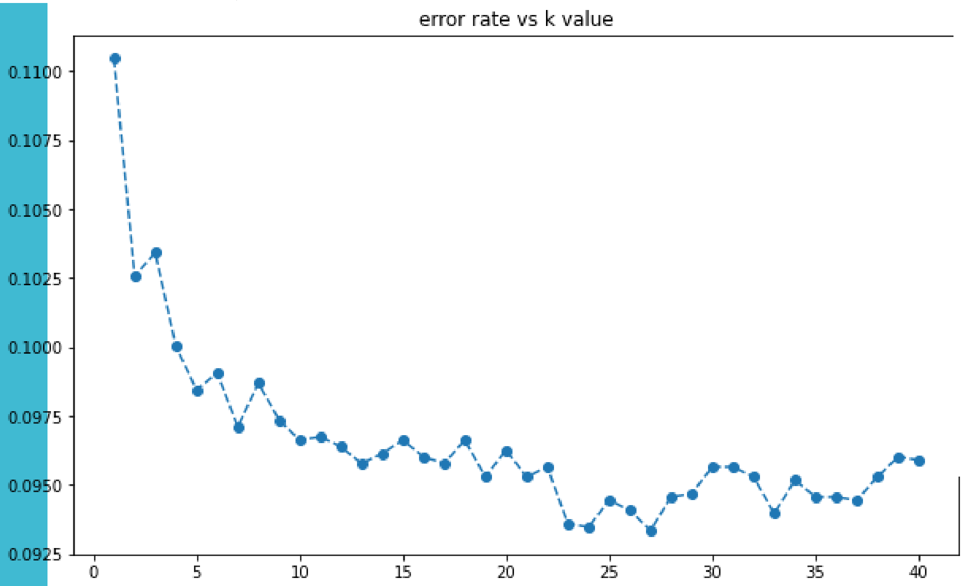
The accuracy for this model is: 80.06%

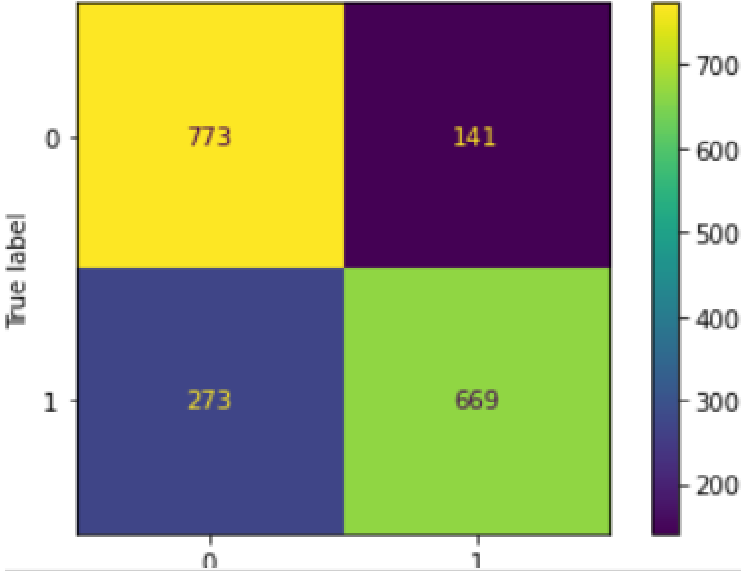
	precision	recall	f1-score	support
0	0.78	0.83	0.80	914
1	0.83	0.77	0.80	942



K- Nearest Neighbors (k=27)

The accuracy of this model is: 77.69%



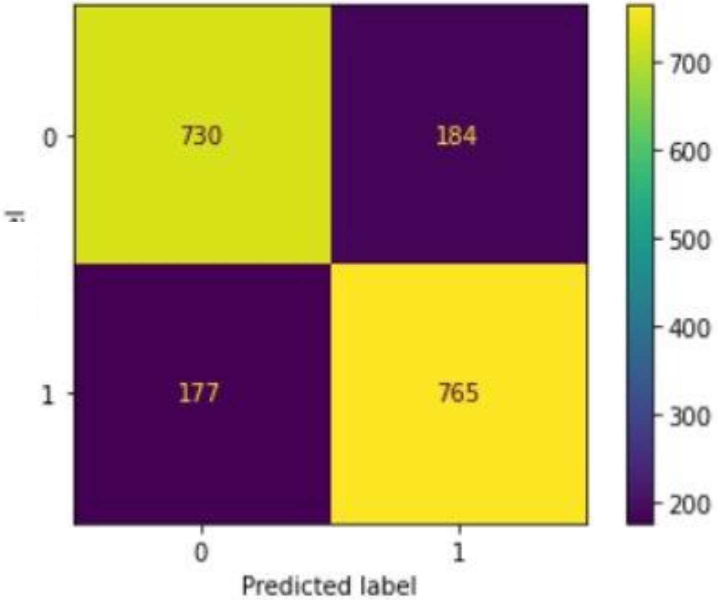


	precision	recall	f1-score	support
0	0.74	0.85	0.79	914
1	0.83	0.71	0.76	942

Random Forest Classifier

The accuracy for this model is: 80.54%

	precision	recall	f1-score	support
0	0.80	0.80	0.80	914
1	0.81	0.81	0.81	942



Conclusion after Machine Learning

- Using our evaluation metrics, we can conclude that the logistic regression model was the best fit model on our data set giving an overall F1 score of 0.82

- Questions?