

PROJECT - 2 INCOME QUALIFICATION SCREENSHOTS

SOURCE CODE - SCREENSHOTS

```
# Project 2 - Income Qualification
#### ADITHYAN.M.N.

## Problem Statement:
**Many social programs have a hard time ensuring that the right people are given enough aid. It's tricky when a program focuses on the poorest segment of the population. This segment of the population can't provide the necessary income and expense records to prove that they qualify.**

**In Latin America, a popular method called Proxy Means Test (PMT) uses an algorithm to verify income qualification. With PMT, agencies use a model that considers a family's observable household attributes like the material of their walls and ceiling or the assets found in their homes to**

**While this is an improvement, accuracy remains a problem as the region's population grows and poverty declines.**

**The Inter-American Development Bank (IDB) believes that new methods beyond traditional econometrics, based on a dataset of Costa Rican household characteristics, might help improve PMT's performance.**

## Following Actions need to be Performed
1. Identify the output variable.
2. Understand the type of data.
3. Check if there are any biases in your dataset.
4. Check whether all members of the house have the same poverty level.
5. Check if there is a house without a family head.
6. Set poverty level of the members and the head of the house within a family.
7. Count how many null values are existing in columns.
8. Remove null value rows of the target variable.
9. Predict the accuracy using random forest classifier.
10. Check the accuracy using random forest with cross validation.

# Solution:

In [1]: # Importing
import os
import numpy as np
import pandas as pd
from sklearn.feature_extraction import DictVectorizer
import collections
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
from sklearn.model_selection import KFold, cross_val_score, cross_validate

In [2]: # Import the dataset
df=pd.read_csv('train.csv')
print('Shape of the data,df.shape')
print()
print(df.head())

Shape of the data (9597, 143)
   Id      v2a1  hacdur  rooms  hacapo  v14a  refrig  v18q  v18ql  \
0  ID_279628644  100000.0  0  3  0  1  1  0  NaN
1  ID_729eb3d4d  135000.0  0  4  0  3  1  1  1.0
```

```
In [2]: # Import the dataset
df=pd.read_csv('train.csv')
print('Shape of the data,df.shape')
print()
print(df.head())

Shape of the data (9597, 143)
   Id      v2a1  hacdur  rooms  hacapo  v14a  refrig  v18q  v18ql  \
0  ID_279628644  100000.0  0  3  0  1  1  0  NaN
1  ID_729eb3d4d  135000.0  0  4  0  3  1  1  1.0
2  ID_686b51c54  NaN      0  0  0  1  1  0  NaN
3  ID_d671db9c  180000.0  0  5  0  1  1  1  1.0
4  ID_956d6f5f5  180000.0  0  5  0  1  1  1  1.0

m4h1 ... SQBescolari  SQBage  SQBhogar_total  SQBdejefe  SQBhogar_nin  \
0  0 ... 100 1369 1 100 0
1  0 ... 144 4489 1 144 0
2  0 ... 121 8464 1 0 0
3  0 ... 81 289 16 121 4
4  0 ... 121 1369 16 121 4

SQBovercrowding  SQBdependency  SQBweaned  ageeq  Target
0  1.000000  0.0  100.0 1849 4
1  1.000000  64.0 144.0 4489 4
2  0.250000  64.0 121.0 8464 4
3  1.777778  1.0 121.0 289 4
4  1.777778  1.0 121.0 1369 4

[5 rows x 143 columns]

## Understanding the Data given.

In [3]: #Understanding the Data given to us at hand.
datatype_df = df.dtypes.reset_index()
datatype_df.columns = ['col_name','col_type']
datatype_df.groupby('col_type').size()
# we can infer that there are 3 type of Data in the given dataframe from above.

Out[3]: col_type
Int64 130
float64 0
object 5
dtype: Int64

## Checking For Biases

In [4]: #We can understand the biases by looking at the targets if the given dataset.
df.Target.value_counts()
#from this we can understand the difference in cases which suggests BIAS

Out[4]: 4 3996
        2 1597
        3 1209
        1 755
        Name: Target, dtype: Int64
```

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In [4]: #We can understand the biases by looking at the targets of the given dataset.
df.Target.value_counts()
#From this we can understand the difference in cases which suggests BIAS

