Machine Learning Freelance Platform Projects

```
# importing all neccessary librearies
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
```

```
# Reading of the dataset
df=pd.read_csv("Freelance_Platform_Projects.csv")
df.head()
```

	Title	Category Name	Experience	Sub Category Name	Currency	Budget	Location	Freelancer Preferred From	Type	Date Posted	Description	Duration	Client Registration Date	Client City	Client Country	Client Currency	Client Job Title
0	i need an interactive form building n my site	Technology & Programming	Entry ($)	Website Development	GBP	20.0	remote	ALL	fixed_price	2023-01-30 16:04:50	i want to cllect leads/data on my site. i want...	NaN	2016-05-17	Tadcaster	United Kingdom	GBP	Paid Social Media Manager
1	3D model of BIG MINING MACHINE	Design	Expert ($$$)	3D Design	EUR	2007.0	remote	ALL	fixed_price	2023-01-30 16:04:50	Hi everyone,\ntoday im looking for "SKILLED" 3...	NaN	2019-06-05	Ostrava	Czech Republic	USD	indie game and VR company
2	Sales Email Template	Marketing, Branding & Sales	Expert ($$$)	Sales & Calls	GBP	25.0	remote	ALL	hourly	2023-01-30 15:55:38	Looking for a template that can be used when w...	NaN	2022-12-05	Ardrossan	United Kingdom	GBP	NaN
3	Need Writer to Write a Review Article	Writing & Translation	Entry ($)	Content Writing	USD	30.0	remote	ALL	fixed_price	2023-01-30 15:55:38	I need a writer who can able to write a review...	NaN	2014-10-08	Kolkata	India	USD	Blogging | Digital Marketing | SEO
4	I need a 3d work of my house	Design	Intermediate ($$)	3D Design	GBP	30.0	remote	ALL	fixed_price	2023-01-30 15:41:40	I require 3d work of my house. 3d plan already...	NaN	2022-01-02	Gloucester	United Kingdom	GBP	NaN

```
# now we will check the shape and size of the dataset

print(df.shape)
print(df.size)
```

```
(1402, 17)
23834
```

```
#calculate all element
df.size
```

```
23834
```

```
# Now the most important part of machine learning is that to explore the data
# Before creating any machine learning model it is very important to have
# the neat and clean data
# The neat and clean data means such a data which do not have outeliers, skewness,
# null values, and of course, should be numeric in nature
# so lets move towords Exploratory data analysis
```

EXPLORATORY DATA ANALYSIS

```
# lets do some analysis about out features and their datatypes

df.info()
# A i can see there are 1402 total entries but in two columns namely Duration
# and Client job title
# have not equal non_null entries as total entries
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1402 entries, 0 to 1401
Data columns (total 17 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Title                     1402 non-null   object 
 1   Category Name             1402 non-null   object 
 2   Experience                1402 non-null   object 
 3   Sub Category Name         1402 non-null   object 
 4   Currency                  1402 non-null   object 
 5   Budget                    1402 non-null   float64
 6   Location                  1402 non-null   object 
 7   Freelancer Preferred From  1402 non-null   object 
 8   Type                      1402 non-null   object 
 9   Date Posted               1402 non-null   object 
 10  Description               1402 non-null   object 
 11  Duration                  183 non-null    object 
 12  Client Registration Date  1402 non-null   object 
 13  Client City               1402 non-null   object 
 14  Client Country            1402 non-null   object 
 15  Client Currency           1402 non-null   object 
 16  Client Job Title          564 non-null    object 
dtypes: float64(1), object(16)
memory usage: 186.3+ KB
```

```
# statistical information
df.describe()
```

