In [355…

```
import pandas as pd
import warnings

warnings.filterwarnings('ignore')

train_df = pd.read_csv("F:\Programming\DataScience\SimpliLearn\Mod3_MachineLearning\
test_df = pd.read_csv("F:\Programming\DataScience\SimpliLearn\Mod3_MachineLearning\p
```

In [262…

```
train_df.head()
```

Out[262…

| | Id | v2a1 | hacdor | rooms | hacapo | v14a | refrig | v18q | v18q1 | r4h1 | ... | SQBescola |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | ID_279628684 | 190000.0 | 0 | 3 | 0 | 1 | 1 | 0 | NaN | 0 | ... | 1( |
| **1** | ID_f29eb3ddd | 135000.0 | 0 | 4 | 0 | 1 | 1 | 1 | 1.0 | 0 | ... | 1‹ |
| **2** | ID_68de51c94 | NaN | 0 | 8 | 0 | 1 | 1 | 0 | NaN | 0 | ... | 1: |
| **3** | ID_d671db89c | 180000.0 | 0 | 5 | 0 | 1 | 1 | 1 | 1.0 | 0 | ... | ٤ |
| **4** | ID_d56d6f5f5 | 180000.0 | 0 | 5 | 0 | 1 | 1 | 1 | 1.0 | 0 | ... | 1: |

5 rows × 143 columns

In [263…

```
test_df.head()
```

Out[263…

| | Id | v2a1 | hacdor | rooms | hacapo | v14a | refrig | v18q | v18q1 | r4h1 | ... | age | SQB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | ID_2f6873615 | NaN | 0 | 5 | 0 | 1 | 1 | 0 | NaN | 1 | ... | 4 | |
| **1** | ID_1c78846d2 | NaN | 0 | 5 | 0 | 1 | 1 | 0 | NaN | 1 | ... | 41 | |
| **2** | ID_e5442cf6a | NaN | 0 | 5 | 0 | 1 | 1 | 0 | NaN | 1 | ... | 41 | |
| **3** | ID_a8db26a79 | NaN | 0 | 14 | 0 | 1 | 1 | 1 | 1.0 | 0 | ... | 59 | |
| **4** | ID_a62966799 | 175000.0 | 0 | 4 | 0 | 1 | 1 | 1 | 1.0 | 0 | ... | 18 | |

5 rows × 142 columns

In [264…

```
print("Shape of train dataset: {}\nShape of test dataset: {}".format(train_df.shape,
```

```
Shape of train dataset: (9557, 143)
Shape of test dataset: (23856, 142)
```

In [265…

```
concat_features = test_df.columns.tolist() + train_df.columns.tolist()
```

In [266…

```
def find_dup(arr, n):
  dup_count = []
  unique_count = []
  for i in range(len(arr)):
    match_count = 0
    for j in range(len(arr)):
      if i!=j:
        if arr[i] == arr[j]:
```

```
            match_count += 1

        if match_count >= n:
          dup_count.append(arr[i])
        else: unique_count.append(arr[i])
      return dup_count, unique_count

    dup, unique = find_dup(concat_features, 1)
    print("Independent feature: {}".format(set(dup)))
    print("Dependent feature: {}".format(set(unique)))
```

```
Independent feature: {'estadocivil7', 'SQBovercrowding', 'female', 'etecho2', 'hacap
o', 'paredblolad', 'parentesco1', 'edjefa', 'lugar1', 'abastaguafuera', 'r4h1', 'ene
rgcocinar4', 'r4m2', 'instlevel7', 'tamviv', 'abastaguadentro', 'elimbasu3', 'dis',
'tipovivi5', 'cielorazo', 'epared2', 'estadocivil5', 'instlevel8', 'instlevel5', 'SQ
Bedjefe', 'elimbasu1', 'eviv3', 'parentesco3', 'tipovivi4', 'paredpreb', 'tipovivi
1', 'etecho1', 'hogar_total', 'SQBdependency', 'eviv2', 'paredmad', 'SQBhogar_tota
l', 'noelec', 'r4h3', 'v2a1', 'pisomadera', 'lugar5', 'parentesco2', 'r4m1', 'elimba
su6', 'tipovivi3', 'hogar_adul', 'pisomoscer', 'pareddes', 'SQBmeaned', 'estadocivil
3', 'pisonatur', 'public', 'age', 'male', 'instlevel6', 'rooms', 'parentesco6', 'tec
hocane', 'epared3', 'energcocinar2', 'dependency', 'lugar3', 'sanitario3', 'hhsize',
'instlevel1', 'r4t1', 'computer', 'television', 'hogar_mayor', 'tamhog', 'epared1',
'area2', 'bedrooms', 'lugar6', 'SQBescolari', 'hacdor', 'v18q', 'sanitario2', 'rez_e
sc', 'estadocivil1', 'parentesco5', 'overcrowding', 'energcocinar3', 'paredfibras',
'r4h2', 'meaneduc', 'pisoother', 'elimbasu4', 'qmobilephone', 'paredzinc', 'parentes
co4', 'v14a', 'idhogar', 'parentesco11', 'area1', 'r4m3', 'paredother', 'instlevel
9', 'parentesco9', 'v18q1', 'agesq', 'parentesco8', 'sanitario6', 'parentesco12', 'p
arentesco7', 'paredzocalo', 'SQBhogar_nin', 'refrig', 'sanitario1', 'etecho3', 'r4t
3', 'tipovivi2', 'Id', 'parentesco10', 'elimbasu5', 'instlevel3', 'r4t2', 'sanitario
5', 'hogar_nin', 'eviv1', 'estadocivil4', 'abastaguano', 'instlevel2', 'pisonotien
e', 'techoentrepiso', 'estadocivil6', 'lugar2', 'instlevel4', 'edjefe', 'techootro',
'energcocinar1', 'elimbasu2', 'mobilephone', 'escolari', 'pisocemento', 'planpri',
'coopele', 'techozinc', 'SQBage', 'lugar4', 'estadocivil2'}
Dependent feature: {'Target'}
```