Out[4]:
4    5957
2    1597
3     1269
1       755
Name: Target, dtype: int64

In [5]: df.columns
#From this we can infer that the total columns in this dataset is 143
Out[5]:
Index(['Id', 'v2a1', 'hader', 'rooms', 'hacapo', 'v14a', 'refrig', 'v18q',
      'v18q1', 'r4h1',
      ...,
      'sqbescolar1', 'sqbage', 'sqbhogar_total', 'sqbedjeje', 'sqbhogar_nin',
      'sqbovercrowding', 'sqbdependency', 'sqbmeanduc', 'agesq', 'Target'],
      dtype=object, length=143)

### Pre - Processing

In [6]: #Finding all the columns which have null values in them.
#The Goal is to remove them because sklearn does not accept null values to train any dataset.
null_columns=df.columns[df.isnull().any()]
df[null_columns].isnull().sum()

Out[6]:
v2a1      6888
v18q1     7342
rez_esc   2928
meanduc     5
sqbmeanduc  5
dtype: int64

In [7]: print ('Percentage of null values in v2a1 : ', df['v2a1'].isnull().sum()/df.shape[0]*100)
print ('Percentage of null values in v18q1 : ', df['v18q1'].isnull().sum()/df.shape[0]*100)
print ('Percentage of null values in rez_esc : ', df['rez_esc'].isnull().sum()/df.shape[0]*100)
print ('Percentage of null values in meanduc : ', df['meanduc'].isnull().sum()/df.shape[0]*100)
print ('Percentage of null values in sqbmeanduc : ', df['sqbmeanduc'].isnull().sum()/df.shape[0]*100)

Percentage of null values in v2a1 : 71.7798472323951
Percentage of null values in v18q1 : 76.82327800091033
Percentage of null values in rez_esc : 82.9549021595167
Percentage of null values in meanduc : 0.0523176720090897
Percentage of null values in sqbmeanduc : 0.0523176720090897