Budget

```
df.columns = df.columns.str.replace(" ","_")
df.columns
```

```
Index(['Title', 'Category_Name', 'Experience', 'Sub_Category_Name', 'Currency',
       'Budget', 'Location', 'Freelancer_Preferred_From', 'Type',
       'Date_Posted', 'Description', 'Duration', 'Client_Registration_Date',
       'Client_City', 'Client_Country', 'Client_Currency', 'Client_Job_Title'],
      dtype='object')

  50%        30.000000
```

```
#check null values
df.isnull().sum()
```

```
Title                           0
Category_Name                   0
Experience                      0
Sub_Category_Name               0
Currency                        0
Budget                          0
Location                        0
Freelancer_Preferred_From       0
Type                            0
Date_Posted                     0
Description                     0
Duration                     1219
Client_Registration_Date        0
Client_City                     0
Client_Country                  0
Client_Currency                 0
Client_Job_Title              838
dtype: int64
```

```
# So, there are two such columns which as over 60-70% null values
# so, there is no sense of keeping those columns, so we prefer to
# delete those columns

df=df.drop(df[["Duration","Client_Job_Title"]],axis =1)
df.head()
```

	Title	Category_Name	Experience	Sub_Category_Name	Currency	Budget	Location	Freelancer_Preferred_From	Type	Date_Posted	Description	Client_Registration_Date	Client_City	Client_Country	Client_Currency
0	i need an interactive form building n my site	Technology & Programming	Entry ($)	Website Development	GBP	20.0	remote	ALL	fixed_price	2023-01-30 16:04:50	i want to cllect leads/data on my site. i want...	2016-05-17	Tadcaster	United Kingdom	GBP
1	3D model of BIG MINING MACHINE	Design	Expert ($$$)	3D Design	EUR	2007.0	remote	ALL	fixed_price	2023-01-30 16:04:50	Hi everyone,\ntoday im looking for "SKILLED" 3...	2019-06-05	Ostrava	Czech Republic	USD
2	Sales Email Template	Marketing, Branding & Sales	Expert ($$$)	Sales & Calls	GBP	25.0	remote	ALL	hourly	2023-01-30 15:55:38	Looking for a template that can be used when w...	2022-12-05	Ardrossan	United Kingdom	GBP
3	Need Writer to Write a Review Article	Writing & Translation	Entry ($)	Content Writing	USD	30.0	remote	ALL	fixed_price	2023-01-30 15:55:38	I need a writer who can able to write a review...	2014-10-08	Kolkata	India	USD
4	I need a 3d work of my house	Design	Intermediate ($$)	3D Design	GBP	30.0	remote	ALL	fixed_price	2023-01-30 15:41:40	I require 3d work of my house. 3d plan already...	2022-01-02	Gloucester	United Kingdom	GBP

```
# now we can see our data does not contain any null values
df.isnull().sum()
```

```
Title                        0
Category_Name                0
Experience                   0
Sub_Category_Name            0
Currency                     0
Budget                       0
Location                     0
Freelancer_Preferred_From    0
Type                         0
Date_Posted                  0
Description                  0
Client_Registration_Date     0
Client_City                  0
Client_Country               0
Client_Currency              0
dtype: int64
```

```
#check duplicates value
dupl=df[df.duplicated()]
dupl.count()
```

```
Title                        0
Category_Name                0
Experience                   0
Sub_Category_Name            0
Currency                     0
Budget                       0
Location                     0
Freelancer_Preferred_From    0
Type                         0
Date_Posted                  0
Description                  0
Client_Registration_Date     0
Client_City                  0
Client_Country               0
Client_Currency              0
dtype: int64
```

```
df["Title"].nunique()
```

```
1353
```

```
df["Description"].nunique()
```

```
1368
```

```
df=df.drop(df[["Title","Description"]],axis=1)
```

```
# now we will check for all data type of all columns
df.dtypes
```

```
    Category_Name                object
    Experience                   object
    Sub_Category_Name            object
    Currency                     object
    Budget                      float64
    Location                     object
    Freelancer_Preferred_From    object
    Type                         object
    Date_Posted                  object
    Client_Registration_Date     object
    Client_City                  object
    Client_Country               object
    Client_Currency              object
    dtype: object
```