## The dependent feature is Target

In [267…

```
# Second problem is to find whether our data set is biased or not. For this let us f

for col in train_df.columns:
  print("{} - {}".format(col, train_df[col].dtypes))
```

```
Id - object
v2a1 - float64
hacdor - int64
rooms - int64
hacapo - int64
v14a - int64
refrig - int64
v18q - int64
v18q1 - float64
r4h1 - int64
r4h2 - int64
r4h3 - int64
r4m1 - int64
r4m2 - int64
r4m3 - int64
r4t1 - int64
r4t2 - int64
r4t3 - int64
tamhog - int64
tamviv - int64
escolari - int64
rez_esc - float64
hhsize - int64
paredblolad - int64
```

```
paredzocalo - int64
paredpreb - int64
pareddes - int64
paredmad - int64
paredzinc - int64
paredfibras - int64
paredother - int64
pisomoscer - int64
pisocemento - int64
pisoother - int64
pisonatur - int64
pisonotiene - int64
pisomadera - int64
techozinc - int64
techoentrepiso - int64
techocane - int64
techootro - int64
cielorazo - int64
abastaguadentro - int64
abastaguafuera - int64
abastaguano - int64
public - int64
planpri - int64
noelec - int64
coopele - int64
sanitario1 - int64
sanitario2 - int64
sanitario3 - int64
sanitario5 - int64
sanitario6 - int64
energcocinar1 - int64
energcocinar2 - int64
energcocinar3 - int64
energcocinar4 - int64
elimbasu1 - int64
elimbasu2 - int64
elimbasu3 - int64
elimbasu4 - int64
elimbasu5 - int64
elimbasu6 - int64
epared1 - int64
epared2 - int64
epared3 - int64
etecho1 - int64
etecho2 - int64
etecho3 - int64
eviv1 - int64
eviv2 - int64
eviv3 - int64
dis - int64
male - int64
female - int64
estadocivil1 - int64
estadocivil2 - int64
estadocivil3 - int64
estadocivil4 - int64
estadocivil5 - int64
estadocivil6 - int64
estadocivil7 - int64
parentesco1 - int64
parentesco2 - int64
parentesco3 - int64
parentesco4 - int64
parentesco5 - int64
parentesco6 - int64
parentesco7 - int64
parentesco8 - int64
parentesco9 - int64
parentesco10 - int64
```

```
parentesco11 - int64
parentesco12 - int64
idhogar - object
hogar_nin - int64
hogar_adul - int64
hogar_mayor - int64
hogar_total - int64
dependency - object
edjefe - object
edjefa - object
meaneduc - float64
instlevel1 - int64
instlevel2 - int64
instlevel3 - int64
instlevel4 - int64
instlevel5 - int64
instlevel6 - int64
instlevel7 - int64
instlevel8 - int64
instlevel9 - int64
bedrooms - int64
overcrowding - float64
tipovivi1 - int64
tipovivi2 - int64
tipovivi3 - int64
tipovivi4 - int64
tipovivi5 - int64
computer - int64
television - int64
mobilephone - int64
qmobilephone - int64
lugar1 - int64
lugar2 - int64
lugar3 - int64
lugar4 - int64
lugar5 - int64
lugar6 - int64
area1 - int64
area2 - int64
age - int64
SQBescolari - int64
SQBage - int64
SQBhogar_total - int64
SQBedjefe - int64
SQBhogar_nin - int64
SQBovercrowding - float64
SQBdependency - float64
SQBmeaned - float64
agesq - int64
Target - int64
```

