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### **Problem description:**

Data cleansing and transformation done on the data.

### **Data understanding:**

Input variables:

# bank client data:

1 - age (numeric)

2 - job : type of job (categorical: 'admin.', 'blue-collar', 'entrepreneur', 'housemaid', 'management', 'retired', 'self-employed', 'services', 'student', 'technician', 'unemployed', 'unknown')

3 - marital : marital status (categorical: 'divorced', 'married', 'single', 'unknown'; note: 'divorced' means divorced or widowed)

4 - education (categorical:

'basic.4y', 'basic.6y', 'basic.9y', 'high.school', 'illiterate', 'professional.course', 'university.degree', 'unknown')

5 - default: has credit in default? (categorical: 'no', 'yes', 'unknown')

6 - housing: has housing loan? (categorical: 'no', 'yes', 'unknown')

7 - loan: has personal loan? (categorical: 'no', 'yes', 'unknown')

# related with the last contact of the current campaign:

8 - contact: contact communication type (categorical: 'cellular', 'telephone')

9 - month: last contact month of year (categorical: 'jan', 'feb', 'mar', ..., 'nov', 'dec')

10 - day\_of\_week: last contact day of the week (categorical: 'mon', 'tue', 'wed', 'thu', 'fri')

11 - duration: last contact duration, in seconds (numeric). Important note: this attribute highly affects the output target (e.g., if duration=0 then y='no'). Yet, the duration is not known before a call is performed. Also, after the end of the call y is obviously known. Thus, this input should only be included for benchmark purposes and should be discarded if the intention is to have a realistic predictive model.

# other attributes:

12 - campaign: number of contacts performed during this campaign and for this client (numeric, includes last contact)

13 - pdays: number of days that passed by after the client was last contacted from a previous campaign (numeric; 999 means client was not previously contacted)

14 - previous: number of contacts performed before this campaign and for this client (numeric)

15 - poutcome: outcome of the previous marketing campaign (categorical:

'failure','nonexistent','success')

# social and economic context attributes

16 - emp.var.rate: employment variation rate - quarterly indicator (numeric)

17 - cons.price.idx: consumer price index - monthly indicator (numeric)

18 - cons.conf.idx: consumer confidence index - monthly indicator (numeric)

19 - euribor3m: euribor 3 month rate - daily indicator (numeric)

20 - nr.employed: number of employees - quarterly indicator (numeric)

Output variable (desired target):

21 - y - has the client subscribed a term deposit? (binary: 'yes','no')

### **Type of data:**

.csv file with 5 float, 5 int and 11 object data type features

### **Problem hypotheses:**

1. There are duplicate data
2. There are NA values
3. 'y' feature is skewed
4. Some outliers are in the feature
5. Some features have multicollinearity

### **Approaches:**

1. Using pandas drop\_duplicates()
2. There is no NA or Null values in the data set after checking by is.null().sum() and is.na.sum()
3. Using under-sampling technique since the oversampling will create several duplicate data
4. Drawing boxplot and get the interquartile
5.
  - 1) Using Variable Inflation Factor (VIF), setting it with a default threshold of 5.0. Those features that are greater than 5.0 would be considered high multicollinearity and will be removed.
  - 2) Drawing heatmap picture and using VIF function to remove those high multicollinearity features.

3) Running a random forest model and then getting the most important features

**Model problem hypotheses:**

1. Accuracy of logistic regression is low
2. Random forest model is overfitting
3. Xgboost will perform better with hyperparameter tuning