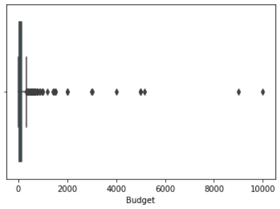
```
# As two columns namely Data Posted and Client Registration Date are object but
# actualy should be date time
# so lets convert it to datetime data
df["Client_Registration_Date"] = pd.to_datetime(df["Client_Registration_Date"])
df["Date_Posted"] = pd.to_datetime(df["Date_Posted"])
```

```
# lets do some feature engineering here
import datetime as dt
df["Day_Registraterd"] = df["Client_Registration_Date"].dt.day
df["Day_Posted"] = df["Date_Posted"].dt.day
```

```
df =df.drop(df[["Client_Registration_Date","Date_Posted"]], axis=1)
```

```
# now we will check for outliers in our data in case of numeric columns
sns.boxplot(df["Budget"])
```

```
    <AxesSubplot:xlabel='Budget'>
```



```
# find IQR
Q1=df.quantile(0.25)
Q3=df.quantile(0.75)
IQR=Q3-Q1
print(IQR)
```

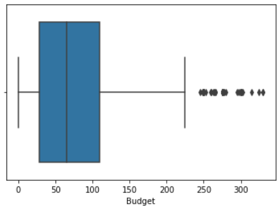
```
    Budget              120.00
    Day_Registraterd     16.00
    Day_Posted            4.75
    dtype: float64
```

```
# remove outliers in our data
df=df[~((df < (Q1-1.5*IQR)) | (df > (Q3+1.5*IQR))).any(axis=1)]
df.shape
```

```
    (1284, 13)
```

```
# now we check outliers
sns.boxplot(df['Budget'])
```

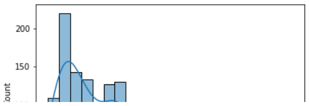
```
    <AxesSubplot:xlabel='Budget'>
```



```
# set index
df.reset_index()
df= df.reset_index(drop = True)
df.head()
```

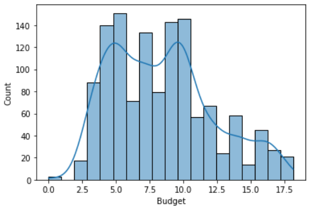
	Category_Name	Experience	Sub_Category_Name	Currency	Budget	Location	Freelancer_Preferred_From	Type	Client_City	Client_Country	Client_Currency	Day_Registraterd	Day_Posted
0	Technology & Programming	Entry ($)	Website Development	GBP	20.0	remote	ALL	fixed_price	Tadcaster	United Kingdom	GBP	17	30
1	Marketing, Branding & Sales	Expert ($$$)	Sales & Calls	GBP	25.0	remote	ALL	hourly	Ardrossan	United Kingdom	GBP	5	30
2	Writing & Translation	Entry ($)	Content Writing	USD	30.0	remote	ALL	fixed_price	Kolkata	India	USD	8	30
3	Design	Intermediate ($$)	3D Design	GBP	30.0	remote	ALL	fixed_price	Gloucester	United Kingdom	GBP	2	30
4	Technology & Programming	Entry ($)	Website Development	GBP	20.0	remote	ALL	hourly	Leeds	United Kingdom	GBP	11	30

```
# lets check for skewness in numeric feature
sns.histplot(df["Budget"],kde =True)
plt.show()
# it is highly positive skewed
# so to perform model well it would be better resolve this problem
```



```
# removed skewness
df["Budget"]= np.sqrt(df["Budget"])
```

```
# lets check for skewness in numeric feature
sns.histplot(df["Budget"],kde =True)
plt.show()
#so, now it seems better than previous distribution or skewness problem resolved
```



```
df["Budget"].value_counts()
```

```
    10.000000    92
    7.071068     80
    4.472136     74
    3.162278     68
    5.477226     62
                 ..
    7.141428      1
    6.928203      1
    10.344080     1
    14.966630     1
    7.810250      1
    Name: Budget, Length: 144, dtype: int64
```

```
data=df.copy()
```