In [8]: #Removing the columns which have more than 50% null values
#We can say that these are not important to the data.
df=df.drop(['v2a1','v18q1','rez_esc'],axis=1)
print(df.shape)
#Notice the shape has become 140 from 143
#This is because we removed the columns with more than 50% Null values
(9557, 140)
```

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In [9]: #Imputing the meanduc & sqbmeanduc columns
#We are imputing the data because as already mentioned we have to change the null values to zero.
imp = SimpleImputer(missing_values=np.nan, strategy='median')
imp.fit(df[['meanduc', 'sqbmeanduc']])
df[['meanduc', 'sqbmeanduc']] = imp.transform(df[['meanduc', 'sqbmeanduc']])
df[['meanduc', 'sqbmeanduc']].isnull().sum()

Out[9]:
meanduc      0
sqbmeanduc   0
dtype: int64

In [10]: df=df.drop(['Id'],axis=1)
df.describe(include='O')

Out[10]:
      idhogar  dependency  edjeje  edjeja
count    9557         9557    9557    9557
unique     2668          31      22      22
top  168a6d014         yes      no      no
freq         13         2192    3762    6230

In [11]: df.dependency = df.dependency.replace(to_replace=['yes','no'],value=[0,1],astype='float')
median_op=median(df.edjeje[df.edjeje.isin(['yes','no'])==false].astype('float'))
df.edjeje = df.edjeje.replace(to_replace=['yes','no'],value=[median_op,1].astype('float'))
median_sq = np.median(df.edjeja[df.edjeja.isin(['yes','no'])==false].astype('float'))
df.edjeja = df.edjeja.replace(to_replace=['yes','no'],value=[median_sq,1].astype('float'))

In [12]: df.describe(include='O')

Out[12]:
      idhogar
count     9557
unique     2668
top  168a6d014
freq         13

In [13]: print(df.idhogar.nunique()) #Returns the number of unique values in the column idhogar
2668

### Checking whether all members of the house have the same poverty level.

In [14]: df['idhogar']

Out[14]:
0    21ab7fcc1
1    9eh7a6d08
2    2c7317ea8
3    20f8a945f
4    2b58d945f
...
9552    d6c0b6aa3
9553    d6c0b6aa3
9554    d6c0b6aa3
```

```
Learning on Simplilearn x Home Page - Select or create a x Project - 2 - Income Qualificat... x
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## Checking whether all members of the house have the same poverty level.

In [14]: df['idhogar']
Out[14]:
0      2167fcc1
1      06c7a688
2      2c7317ea8
3      2b58d945f
4      2b58d945f
...
9952     dc0b6aa3
9953     dc0b6aa3
9954     dc0b6aa3
9955     dc0b6aa3
9956     dc0b6aa3
Name: idhogar, Length: 9957, dtype: object

In [15]: len(df['idhogar'].unique())
Out[15]: 2988

In [16]: #Grouping by idhogar we can find the number of families
poverty_level=(df.groupby('idhogar')['Target'].nunique())>1).index
print(poverty_level)

Index(['001ff74ca', '001275ec2', '004616164', '004883866', '005005417',
      '000031a63', '000355f62', '00093f597', '000664543', '00041f1f4',
      ...,
      'ff210f6c', 'ff31b04b', 'ff30d0e71', 'ff6d16f40', 'ff703ced4',
      'ff941a59', 'ff9d5ab17', 'ffa6a0e97', 'ffe90d46f', 'fff7d6b1',
      dtype='object', name='idhogar', length=2988)

## Checking if there is a house without a family head.

In [17]: no_head=(df.groupby('idhogar')['parentesco1'].sum()==0).index;
print('Number of families without a house head = {}'.format(no_head))

Number of families without a house head = Index(['001ff74ca', '005123ec3', '004616164', '004983866', '005005417',
      '000031a63', '000355f62', '00093f597', '000664543', '00041f1f4',
      ...,
      'ff220f6c', 'ff31b04b', 'ff30d0e71', 'ff6d16f40', 'ff703ced4',
      'ff941a59', 'ff9d5ab17', 'ffa6a0e97', 'ffe90d46f', 'fff7d6b1',
      dtype='object', name='idhogar', length=2988)

## Setting the poverty level of the members and the head of the house as same in a family.

In [18]: target_mean=df.groupby('idhogar')['Target'].mean().astype('int64').reset_index().rename(columns={'Target':'target_mean'})
df = df.merge(target_mean,how='left',on='idhogar')
df.Target=df.target_mean
df.drop('target_mean',axis=1,inplace=True)
df.head()

Out[18]:
   hactor  rooms  hacapo  v14a  rethg  v19q  r4ht  r4t2  r4t3  r4nt  ...  SQBescolan  SQBage  SQBhogar_total  SQBdefete  SQBhogar_nin  SQBevercrowdr
0      0      3      0      1      1      0      0      1      1      0  ...          100      1049              1          100              0      1.00000
1      1      0      4      0      1      1      1      0      1      1      0  ...          144      4479              1          144              0      1.00000
2      1      0      4      0      1      1      1      0      1      1      0  ...          121      3454              1           121              4      1.77777
3      1      0      5      0      1      1      1      0      2      2      1  ...          81       289              16          121              4      1.77777
4      1      0      5      0      1      1      1      0      2      2      1  ...          121      1369              16          121              4      1.77777
5 rows x 19 columns
```

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## Setting the poverty level of the members and the head of the house as same in a family.

In [18]: target_mean=df.groupby('idhogar')['Target'].mean().astype('int64').reset_index().rename(columns={'Target':'target_mean'})
df = df.merge(target_mean,how='left',on='idhogar')
df.Target=df.target_mean
df.drop('target_mean',axis=1,inplace=True)
df.head()

Out[18]:
   hactor  rooms  hacapo  v14a  rethg  v19q  r4ht  r4t2  r4t3  r4nt  ...  SQBescolan  SQBage  SQBhogar_total  SQBdefete  SQBhogar_nin  SQBevercrowdr
0      0      3      0      1      1      0      0      1      1      0  ...          100      1049              1          100              0      1.00000
1      1      0      4      0      1      1      1      0      1      1      0  ...          144      4479              1          144              0      1.00000
2      1      0      4      0      1      1      0      0      0      0      0  ...          121      3454              1           121              4      1.77777
3      1      0      5      0      1      1      1      0      2      2      1  ...           81       289              16          121              4      1.77777
4      1      0      5      0      1      1      1      0      2      2      1  ...          121      1369              16          121              4      1.77777
5 rows x 19 columns

In [19]: df = df.drop(['idhogar'],axis=1)
df.shape

Out[19]: (9957, 138)

## Initialising

In [20]: X = df.drop(['Target'],axis=1)
print('shape of the x',X.shape)
y = df.Target
print('shape of the y',y.shape)

shape of the x (9957, 137)
shape of the y (9957,)

