Income Qualification Project

Following actions should 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.

In [1]:

```
# importing libraries

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
sns.set()

%matplotlib.inline
```

```
UsageError: Line magic function `%matplotlib.inline` not found.
```

In [4]:

```
# importing training and testing datasets

iq_train = pd.read_csv("iqtrain.csv")
iq_test = pd.read_csv("iqtest.csv")

print(iq_train.shape,iq_test.shape)
```

```
(9557, 143) (23856, 142)
```

In [5]:

```
iq_train.head()
```

Out[5]:

	Id	v2a1	hacdor	rooms	hacapo	v14a	refrig	v18q	v18q1	r4h1	...	SC
0	ID_279628684	190000.0	0	3	0	1	1	0	NaN	0	...	
1	ID_f29eb3ddd	135000.0	0	4	0	1	1	1	1.0	0	...	
2	ID_68de51c94	NaN	0	8	0	1	1	0	NaN	0	...	
3	ID_d671db89c	180000.0	0	5	0	1	1	1	1.0	0	...	
4	ID_d56d6f5f5	180000.0	0	5	0	1	1	1	1.0	0	...	

5 rows × 143 columns

In [6]:

```
iq_test.head()
```

Out[6]:

	Id	v2a1	hacdor	rooms	hacapo	v14a	refrig	v18q	v18q1	r4h1	...	ag
0	ID_2f6873615	NaN	0	5	0	1	1	0	NaN	1	...	
1	ID_1c78846d2	NaN	0	5	0	1	1	0	NaN	1	...	4
2	ID_e5442cf6a	NaN	0	5	0	1	1	0	NaN	1	...	4
3	ID_a8db26a79	NaN	0	14	0	1	1	1	1.0	0	...	5
4	ID_a62966799	175000.0	0	4	0	1	1	1	1.0	0	...	1

5 rows × 142 columns

In [7]:

```
iq_train.columns
```

Out[7]:

```
Index(['Id', 'v2a1', 'hacdor', 'rooms', 'hacapo', 'v14a', 'refrig', 'v18
q',
       'v18q1', 'r4h1',
       ...
       'SQBescolari', 'SQBage', 'SQBhogar_total', 'SQBedjefe', 'SQBhogar_n
in',
       'SQBovercrowding', 'SQBdependency', 'SQBmeaned', 'agesq', 'Targe
t'],
      dtype='object', length=143)
```

In [8]:

```
iq_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9557 entries, 0 to 9556
Columns: 143 entries, Id to Target
dtypes: float64(8), int64(130), object(5)
memory usage: 10.4+ MB
```

In [9]:

```
iq_train.describe()
```

Out[9]:

	v2a1	hacdor	rooms	hacapo	v14a	refrig	
count	2.697000e+03	9557.000000	9557.000000	9557.000000	9557.000000	9557.000000	9557
mean	1.652316e+05	0.038087	4.955530	0.023648	0.994768	0.957623	C
std	1.504571e+05	0.191417	1.468381	0.151957	0.072145	0.201459	C
min	0.000000e+00	0.000000	1.000000	0.000000	0.000000	0.000000	C
25%	8.000000e+04	0.000000	4.000000	0.000000	1.000000	1.000000	C
50%	1.300000e+05	0.000000	5.000000	0.000000	1.000000	1.000000	C
75%	2.000000e+05	0.000000	6.000000	0.000000	1.000000	1.000000	C
max	2.353477e+06	1.000000	11.000000	1.000000	1.000000	1.000000	1

8 rows × 138 columns

1. Identify the Output Variable

In [11]:

```
Y = iq_train['Target']
```

In [12]:

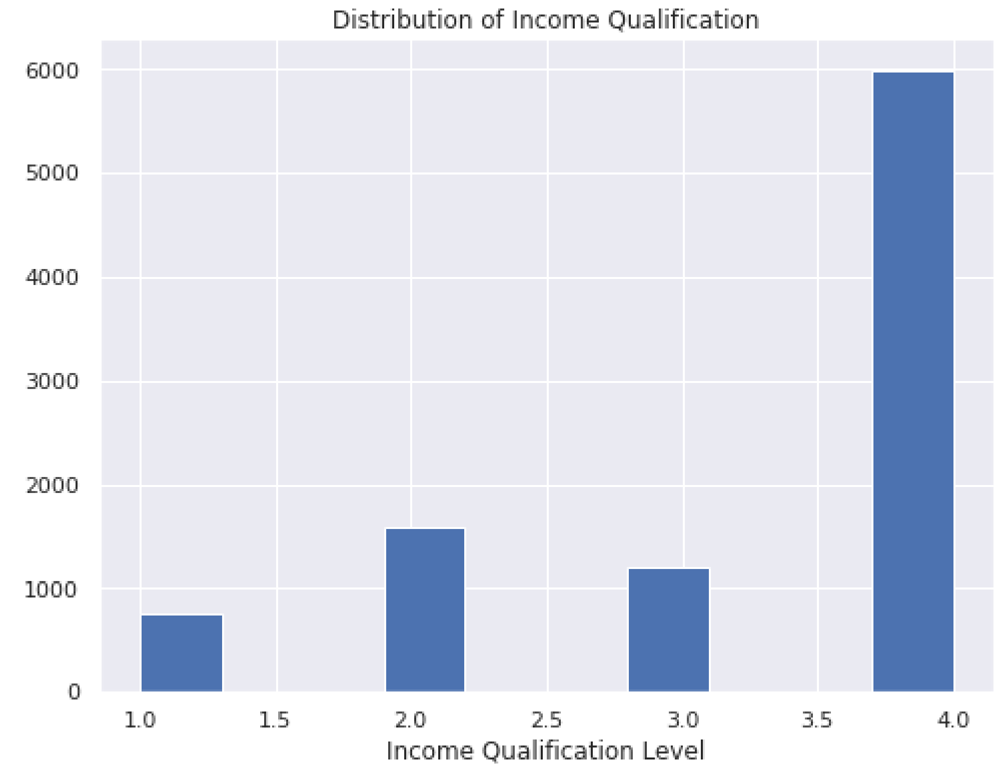
```
Y
```

Out[12]:

```
0       4
1       4
2       4
3       4
4       4
       ..
9552    2
9553    2
9554    2
9555    2
9556    2
Name: Target, Length: 9557, dtype: int64
```

In [13]:

```
plt.figure(figsize=(8,6))
plt.hist(Y)
plt.xlabel('Income Qualification Level')
plt.title('Distribution of Income Qualification')
plt.show()
```