CLUSTERS OF THE PROJECTS

```
data.head()
```

	Category_Name	Experience	Sub_Category_Name	Currency	Budget	Location	Freelancer_Preferred_From	Type	Client_City	Client_Country	Client_Currency	Day_Registraterd	Day_Posted
0	Technology & Programming	Entry ($)	Website Development	GBP	4.472136	remote	ALL	fixed_price	Tadcaster	United Kingdom	GBP	17	30
1	Marketing, Branding & Sales	Expert ($$$)	Sales & Calls	GBP	5.000000	remote	ALL	hourly	Ardrossan	United Kingdom	GBP	5	30
2	Writing & Translation	Entry ($)	Content Writing	USD	5.477226	remote	ALL	fixed_price	Kolkata	India	USD	8	30
3	Design	Intermediate ($$)	3D Design	GBP	5.477226	remote	ALL	fixed_price	Gloucester	United Kingdom	GBP	2	30
4	Technology & Programming	Entry ($)	Website Development	GBP	4.472136	remote	ALL	hourly	Leeds	United Kingdom	GBP	11	30

```
# As we know any machine learning model only works on numeric data
# so we will convert all categorical collumns into numerical data using
#lable encoder of sklearn library

from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()

data['Category_Name']=encoder.fit_transform(data['Category_Name'])
data['Experience']=encoder.fit_transform(data['Experience'])
data['Sub_Category_Name']=encoder.fit_transform(data['Sub_Category_Name'])
data['Currency']=encoder.fit_transform(data['Currency'])
data['Location']=encoder.fit_transform(data['Location'])
data['Freelancer_Preferred_From']=encoder.fit_transform(data['Freelancer_Preferred_From'])
data['Type']=encoder.fit_transform(data['Type'])
data['Client_City']=encoder.fit_transform(data['Client_City'])
data['Client_Country']=encoder.fit_transform(data['Client_Country'])
data['Client_Currency']=encoder.fit_transform(data['Client_Currency'])

data.head()
```

	Category_Name	Experience	Sub_Category_Name	Currency	Budget	Location	Freelancer_Preferred_From	Type	Client_City	Client_Country	Client_Currency	Day_Registraterd	Day_Posted
0	6	0	85	1	4.472136	1	0	0	423	66	1	17	30
1	3	1	67	1	5.000000	1	0	1	14	66	1	5	30
2	8	0	21	2	5.477226	1	0	0	224	25	2	8	30
3	1	2	0	1	5.477226	1	0	0	160	66	1	2	30
4	6	0	85	1	4.472136	1	0	1	238	66	1	11	30

KMeans Clustering

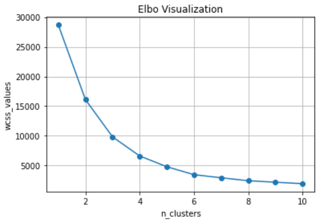
```
# we will create clusters of the projects by applying KMeans cluster
x = data.iloc[:,[0,4]].values
```

```
from sklearn.cluster import KMeans
wcss_list = []
for i in range(1,11):
    k=KMeans(n_clusters=i,random_state=1)
    k.fit(x)
    wcss_list.append(k.inertia_)
```

```
wcss_list
```

```
[28693.522207384212,
 16099.4780439866,
 9819.800315813207,
 6603.213288162871,
 4791.114053973585,
 3452.5171314843446,
 2930.7367704985536,
 2435.755121342262,
 2185.7381913847416,
 1935.81144524291]
```

```
# for declaration of optimum values for number of clusters lets plot the elbow method
# the first sharp bent will give the best value for number of clusters
plt.plot(range(1,11),wcss_list,"o-")
plt.title("Elbo Visualization")
plt.xlabel("n_clusters")
plt.ylabel("wcss_values")
plt.grid()
plt.show()
```



```
model= KMeans(n_clusters=4,random_state=1)
pred=model.fit_predict(x)
```