In [268…

```
train_df.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 [269…

```
test_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 23856 entries, 0 to 23855
Columns: 142 entries, Id to agesq
dtypes: float64(8), int64(129), object(5)
memory usage: 25.8+ MB
```

We have 143 features in our train_df, out of which:

- 8 columns are of float64 type
- 130 columns are of int64 type
- 5 columns are of object type

We have 142 features in our test_df, out of which:

- 8 columns are of float64 type
- 129 columns are of int64 type
- 5 columns are of object type

In [270…

```
# Let's first check which columns have high no. of null values

def null_counter(df):
  null_count_arr = []
  null_percent_arr = []

  for col in df.columns:
    null_count = df[col].isnull().sum()
    null_percent = round(null_count/df.shape[0]*100, 3)

    null_count_arr.append(null_count)
    null_percent_arr.append(null_percent)

  return (null_count_arr, null_percent_arr)
```

In [271…

```
train_null_count, train_null_percent = null_counter(train_df)

data = {
  'Column_name': train_df.columns,
  'Null_count': train_null_count,
  'Null_percent': train_null_percent
}

null_info_df = pd.DataFrame.from_dict(data)

null_info_df
```

Out[271…

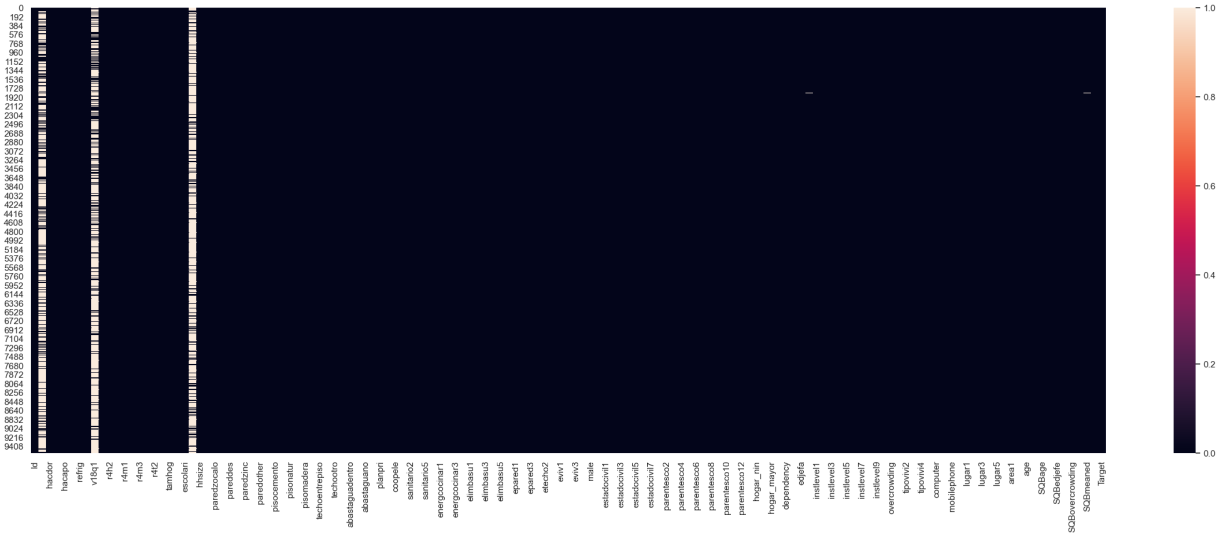
| | Column_name | Null_count | Null_percent |
|---|---|---|---|
| **0** | Id | 0 | 0.000 |
| **1** | v2a1 | 6860 | 71.780 |
| **2** | hacdor | 0 | 0.000 |
| **3** | rooms | 0 | 0.000 |
| **4** | hacapo | 0 | 0.000 |
| **...** | ... | ... | ... |
| **138** | SQBovercrowding | 0 | 0.000 |
| **139** | SQBdependency | 0 | 0.000 |
| **140** | SQBmeaned | 5 | 0.052 |
| **141** | agesq | 0 | 0.000 |
| **142** | Target | 0 | 0.000 |

143 rows × 3 columns

In [272…