Income level distribution with Income Qualification level 4.0 maximum

2. Understanding the type of data

In [17]:

```
type(iq_train)
```

Out[17]:

```
pandas.core.frame.DataFrame
```

In [18]:

```
iq_train.info()
```

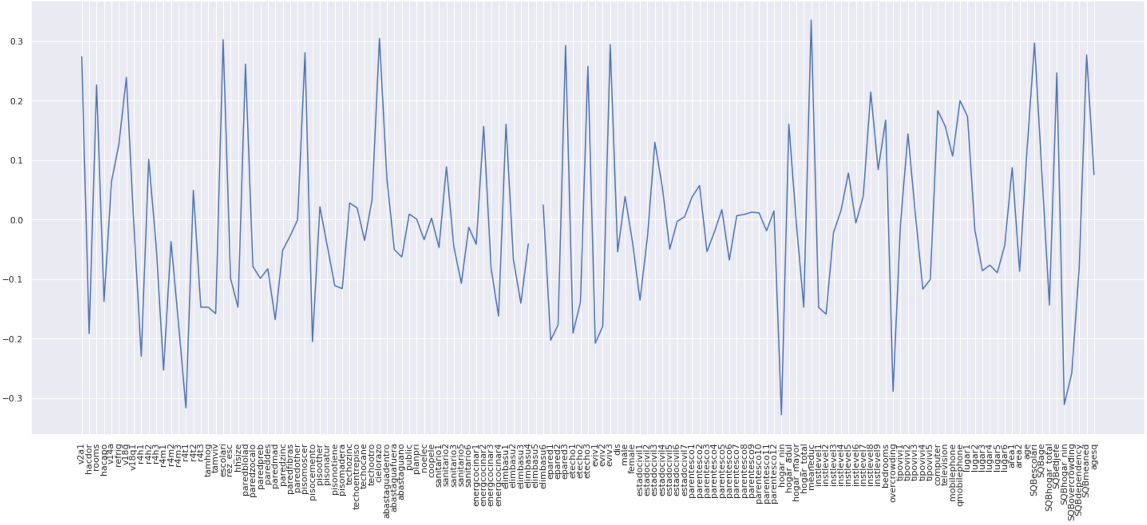
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9557 entries, 0 to 9556
Columns: 143 entries, Id to Target
dtypes: float64(8), int64(130), object(5)
memory usage: 10.4+ MB
```

8 float columns, 130 integer type columns and 5 object type columns

3. Check if there are any biases on your dataset

In [20]:

```
plt.figure(figsize=(25,10))
plt.plot(iq_train.corr().loc['Target'].drop('Target'))
plt.xticks(rotation='vertical')
plt.show()
```



slope varies from -0.3 to +0.3

4. Check whether all members of the house have the same poverty level.

In [21]:

```
# assuming idhogar is unique id for household

sum(iq_train.groupby('idhogar')['Target'].nunique()!=1)
```

Out[21]:

```
85
```

There are 85 households where all members of the house do not have same poverty level

5. Check if there is a house without a family head.

In [22]:

```
sum(iq_train.groupby('idhogar')['parentesco1'].sum()==0)
```

Out[22]:

```
15
```

There are 15 houses without a family head

6. Set poverty level of the members and the head of the house within a family.

In [24]:

```
def setPovertyLevel(df):
    for name in df['idhogar'].unique():
        if df.groupby('idhogar').get_group(name)['Target'].nunique()!=1:
            houses = df[df['idhogar']==name]
            povertyLevel = houses[houses['parentesco1']==1]['Target']
            iq_train.loc[iq_train['idhogar']==name, 'Target'] = float(povertyLevel)

setPovertyLevel(iq_train)
sum(iq_train.groupby('idhogar')['Target'].nunique()!=1)
```

Out[24]:

```
0
```

No household having having different level of poverty among members.

7. Count how many null values are existing in columns.

In [25]:

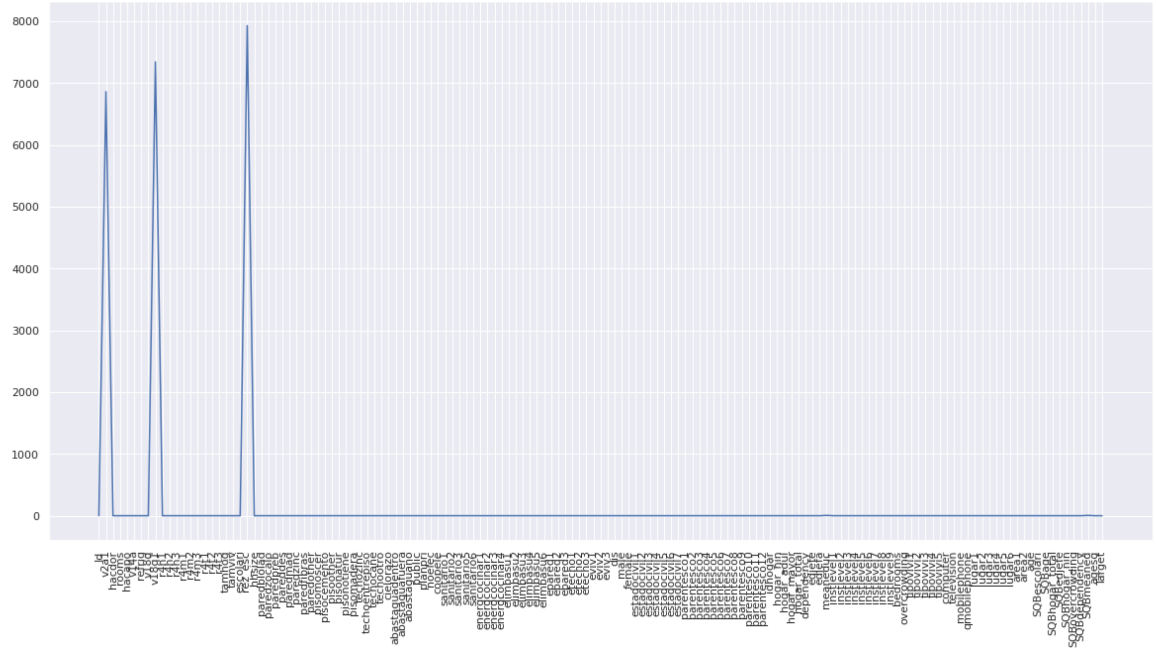
```
dict = {}
def checkNull(df):
    for col in df.columns:
        if df[col].isnull().any():
            dict[col] = df[col].isnull().sum()

checkNull(iq_train)
print('Number of null value columns in training dataset ',dict)
checkNull(iq_test)
print('Number of null value columns in testing dataset ',dict)
```

```
Number of null value columns in training dataset  {'v2a1': 6860, 'v18q1':
7342, 'rez_esc': 7928, 'meaneduc': 5, 'SQBmeaned': 5}
Number of null value columns in testing dataset  {'v2a1': 17403, 'v18q1':
18126, 'rez_esc': 19653, 'meaneduc': 31, 'SQBmeaned': 31}
```

6 columns with the above number of null values

In [26]:

```
plt.figure(figsize=(20,10))
plt.plot(iq_train.isnull().sum())
plt.xticks(rotation='vertical')
plt.show()
```



In [27]:

```
iq_test[iq_test['v18q1'].isnull()]['v18q'].unique()
```

Out[27]:

```
array([0])
```

In [29]:

```
iq_train.loc[iq_train['v18q1'].isnull(),'v18q1'] = 0
iq_train['v18q1'].isnull()