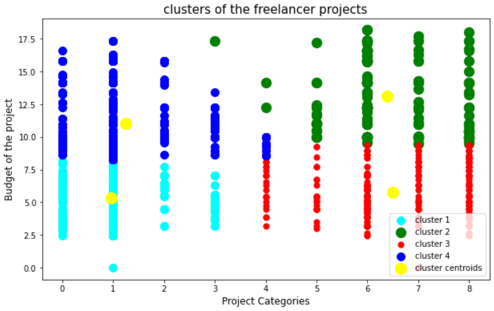
```
pred[:5]
```

```
array([2, 0, 2, 0, 2], dtype=int32)
```

```
model.cluster_centers_
```

```
array([[ 0.97050147,  5.34578602],
       [ 6.39545455, 13.10219456],
       [ 6.49575071,  5.76758142],
       [ 1.24462366, 11.0157424 ]])
```

```
plt.figure(figsize = (10,6))
plt.scatter(x[pred==0,0], x[pred== 0,1], s = 100, c= "cyan", label = "cluster 1")
plt.scatter(x[pred==1,0], x[pred== 1,1], s = 150, c= "green", label = "cluster 2")
plt.scatter(x[pred==2,0], x[pred== 2,1], s = 50, c= "red", label = "cluster 3")
plt.scatter(x[pred==3,0], x[pred== 3,1], s = 100, c= "blue", label = "cluster 4")
plt.scatter(model.cluster_centers_[:,0],
            model.cluster_centers_[:,1],s=200,c="yellow",
            label="cluster centroids")
plt.xlabel("Project Categories",fontsize = 12)
plt.ylabel("Budget of the project",fontsize = 12)
plt.title("clusters of the freelancer projects", fontsize =15)
plt.legend(loc ="lower right")
plt.show()
```



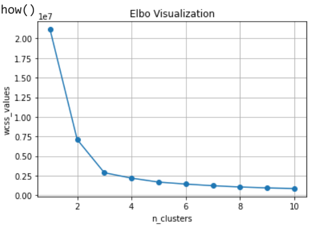
```
# lets do principal components analysis
# by setting number of components to 2
# then we will create clusters of projects on that components
```

```
from sklearn.decomposition import PCA
pca = PCA(n_components = 2)
data_t = pca.fit_transform(data)
```

```
from sklearn.cluster import KMeans
wcss_list = []
for i in range(1,11):
    k=KMeans(n_clusters=i)
    k.fit(data_t)
    wcss_list.append(k.inertia_)
wcss_list
```

```
[21135523.0910491,
 7106857.786223913,
 2879890.0690957475,
 2191150.8217724515,
 1684833.0310194232,
 1434583.1696904602,
 1225644.8858338292,
 1062375.0142885665,
 946457.100854142,
 859141.5113559649]
```

```
# create elbo visualization for easily find cluster
plt.plot(range(1,11),wcss_list,"o-")
plt.title("Elbo Visualization")
plt.xlabel("n_clusters")
plt.ylabel("wcss_values")
plt.grid()
plt.show()
```

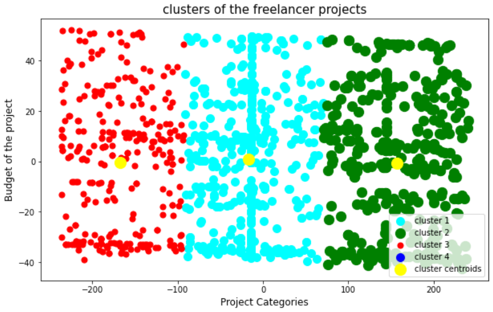


```
model= KMeans(n_clusters=3)
pred=model.fit_predict(data_t)
```

```
pred[:5]
```

```
array([2, 1, 0, 1, 0], dtype=int32)
```