## Deploying Random Forest Classifier.

In [21]: #A random forest is a meta estimator that fits a number of decision tree classifiers on various sub-samples of the dataset
#and uses averaging to improve the predictive accuracy and control over-fitting.
#this Classifier is highly recommended due to its high accuracy and ability to not overfit the data.
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2,random_state=10)
Rand_Forest_Class = RandomForestClassifier(n_estimators=10)
Rand_Forest_Class.fit(X_train,y_train)
Prediction = Rand_Forest_Class.predict(X_test)

## Check the accuracy using Random Forest Classifier

In [22]: print('Accuracy score: ', accuracy_score(Prediction,y_test))
print('Confusion Matrix:')
print(confusion_matrix(Prediction,y_test))
print('Classification Report:')
print(classification_report(Prediction,y_test))

Accuracy score: 0.9048117154811716
Confusion Matrix:
```

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In [21]: A random forest is a meta estimator that fits a number of decision tree classifiers on various sub-samples of the dataset
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print('Confusion Matrix')
print(confusion_matrix(Prediction,y_test))
print('Classification Report')
print(classification_report(Prediction,y_test))

Accuracy score: 0.9048117154811716
Confusion Matrix
[[ 151  4  3  0]
 [ 8 237 10 16]
 [ 1  6 164 10]
 [ 29 50 39 1176]]
Classification Report
              precision    recall  f1-score   support

    1       0.78      0.90      0.83      146
    2       0.81      0.89      0.85      289
    3       0.76      0.91      0.83      181
    4       0.97      0.91      0.94     1296

 accuracy      0.83      0.90      0.90     1912
 macro avg     0.83      0.90      0.86     1912
 weighted avg     0.91      0.90      0.91     1912

### Using KFold Crossvalidation to validate the performance of the designed classifier.

In [23]: kfold = KFold(n_splits=10 , random_state=1 , shuffle =True)
Result = cross_val_score(estimator=Rand_Forest_Class,
                          X=X,
                          Y=y,
                          cv=kfold,
                          scoring='accuracy')

print('K-fold accuracy scores : \n', Result)
print('Mean score : \n', Result.mean())

K-fold accuracy scores :
[0.91945607 0.94979079 0.90099502 0.92687029 0.93096234 0.93410042
 0.94768874 0.92041805 0.92894293 0.93612565]
Mean score :
0.930626191542422

### Hence we have verified with KFold CrossValidation that the classifier classifies the data with an accuracy of 93%
```