```
import matplotlib.pyplot as plt
import seaborn as sns

plt.figure(figsize=(30, 10))
sns.heatmap(train_df.isnull())
plt.show()
```



From the above plot we can see that three features have high no. of null values. These features are:

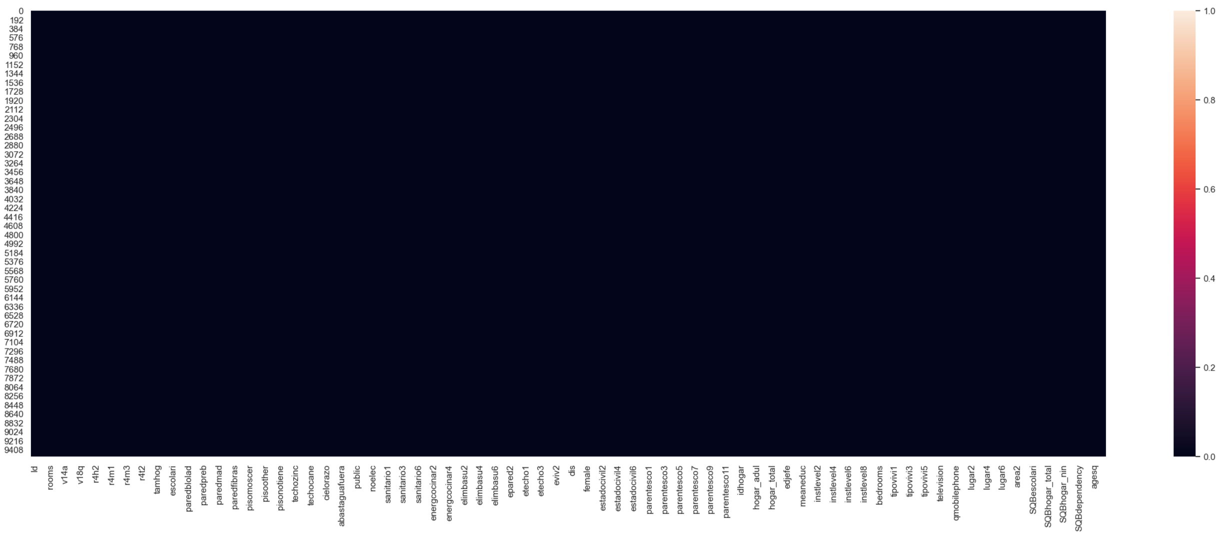
1. v2a1 with 71.78%
2. v18q1 with 76.82%
3. rez_esc with 82.95%

Since these three columns have high no. of missing values, hence, they will not contribute much to the model learning. So it would make no difference if we drop them.

In [273…

```
train_df = train_df.drop([ 'v2a1', 'v18q1', 'rez_esc'], axis=1)

plt.figure(figsize=(30, 10))
sns.heatmap(train_df.isnull())
plt.show()
```



In [274…

```
has_head_df = train_df[['Id', 'idhogar', 'parentesco1']]
has_head_df
```

Out[274…

| | Id | idhogar | parentesco1 |
|---|---|---|---|
| **0** | ID_279628684 | 21eb7fcc1 | 1 |
| **1** | ID_f29eb3ddd | 0e5d7a658 | 1 |
| **2** | ID_68de51c94 | 2c7317ea8 | 1 |
| **3** | ID_d671db89c | 2b58d945f | 0 |
| **4** | ID_d56d6f5f5 | 2b58d945f | 0 |
| **...** | ... | ... | ... |
| **9552** | ID_d45ae367d | d6c086aa3 | 1 |
| **9553** | ID_c94744e07 | d6c086aa3 | 0 |
| **9554** | ID_85fc658f8 | d6c086aa3 | 0 |
| **9555** | ID_ced540c61 | d6c086aa3 | 0 |
| **9556** | ID_a38c64491 | d6c086aa3 | 0 |

9557 rows × 3 columns

In [275…

