Analysis of Data Related to Direct Marketing Campaigns (Phone Calls) of a Banking Institution By Ebenezer Omari

Descriptive Introduction

The data is related with direct marketing campaigns of a banking institution. The marketing campaigns were based on phone calls. Often, more than one contact to the same client was required, in order to access if the product (bank term deposit) would be ('yes') or not ('no') subscribed.

The main objectives are to:

1. Identify patterns, correlations, and any necessary data preprocessing steps, such as handling missing values, outliers, and data normalization.
2. Evaluate which features might be most relevant to predicting client subscription and consider creating new features if applicable.
3. Use a machine learning algorithm of choice to build a model predicting the subscription outcome.
4. Use appropriate metrics such as accuracy, precision, recall, and F1 score to assess model effectiveness. Consider any imbalanced classes and adjust accordingly, possibly using techniques like oversampling, under sampling, or adjusting the class weights
5. Summarize key findings from the EDA and insights from the model, such as which features were most impactful, common characteristics of clients likely to subscribe, and actionable recommendations for the marketing team.

Data Preprocessing

To prepare the data for analysis, the following steps were taken:

1. Checked for duplicates
2. Checked for any rows with missing values
3. Checked the structure of the data set
4. Converted features to a factor
5. Split the data into training(70%) and testing(30%) sets for our data model

Descriptive Statistics Exploratory Data Analysis of Age

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
18.00	33.00	39.00	40.94	48.00	95.00

Analysis

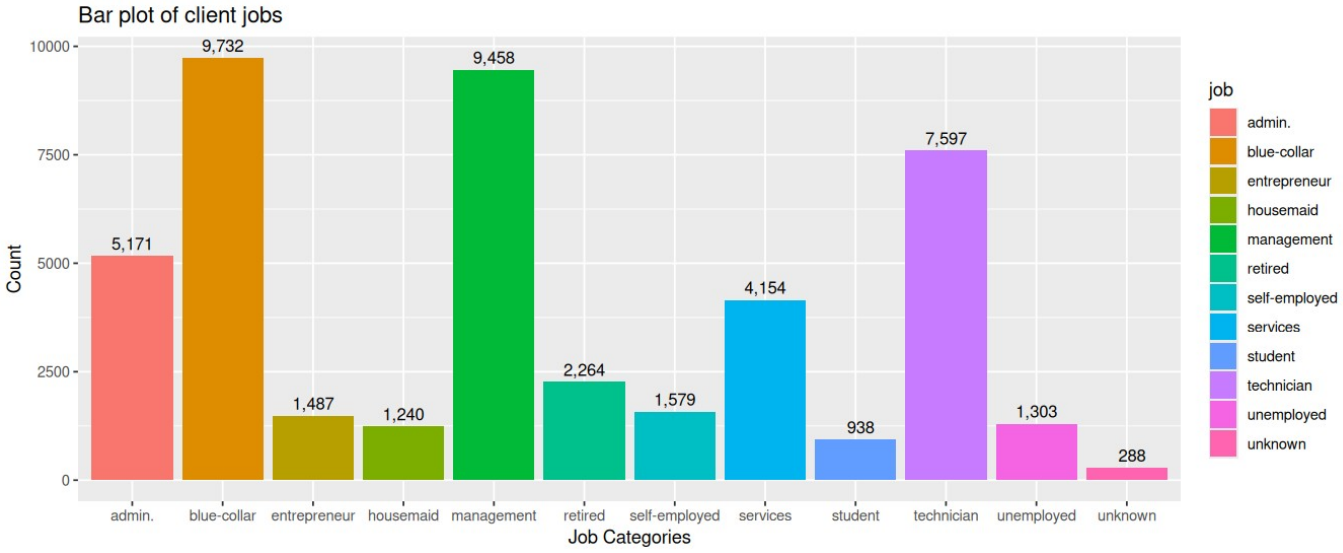
The summary of the age variable gives insights to the distribution of ages in the data set. The age ranges from 18 years to 95 years. The average year is 41 years. Half of the clients are younger than 39 years.

1st quartile: 25% of the clients are below 33 years.

2nd quartile: 75% of the clients are below 48 years.

The distribution of the age data is positively skewed due to the mean greater than the median.