TRAIN AND TEST DATASET FILES

train																												
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
id	v2a1	hacdr	rooms	hacapo	v14a	refrig	v18q	v18q1	r4h1	r4h2	r4h3	r4m1	r4m2	r4m3	r4t1	r4t2	r4t3	tamhgh	tamviv	escolari	rez_esc	hsize	paredblol	paredcroz	paredprel	paredres	paredmac	paredincp
1	ID_279828	130000	0	3	0	1	1	0	0	1	1	0	0	0	0	0	1	1	1	10	1	1	0	0	0	0	0	0
2	ID_129eb3	135000	0	4	0	1	1	1	1	0	1	1	0	0	0	0	1	1	1	12	1	0	0	0	0	0	0	1
3	ID_884e51c94	130000	0	8	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	11	1	0	0	0	0	0	1	0
4	ID_d671dt	180000	0	5	0	1	1	1	1	0	2	2	1	1	2	1	3	4	4	9	1	4	1	0	0	0	0	0
5	ID_d56af6	180000	0	5	0	1	1	1	1	0	2	2	1	1	2	1	3	4	4	11	4	1	0	0	0	0	0	0
6	ID_e0t0b1	180000	0	5	0	1	1	1	1	0	2	2	1	1	2	1	3	4	4	11	4	1	0	0	0	0	0	0
7	ID_e9e0c1	180000	0	5	0	1	1	1	1	0	2	2	1	1	2	1	3	4	4	2	0	4	1	0	0	0	0	0
8	ID_3e04e1	130000	1	2	0	1	1	0	0	1	1	1	2	1	3	2	2	4	4	0	0	4	1	0	0	0	0	0
9	ID_1284f8	130000	1	2	0	1	1	0	0	1	1	2	1	3	2	2	4	4	4	9	4	1	0	0	0	0	0	0
10	ID_5152b1	130000	1	2	0	1	1	0	0	1	1	2	1	3	2	2	4	4	4	11	4	1	0	0	0	0	0	0
11	ID_d844f5	130000	1	2	0	1	1	0	0	1	1	2	1	3	2	2	4	4	4	3	1	4	1	0	0	0	0	0
12	ID_d844f5	130000	1	2	0	1	1	0	0	1	1	2	1	3	2	2	4	4	4	3	1	4	1	0	0	0	0	0
13	ID_d82271	100000	0	3	0	1	1	0	0	0	0	0	2	2	0	2	2	2	2	12	2	0	0	0	1	0	0	0
14	ID_d94071	100000	0	3	0	1	1	0	0	0	0	0	2	2	0	2	2	2	2	11	2	0	0	1	0	0	0	0
15	ID_064b57869	100000	0	4	0	1	1	1	1	0	1	1	0	1	1	0	2	2	2	2	4	2	0	0	1	0	0	0
16	ID_5c817d844	100000	0	4	0	1	1	1	1	0	1	1	0	1	1	0	2	2	2	2	15	2	0	0	1	0	0	0
17	ID_0a29e1	90000	1	2	0	1	1	0	0	2	2	0	2	2	0	4	4	4	4	11	4	0	0	0	0	0	0	0
18	ID_4f15f1	90000	1	2	0	1	1	0	0	2	2	0	2	2	0	4	4	4	4	2	4	0	0	0	0	0	1	0
19	ID_336c51	90000	1	2	0	1	1	0	0	2	2	0	2	2	0	4	4	4	4	11	4	0	0	0	0	0	1	0
20	ID_c51938	90000	1	2	0	1	1	0	0	2	2	0	2	2	0	4	4	4	4	10	4	0	0	0	0	0	1	0
21	ID_33566f	215000	0	4	0	1	1	0	0	1	1	0	1	1	0	4	4	4	4	12	2	1	0	0	0	0	0	0
22	ID_74a2b1	215000	0	4	0	1	1	0	0	1	1	0	1	1	0	2	2	2	2	15	2	1	0	0	0	0	0	0
23	ID_15d391	150000	0	3	0	1	1	0	0	1	1	0	1	1	0	2	2	2	2	4	2	0	0	0	0	0	0	0
24	ID_a0eff0	150000	0	3	0	1	1	0	0	1	1	0	1	1	0	2	2	2	2	16	2	0	0	0	0	0	1	0
25	ID_84810f	100000	1	1	1	0	1	0	0	2	2	0	1	1	0	3	3	3	3	6	3	1	0	0	0	0	0	0
26	ID_298682	100000	1	1	1	0	1	0	0	2	2	0	1	1	0	3	3	3	3	13	3	1	0	0	0	0	0	0
27	ID_1a5b18	100000	1	1	1	0	1	0	0	2	2	0	1	1	0	3	3	3	3	12	3	1	0	0	0	0	0	0
28	ID_e5c0f805	100000	0	5	0	1	1	0	0	1	1	0	0	0	0	1	1	1	1	15	3	1	0	0	0	0	1	0
29	ID_e1853c	120000	0	4	0	1	1	1	1	0	2	2	0	1	1	0	3	3	3	6	3	1	0	0	0	0	0	0
30	ID_cba035	120000	0	4	0	1	1	1	1	0	2	2	0	1	1	0	3	3	3	6	3	1	0	0	0	0	0	0
31	ID_b6c1c7	120000	0	4	0	1	1	1	1	0	2	2	0	1	1	0	3	3	3	8	3	1	0	0	0	0	0	0
32	ID_99b17b	100000	0	5	0	1	1	0	0	1	1	1	0	1	1	0	2	2	2	8	2	1	0	0	0	0	0	0
33	ID_422126	100000	0	5	0	1	1	0	0	1	1	0	1	1	0	2	2	2	2	11	2	1	0	0	0	0	0	0
34	ID_e24d9c3c9	100000	0	5	0	1	1	0	0	4	4	0	1	1	0	5	5	5	5	1	5	0	1	0	0	0	0	0
35	ID_b61cd0c29	100000	0	5	0	1	1	0	0	4	4	0	1	1	0	5	5	5	5	11	5	0	1	0	0	0	0	0
36	ID_18f8ad6	100000	0	5	0	1	1	0	0	4	4	0	1	1	0	5	5	5	5	6	5	0	1	0	0	0	0	0
37	ID_b6b36ca09	100000	0	5	0	1	1	0	0	4	4	0	1	1	0	5	5	5	5	0	5	0	1	0	0	0	0	0
38	ID_57605a403	100000	0	5	0	1	1	0	0	4	4	0	1	1	0	5	5	5	5	3	5	0	1	0	0	0	0	0

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