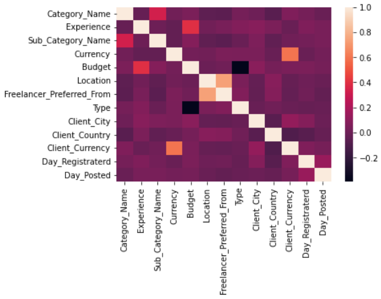
```
# plot cluster
plt.figure(figsize = (10,6))
plt.scatter(data_t[pred==0,0], data_t[pred== 0,1], s = 100, c= "cyan", label = "cluster 1")
plt.scatter(data_t[pred==1,0], data_t[pred== 1,1], s = 150, c= "green", label = "cluster 2")
plt.scatter(data_t[pred==2,0], data_t[pred== 2,1], s = 50, c= "red", label = "cluster 3")
plt.scatter(data_t[pred==3,0], data_t[pred== 3,1], s = 100, c= "blue", label = "cluster 4")
plt.scatter(model.cluster_centers_[:,0],
            model.cluster_centers_[:,1],s=200,c="yellow",
            label="cluster centroids")
plt.xlabel("Project Categories",fontsize = 12)
plt.ylabel("Budget of the project",fontsize = 12)
plt.title("clusters of the freelancer projects", fontsize =15)
plt.legend(loc ="lower right")
plt.show()
```



Regression model for Budget prediction

```
# now, before creating the model it is very important to check for multicolinearity
sns.heatmap(data.corr())
```

```
<AxesSubplot:>
```



```
# As there is positive correlation between independent
#variables we will delete one of them
data2=data.drop(data[["Currency","Category_Name"]], axis = 1)
```

```
data2.head()
```

	Experience	Sub_Category_Name	Budget	Location	Freelancer_Preferred_From	Type	Client_City	Client_Country	Client_Currency	Day_Registraterd	Day_Posted
0	0	85	4.472136	1	0	0	423	66	1	17	30
1	1	67	5.000000	1	0	1	14	66	1	5	30
2	0	21	5.477226	1	0	0	224	25	2	8	30
3	2	0	5.477226	1	0	0	160	66	1	2	30
4	0	85	4.472136	1	0	1	238	66	1	11	30

Creating Model

```
# spliting of data into x and y
x = data2.iloc[:,[0,1,3,4,5,6,7,8,9,10]]
y = data2.iloc[:,2]
```

```
# spliting of data into training and testing
from sklearn.model_selection import train_test_split
xtrain,xtest,ytrain,ytest=train_test_split(x,y,test_size=0.3,random_state=1)
```

```
# import linear regression model
from sklearn.linear_model import LinearRegression


model = LinearRegression()
model.fit(xtrain,ytrain)
ypred = model.predict(xtest)
ypred[:5]
```

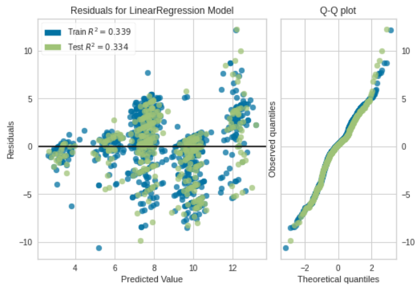
```
array([ 3.39883875, 10.07251734, 12.4017395 ,  9.77291176,  9.83979094])
```

```
ytest[:5]
```

```
303     3.162278
355    13.964240
452     2.449490
259     9.486833
789    10.723805
Name: Budget, dtype: float64
```

```
# import ResidualsPlot
from yellowbrick.regressor import ResidualsPlot


residuals_vis = ResidualsPlot(model,hist = False, qqplot = True)
residuals_vis.fit(xtrain,ytrain)
residuals_vis.score(xtest,ytest)
residuals_vis.show()
```



```
<AxesSubplot:title={'center':'Residuals for LinearRegression Model'}, xlabel='Predicted Value', ylabel='Residuals'>
```

```
# find  mean_absolute_error, mean_squared_error ,r2_score
from sklearn.metrics import mean_absolute_error,mean_squared_error,r2_score


mae = mean_absolute_error(ytest,ypred)
mse = mean_squared_error(ytest,ypred)
rmse = np.sqrt(mse)
r2 = r2_score(ytest,ypred)


print(" mean_absolute_error-",mae)
print(" mean_squared_error-",mse)
print(" root mean squared error-",rmse)
print(" r2_score-",r2)
```

```
 mean_absolute_error- 2.263494777623792
 mean_squared_error- 9.538231744276375
 root mean squared error- 3.088402782066545
 r2_score- 0.33401651778615815
```