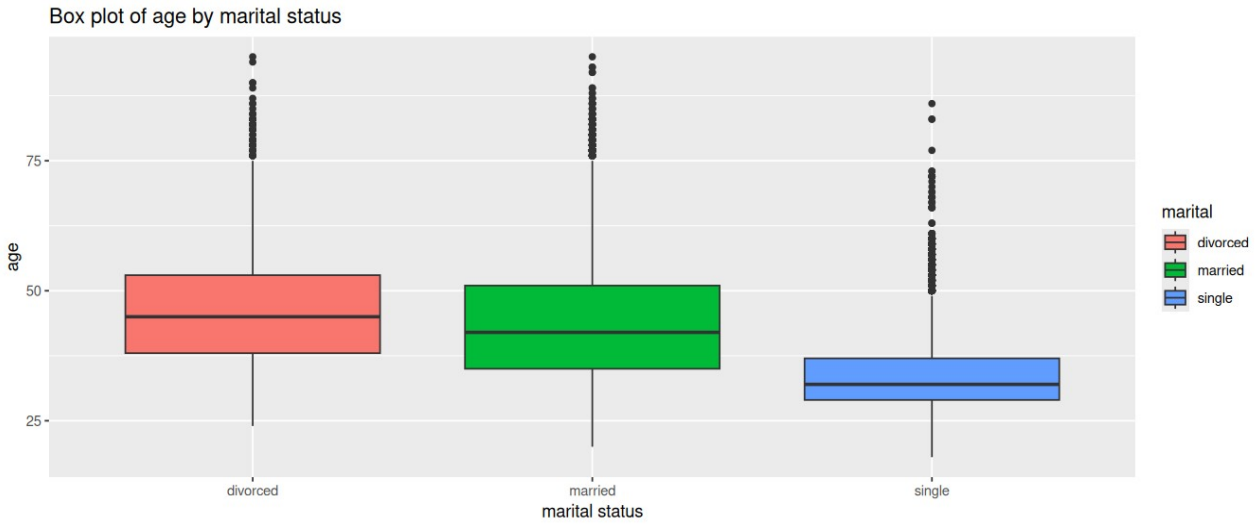
Exploratory Data Analysis (EDA)
Data Visualization on client jobs using bar plot



Analysis

The bar graph shows a bar plot of client jobs. The x axis represent the different job categories, while the y-axis shows the count ranging from 0 to 10,000. The blue collar job category has the highest number of clients recording 9,732, per the evidence from the plot. The management job category has the second highest number of clients recording 9,458. The technician and admin job category has the third and fourth highest number of clients respectively. The lowest number of job category happens to be the unknown with record of 288.

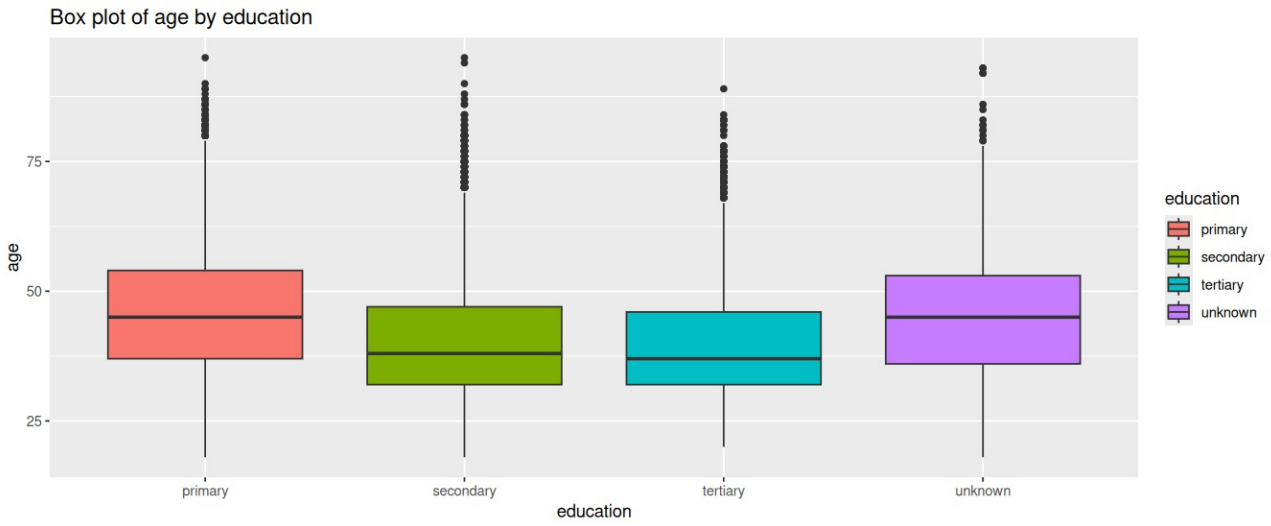
Data Visualization on age by marital status using box plot