```
hhold_head_count = has_head_df.groupby(['idhogar', 'parentesco1']).count()
hhold_head_count
```

Out[275…

| | | Id |
|---|---|---|
| **idhogar** | **parentesco1** | |
| **001ff74ca** | **0** | 1 |
| | **1** | 1 |
| **003123ec2** | **0** | 3 |
| | **1** | 1 |
| **004616164** | **0** | 1 |
| **...** | **...** | ... |
| **ffae4a097** | **1** | 1 |
| **ffe90d46f** | **0** | 3 |
| | **1** | 1 |
| **fff7d6be1** | **0** | 3 |
| | **1** | 1 |

5573 rows × 1 columns

In [276…

```
has_head_pv = pd.pivot_table(hhold_head_count, index='idhogar', columns='parentesco1
has_head_pv
```

Out[276…

| parentesco1 | 0 | 1 |
|---|---|---|

| parentesco1 | 0 | 1 |
|---|---|---|
| **idhogar** | | |
| **001ff74ca** | 1.0 | 1.0 |
| **003123ec2** | 3.0 | 1.0 |
| **004616164** | 1.0 | 1.0 |
| **004983866** | 1.0 | 1.0 |
| **005905417** | 2.0 | 1.0 |
| **...** | ... | ... |
| **ff9343a35** | 3.0 | 1.0 |
| **ff9d5ab17** | 2.0 | 1.0 |
| **ffae4a097** | 1.0 | 1.0 |
| **ffe90d46f** | 3.0 | 1.0 |
| **fff7d6be1** | 3.0 | 1.0 |

2988 rows × 2 columns

In [277…

```
for id in has_head_pv.index:
  if has_head_pv.loc[id, 1] == 0:
    print(id)

# There is no house hold without a family head
```

In [278…

```
pvty_lvl_df = train_df[['idhogar', 'Id', 'parentesco1', 'Target']]
pvty_lvl_df
```

Out[278…

| | idhogar | Id | parentesco1 | Target |
|---|---|---|---|---|
| **0** | 21eb7fcc1 | ID_279628684 | 1 | 4 |
| **1** | 0e5d7a658 | ID_f29eb3ddd | 1 | 4 |
| **2** | 2c7317ea8 | ID_68de51c94 | 1 | 4 |
| **3** | 2b58d945f | ID_d671db89c | 0 | 4 |
| **4** | 2b58d945f | ID_d56d6f5f5 | 0 | 4 |
| **...** | ... | ... | ... | ... |
| **9552** | d6c086aa3 | ID_d45ae367d | 1 | 2 |
| **9553** | d6c086aa3 | ID_c94744e07 | 0 | 2 |
| **9554** | d6c086aa3 | ID_85fc658f8 | 0 | 2 |
| **9555** | d6c086aa3 | ID_ced540c61 | 0 | 2 |
| **9556** | d6c086aa3 | ID_a38c64491 | 0 | 2 |

9557 rows × 4 columns

In [279…

```
x2 = pvty_lvl_df.groupby(['idhogar', 'Target', 'parentesco1'], as_index=False).count
x2
```

Out[279…

| | idhogar | Target | parentesco1 | Id |
|---|---|---|---|---|
| **0** | 001ff74ca | 4 | 0 | 1 |
| **1** | 001ff74ca | 4 | 1 | 1 |
| **2** | 003123ec2 | 2 | 0 | 3 |
| **3** | 003123ec2 | 2 | 1 | 1 |
| **4** | 004616164 | 2 | 0 | 1 |
| **...** | ... | ... | ... | ... |
| **5625** | ffae4a097 | 4 | 1 | 1 |
| **5626** | ffe90d46f | 1 | 0 | 3 |
| **5627** | ffe90d46f | 1 | 1 | 1 |
| **5628** | fff7d6be1 | 4 | 0 | 3 |
| **5629** | fff7d6be1 | 4 | 1 | 1 |

5630 rows × 4 columns

In [280…

```
x2_idhogar_list = x2['idhogar'].tolist()

x2_dup, x2_unique = find_dup(x2_idhogar_list, 3)
print(f'Duplicate records: {x2_dup}\nUnique records: {x2_unique}')
```