iq_test.loc[iq_test['v18q1'].isnull(),'v18q1'] = 0
iq_test['v18q1'].isnull()
```

Out[29]:

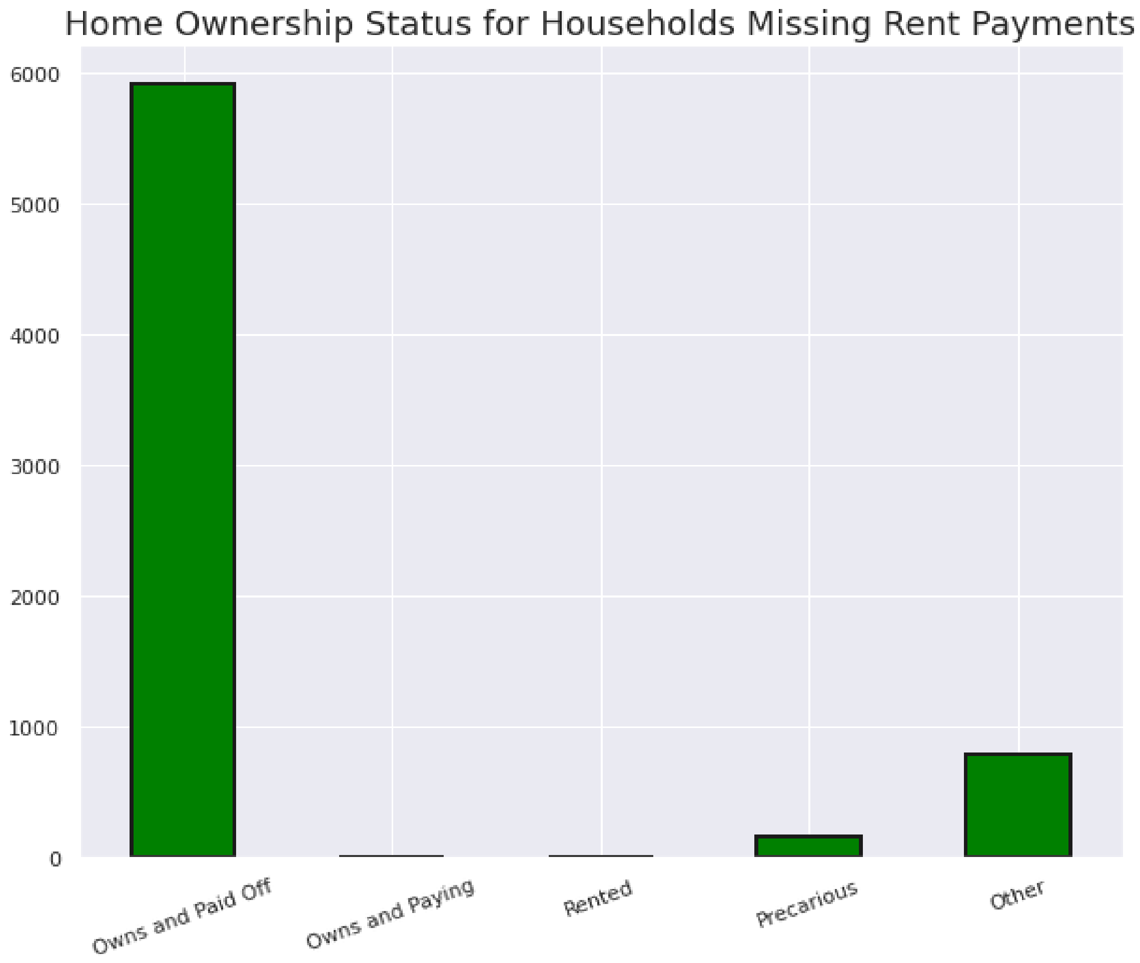
```
0        False
1        False
2        False
3        False
4        False
         ...
23851    False
23852    False
23853    False
23854    False
23855    False
Name: v18q1, Length: 23856, dtype: bool
```

In [30]:

```
own_variables = [x for x in iq_train if x.startswith('tipo')]
```

In [31]:

```
iq_train.loc[iq_train['v2a1'].isnull(), own_variables].sum().plot.bar(figsize = (10, 8
),
                                                                         color = 'green'
,
                                                               edgecolor = 'k', linewidt
h = 2);
plt.xticks([0, 1, 2, 3, 4],
           ['Owns and Paid Off', 'Owns and Paying', 'Rented', 'Precarious', 'Other'],
          rotation = 20)
plt.title('Home Ownership Status for Households Missing Rent Payments', size = 18);
```


Home Ownership Status for Households Missing Rent Payments
6000
5000
4000
3000
2000
1000
0
Owns and Paid Off
Owns and Paying
Rented
Precarious
Other

In [32]:

```
iq_train.loc[iq_train['v2a1'].isnull(),'v2a1'] = 0
iq_train['v2a1'].isnull()

iq_test.loc[iq_test['v2a1'].isnull(),'v2a1'] = 0
iq_test['v2a1'].isnull()
```

Out[32]:

```
0        False
1        False
2        False
3        False
4        False
         ...
23851    False
23852    False
23853    False
23854    False
23855    False
Name: v2a1, Length: 23856, dtype: bool
```

In [33]:

```
iq_train[iq_train['rez_esc'].isnull()]['age'].describe()
```

Out[33]:

```
count    7928.000000
mean       38.833249
std        20.989486
min         0.000000
25%        24.000000
50%        38.000000
75%        54.000000
max        97.000000
Name: age, dtype: float64
```

In [34]:

```
iq_train[(iq_train['rez_esc'].isnull())]['age'].unique()
```

Out[34]:

```
array([43, 67, 92, 37, 38, 30, 28, 18, 34, 79, 39, 19, 70, 50, 22, 26, 69,
       66, 41, 20, 40, 44, 62, 33, 35, 56, 52, 36, 24, 76, 94, 45, 48, 42,
       71, 29, 55,  1, 60, 74, 57, 31, 89, 59,  4, 46, 75, 78, 53, 63, 51,
       21, 47, 49, 68, 73, 97, 72,  6,  5, 58, 27,  3,  2, 61, 25,  0, 23,
       54, 32, 65, 77, 81, 88, 64, 87, 82, 95, 80, 85, 83, 84, 90, 86, 91,
       93, 10])
```

In [35]:

```
iq_train.loc[(iq_train['rez_esc'].isnull()), 'rez_esc'] = 0
iq_test.loc[(iq_test['rez_esc'].isnull()), 'rez_esc'] = 0
```

In [36]:

```
iq_train.loc[(iq_train['meaneduc'].isnull()), 'meaneduc'] = 0
iq_test.loc[(iq_test['meaneduc'].isnull()), 'meaneduc'] = 0
```

In [37]:

```
# We will again check the null values

dict = {}
def checkNull(df):
    for col in df.columns:
        if df[col].isnull().any():
            dict[col] = df[col].isnull().sum()

checkNull(iq_train)
print('Number of null value columns in training dataset ',dict)
checkNull(iq_test)
print('Number of null value columns in testing dataset ',dict)
```

```
Number of null value columns in training dataset  {'SQBmeaned': 5}
Number of null value columns in testing dataset  {'SQBmeaned': 31}
```

8. Remove null value rows of the target variable.

In [38]:

```
iq_train['Target'].isnull().any()
```

Out[38]:

```
False
```

In [39]:

```
iq_train[iq_train['Target'].isnull()==False]
```

Out[39]:

	Id	v2a1	hacdor	rooms	hacapo	v14a	refrig	v18q	v18q1	r4h1	...
0	ID_279628684	190000.0	0	3	0	1	1	0	0.0	0	...
1	ID_f29eb3ddd	135000.0	0	4	0	1	1	1	1.0	0	...
2	ID_68de51c94	0.0	0	8	0	1	1	0	0.0	0	...
3	ID_d671db89c	180000.0	0	5	0	1	1	1	1.0	0	...
4	ID_d56d6f5f5	180000.0	0	5	0	1	1	1	1.0	0	...
...	...	...	...	...	...	...	...	...	...	...	...
9552	ID_d45ae367d	80000.0	0	6	0	1	1	0	0.0	0	...
9553	ID_c94744e07	80000.0	0	6	0	1	1	0	0.0	0	...
9554	ID_85fc658f8	80000.0	0	6	0	1	1	0	0.0	0	...
9555	ID_ced540c61	80000.0	0	6	0	1	1	0	0.0	0	...
9556	ID_a38c64491	80000.0	0	6	0	1	1	0	0.0	0	...

9557 rows × 143 columns

9. Predict the accuracy using random forest classifier.

In [41]:

```
# We will drop squared columns since they will be highly correlated to their square roo
t columns

squared_columns_drop = ['SQBescolari','SQBage','SQBhogar_total','SQBedjefe','SQBhogar_n
in','SQBovercrowding','SQBdependency','SQBmeaned','agesq']
iq_train.drop(squared_columns_drop, axis=1, inplace=True)
iq_test.drop(squared_columns_drop, axis=1, inplace=True)
```

In [42]:

```
# We will drop column in a pair having correlation > 0.95

# Create correlation matrix
corr_matrix = iq_train.corr()

# Select upper triangle of correlation matrix
upper = corr_matrix.where(np.triu(np.ones(corr_matrix.shape), k=1).astype(np.bool))

# Find index of feature columns with correlation greater than 0.95
to_drop = [column for column in upper.columns if any(abs(upper[column]) > 0.95)]
to_drop
```

```
/usr/local/lib/python3.7/site-packages/ipykernel_launcher.py:7: Deprecatio
nWarning: `np.bool` is a deprecated alias for the builtin `bool`. To silen
ce this warning, use `bool` by itself. Doing this will not modify any beha
vior and is safe. If you specifically wanted the numpy scalar type, use `n
p.bool_` here.
Deprecated in NumPy 1.20; for more details and guidance: https://numpy.or
g/devdocs/release/1.20.0-notes.html#deprecations
  import sys
```

Out[42]:

```
['tamhog', 'hhsize', 'coopele', 'female', 'hogar_total', 'area2']
```

In [43]:

```
iq_train.drop(to_drop, axis=1, inplace=True)
iq_test.drop(to_drop, axis=1, inplace=True)
```

In [44]:

```
print(iq_train.shape,iq_test.shape)
```

```
(9557, 128) (23856, 127)
```

In [45]:

```
# label encoding object types

from sklearn.preprocessing import LabelEncoder
```

In [46]:

```
lbl = LabelEncoder()
iq_train.select_dtypes('object').head()
```

Out[46]:

	Id	idhogar	dependency	edjefe	edjefa
0	ID_279628684	21eb7fcc1	no	10	no
1	ID_f29eb3ddd	0e5d7a658	8	12	no
2	ID_68de51c94	2c7317ea8	8	no	11
3	ID_d671db89c	2b58d945f	yes	11	no
4	ID_d56d6f5f5	2b58d945f	yes	11	no

In [47]:

```
iq_train['dependency'] = lbl.fit_transform(iq_train['dependency'])
iq_train['edjefe'] = lbl.fit_transform(iq_train['edjefe'])
iq_train['edjefa'] = lbl.fit_transform(iq_train['edjefa'])

iq_test['dependency'] = lbl.fit_transform(iq_test['dependency'])
iq_test['edjefe'] = lbl.fit_transform(iq_test['edjefe'])
iq_test['edjefa'] = lbl.fit_transform(iq_test['edjefa'])
```

In [48]:

```
iq_train.select_dtypes('float').head()
```

Out[48]:

	v2a1	v18q1	rez_esc	meaneduc	overcrowding
0	190000.0	0.0	0.0	10.0	1.000000
1	135000.0	1.0	0.0	12.0	1.000000
2	0.0	0.0	0.0	11.0	0.500000
3	180000.0	1.0	1.0	11.0	1.333333
4	180000.0	1.0	0.0	11.0	1.333333

In [53]:

```
from sklearn.ensemble import RandomForestClassifier
```

In [54]:

```
model = RandomForestClassifier(n_estimators=100, random_state=10, n_jobs = -1)
```

In [55]:

```
X = iq_train.drop(['Id','Target','idhogar'], axis=1)
```

In [56]:

```
model.fit(X, Y)
```

Out[56]:

```
RandomForestClassifier(n_jobs=-1, random_state=10)
```

10. Check the accuracy using random forest with cross validation.

In [57]:

```
from sklearn.model_selection import cross_val_score
all_accuracies = cross_val_score(estimator=model, X=X, y=Y, cv=10)
```

In [58]:

```
all_accuracies.mean()
```

Out[58]:

```
0.6250694429231747
```

Predicted the accuracy using 10 fold sampling. Accuracy of the model is 62.1%