Analysis

This box plot compares age of clients and marital status. The y-axis represents the age and the x-axis represents the marital status. Each box represents the inter-quartile range for the marital status. From the plot, clients who are divorced has the higher median age followed by clients who are married with a slightly larger box than the divorced, indicating more age variability among those who are married. Clients who are single has the lowest median with small box indicating less variability in age. All marital status have outliers beyond the whiskers. The single status appears to be negatively skewed whilst the divorced and married appears to be evenly distributed. The presence of outliers suggest age alone may not be the predictor of the marital status.

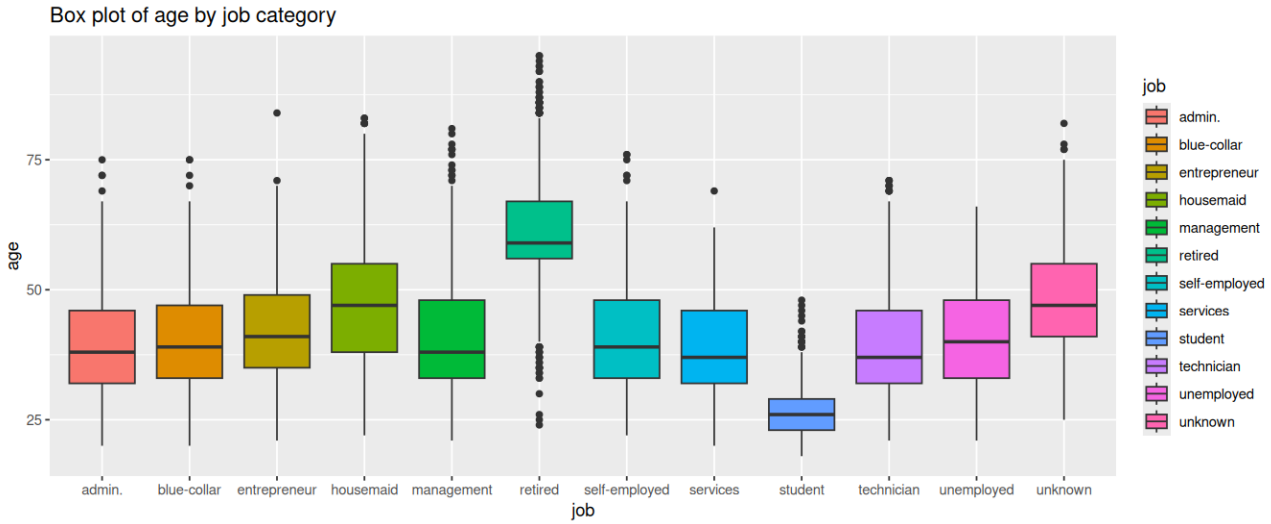
Data Visualization on age by education using box plot



Analysis

This box plot compares age of clients and education. The y-axis represents the age and the x-axis represents the education. Each box represents the inter-quartile range of the education categories From the plot, clients who belong to the unknown category have the highest median and the largest range indicating more variability in age. The unknown category tends to have a slightly positive skewness in distribution whilst the primary category has an even distribution. The tertiary category has the lowest median and a negative skewness in distribution. All categories show some outliers above their distribution.