CLASSIFICATION MODEL

```
# Now for predicting value of type column we will got classification
data2 = df.copy()


data2.head()
```

	Category_Name	Experience	Sub_Category_Name	Currency	Budget	Location	Freelancer_Preferred_From	Type	Client_City	Client_Country	Client_Currency	Day_Registraterd	Day_Posted
0	Technology & Programming	Entry ($)	Website Development	GBP	4.472136	remote	ALL	fixed_price	Tadcaster	United Kingdom	GBP	17	30
1	Marketing, Branding & Sales	Expert ($$$)	Sales & Calls	GBP	5.000000	remote	ALL	hourly	Ardrossan	United Kingdom	GBP	5	30
2	Writing & Translation	Entry ($)	Content Writing	USD	5.477226	remote	ALL	fixed_price	Kolkata	India	USD	8	30
3	Design	Intermediate ($$)	3D Design	GBP	5.477226	remote	ALL	fixed_price	Gloucester	United Kingdom	GBP	2	30
4	Technology & Programming	Entry ($)	Website Development	GBP	4.472136	remote	ALL	hourly	Leeds	United Kingdom	GBP	11	30

```
tp = data2["Type"].copy()
data2 = data2.drop(df[["Type","Day_Posted","Day_Registraterd"]], axis = 1)


from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()
tp_encoded = encoder.fit_transform(tp)
cat_data = pd.get_dummies(data2)
cat_data.head()
```

	Budget	Category_Name_Business	Category_Name_Design	Category_Name_Digital Marketing	Category_Name_Marketing, Branding & Sales	Category_Name_Music & Audio	Category_Name_Social Media	Category_Name_Technology & Programming	Category_Name_Video, Photo & Image	Category_Name_Writing & Translation	...	Client_
1	5.000000	0	0	0	1	0	0	0	0	0	...	

```
x = cat_data
```

```
y = tp_encoded
y[:5]
```

```
    array([0, 1, 0, 0, 1])
```

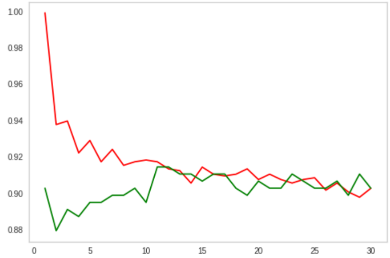
```
# spliting of data into training and testing
from sklearn.model_selection import train_test_split
xtrain,xtest,ytrain,ytest=train_test_split(x,y,test_size=0.2,random_state=1)
```

```
from sklearn.neighbors import KNeighborsClassifier
```

```
trainac=[]
testac=[]

for i in range(1,31):
    knn=KNeighborsClassifier(n_neighbors=i)
    knn.fit(xtrain,ytrain)
    train=knn.score(xtrain,ytrain)
    test=knn.score(xtest,ytest)
    trainac.append(train)
    testac.append(test)
```

```
plt.plot(range(1,31),trainac,color="red")
plt.plot(range(1,31),testac,color="green")
plt.grid()
plt.show()
```



```
knn=KNeighborsClassifier(n_neighbors=11)
knn.fit(xtrain,ytrain)
ypred=knn.predict(xtest)
```

```
#find accuracy_score,confusion_matrix,classification_report
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report
ac=accuracy_score(ytest,ypred)
cm=confusion_matrix(ytest,ypred)
cr=classification_report(ytest,ypred)
print(ac)
print(cm)
print(cr)
```

```
    0.914396887159533
    [[212   2]
     [ 20  23]]
                  precision    recall  f1-score   support

               0       0.91      0.99      0.95       214
               1       0.92      0.53      0.68        43

        accuracy                           0.91       257
       macro avg       0.92      0.76      0.81       257
    weighted avg       0.91      0.91      0.90       257
```

```
# As accuracy score our model is 92% accurate it means it is perform well
train=knn.score(xtrain,ytrain)
test=knn.score(xtest,ytest)
print(train,test)
```

```
    0.9172346640701071 0.914396887159533
```

Decision Tree

```
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score,classification_report
```

```
def mymodel(model):
  model.fit(xtrain,ytrain)
  ypred=model.predict(xtest)
  print(classification_report(ytest,ypred))
  return model
```

```
dt=DecisionTreeClassifier()
```

```
mymodel(dt)
```

```
                  precision    recall  f1-score   support

               0       0.95      0.97      0.96       214
               1       0.82      0.72      0.77        43

        accuracy                           0.93       257
       macro avg       0.88      0.84      0.86       257
    weighted avg       0.92      0.93      0.92       257
```

```
    ▾ DecisionTreeClassifier
    DecisionTreeClassifier()
```

```
dt.score(xtrain,ytrain)
```

```
    0.9990262901655307
```

```
dt.score(xtest,ytest)
```

```
0.9260700389105059
```

```
dt1=DecisionTreeClassifier(max_depth=6)
mymodel(dt1)
```

```
              precision    recall  f1-score   support

           0       0.91      0.99      0.95       214
           1       0.92      0.53      0.68        43

    accuracy                           0.91       257
   macro avg       0.92      0.76      0.81       257
weighted avg       0.91      0.91      0.90       257

▾     DecisionTreeClassifier
DecisionTreeClassifier(max_depth=6)
```

```
dt2=DecisionTreeClassifier(min_samples_leaf=20)
mymodel(dt2)
```

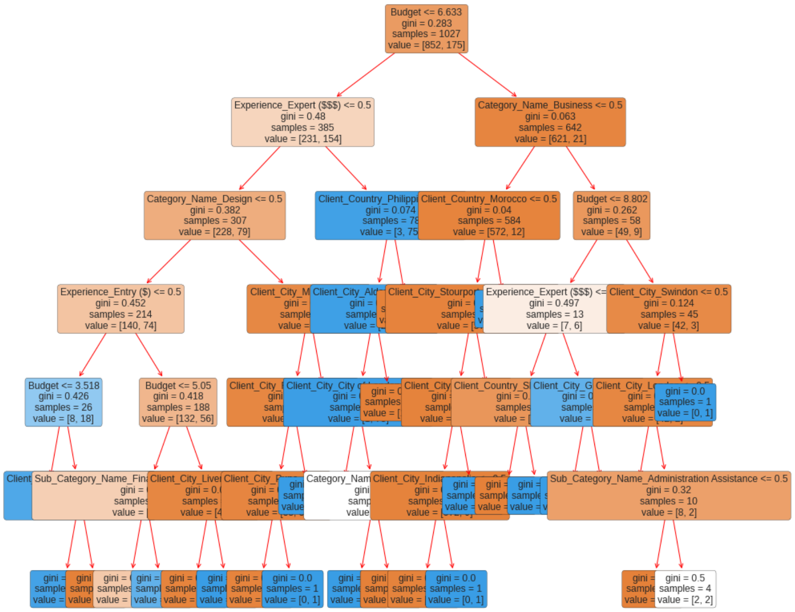
```
              precision    recall  f1-score   support

           0       0.92      0.98      0.95       214
           1       0.86      0.56      0.68        43

    accuracy                           0.91       257
   macro avg       0.89      0.77      0.81       257
weighted avg       0.91      0.91      0.90       257

▾         DecisionTreeClassifier
DecisionTreeClassifier(min_samples_leaf=20)
```

```
from sklearn import tree
fig,ax=plt.subplots(figsize=(15,15))
chart=tree.plot_tree(dt1,
                    feature_names=x.columns,
                    fontsize=12,
                    filled=True,
                    rounded=True)
for node in chart:
  arrow=node.arrow_patch
  if(arrow is not None):
    arrow.set_edgecolor("red")
    arrow.set_linewidth(1)
```



✓ 11s completed at 12:15 AM