Data Visualization on age by jobs

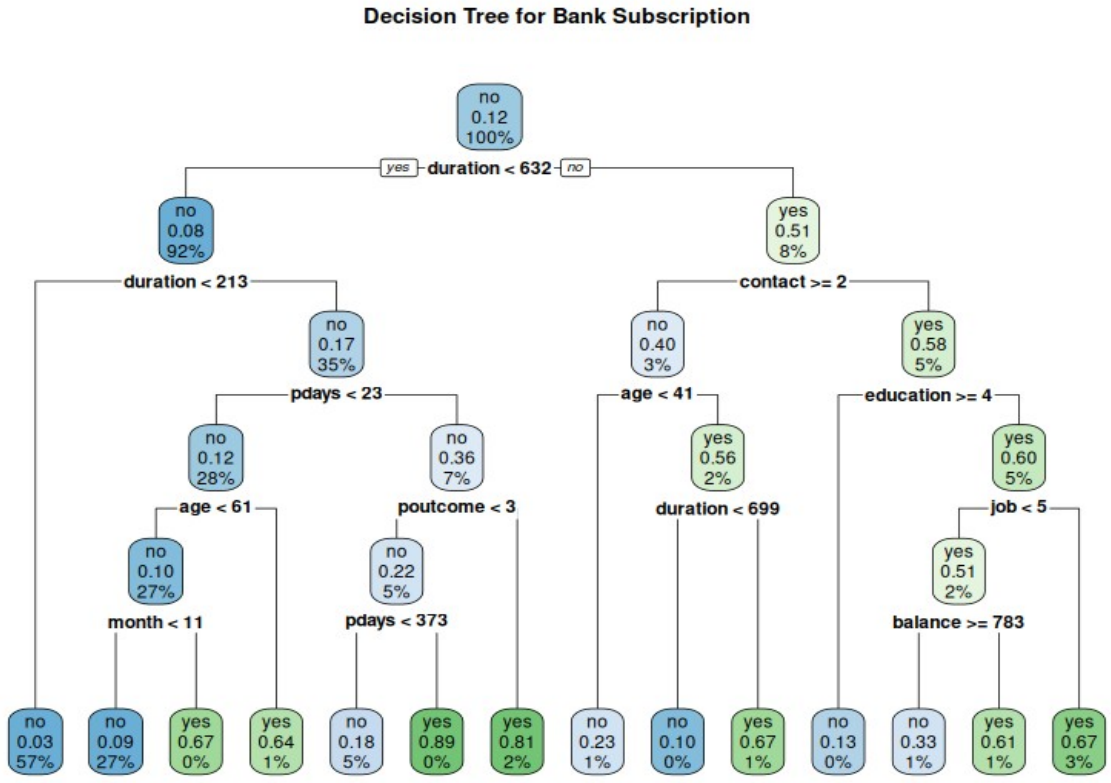


Analysis

This box plot compares age of client and their jobs. The y-axis represents the age and the x-axis represents the jobs. All categories show some outliers above their distribution. The student category has the smallest median age with an even distribution.

Predictive Model

A decision tree model was developed to further predict whether a client will subscribe to a deposit or not (indicated by the variable "y" as "yes" or "no").



The most influential feature that splits the data is the root node. The selection is based on the feature that has high information gain or the highest information gain. Duration being at the top of the root node implies it is the most influential factor to determine whether a customer will subscribe.

The subsequent split of data is the nodes below the root. The decision is based on the condition of each splits, which shows how different the interactions of these features are to influence the prediction.

At the bottom of the tree of the leaf nodes, represent the final classification that is “yes” or “no”. The likelihood of the classification is indicated by the probability of each leaf.

Model Performance

The model seems to perform reasonably well overall, with an accuracy of 88.72%, precision of 92.67%, recall of 94.75% and F1 score of 0.937
This confusion matrix provides valuable insights into the model's performance.

Model Insights

The decision tree provided valuable insights showing influential variables in the model

	feature	importance
duration	duration	122.505842
poutcome	poutcome	49.134318
pdays	pdays	29.738102
previous	previous	20.793185
age	age	18.256913
month	month	11.330381
education	education	3.840576
contact	contact	3.815782
job	job	3.392593
balance	balance	2.313446
day	day	2.160783
campaign	campaign	1.723819
housing	housing	1.430514
marital	marital	1.100395

Duration was found to be the most influential variable in predicting whether a client is likely to subscribe followed by poutcome. This suggest strongly that for marketing purposes, customers with high duration and favourable poutcome conditions that is the outcome of the previous marketing campaigns should be focused on.

Insights and Conclusions

Key findings from our analysis include:

1. Less variability in age with those who are single.
2. The maximum age happens to be 95 years and the minimum age happens to be 18 years.
3. The blue collar job category has the highest number of clients recording 9,732, per the evidence from the plot whiles the unknown recorded the lowest.
4. Data visualization using box plot on age by jobs, age by education, age by marital status showed outliers.
5. The model performed well with an accuracy of 88. 72%.
6. Duration happened to be the most influential feature in predicting whether a client will subscribe or not according to the decision tree model.
7. Customers who engage in longer calls are likely to subscribe and it is strongly correlated with subscription.
8. Poutcome being the second highest of the influential feature shows that the previous campaign results had an influence in the likelihood of success.