```
Duplicate records: []
Unique records: ['001ff74ca', '001ff74ca', '003123ec2', '003123ec2', '004616164', '0
04616164', '004983866', '004983866', '005905417', '005905417', '006031de3', '006031d
e3', '006555fe2', '006555fe2', '00693f597', '00693f597', '006b64543', '006b64543',
'00941f1f4', '00941f1f4', '009ae1cec', '009ae1cec', '00e3e05c5', '00e3e05c5', '00e44
3b00', '00edc0d0f', '00edc0d0f', '0108c62b8', '0108c62b8', '013962b12', '013962b12',
'013e9ee6a', '013e9ee6a', '0172ab1d9', '0172ab1d9', '0172ab1d9', '0194d569d', '01c6f
cb6e', '01d2e2b0b', '01d2e2b0b', '01ff6a086', '01ff6a086', '020713493', '023edfed0',
'023edfed0', '0250e0b59', '0250e0b59', '027651991', '029f3d736', '029f3d736', '02a3d
a971', '02a3da971', '02ae50d8f', '02ae50d8f', '02e9bb4e7', '02e9bb4e7', '02f34e26c',
'02f34e26c', '02ff93d1e', '02ff93d1e', '032d9f940', '032d9f940', '033c39c5c', '033c3
9c5c', '035bb4b72', '035bb4b72', '0369a5d78', '0369a5d78', '039745cbe', '039745cbe',
'03b23f2b1', '03b23f2b1', '03c6bdf85', '03c78a7a9', '03c78a7a9', '03d27346e', '03d27
346e', '03f00ec52', '03f00ec52', '03f4e5f4d', '03f4e5f4d', '03f4e5f4d', '043cef77c',
'043cef77c', '045038655', '0473832dd', '0473832dd', '047659c0f', '047659c0f', '048d6
4af0', '048d64af0', '04a032c94', '04a032c94', '04a8915f6', '04a8915f6', '04b02301b',
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'051f67b16', '052da118c', '053f09ebb', '054074f61', '054074f61', '0564f49cd', '0564f
49cd', '0566c116a', '0566c116a', '058a60804', '058a60804', '0592dc939', '0592dc939',
'05aef4eec', '05aef4eec', '05b0d51e9', '05b0d51e9', '05e1d4a10', '05e1d4a10', '05e6e
eead', '05e6eeead', '05eff3d5c', '05eff3d5c', '060027579', '060027579', '0605671a3',
'0605671a3', '06089482a', '06089482a', '0609006f6', '0609006f6', '061f8ffcf', '061f8
ffcf', '06219c98f', '06219c98f', '0626809c8', '0626809c8', '06325b3e6', '06325b3e6',
'0664cd4f0', '0664cd4f0', '0667ebc47', '0667ebc47', '066ca7a0a', '066ca7a0a', '0673a
6cf3', '0673a6cf3', '06749e51e', '06749e51e', '06804be1b', '06804be1b', '0681b11c9',
'068a639e5', '068a639e5', '06ca88023', '06ca88023', '06dba0576', '06dba0576', '070cd
f915', '070cdf915', '07102d194', '07102d194', '0723fe311', '0723fe311', '075a0a458',
'075a0a458', '077941bc7', '077941bc7', '078a0b6e2', '078a0b6e2', '078a0b6e2', '078a9
a68e', '078a9a68e', '07a5de1ba', '07a5de1ba', '07a6cc87c', '07a6cc87c', '07b8d09c3',
'07b8d09c3', '07d417b1c', '07d417b1c', '07f016cb5', '07f016cb5', '07f72c01f', '07f72
c01f', '08039fb0e', '08039fb0e', '08210d8c6', '08210d8c6', '088555bbe', '0890628f6',
'08908240a', '08908240a', '08b931d98', '08b931d98', '0932e7898', '0932e7898', '09344
```

463d', '09344463d', '09359a050', '09359a050', '09395e7d3', '09395e7d3', '093f0c2c3',
'093f0c2c3', '0966c7521', '0966c7521', '09a26c158', '09aaa0480', '09aaa0480', '09b19
5e7a', '09b3b7300', '09b3b7300', '09b82f76a', '09b82f76a', '09bf46466', '09bf46466',
'09c634256', '09c634256', '09cc036c4', '09cc036c4', '09d748e5f', '09d748e5f', '09d9f
0be5', '09e25d616', '09e25d616', '09e25d616', '09f4217ad', '09f4217ad', '0a096bb64',
'0a096bb64', '0a3be8b29', '0a5108b1a', '0a5108b1a', '0a865fb17', '0a865fb17', '0a90e
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d46f', 'fff7d6be1', 'fff7d6be1']
```

All members are consistent with the poverty level of their head.

In [281…

```
# Now let's see biases in individual features. Let's first divide the dataset as per

float_features_df = train_df.select_dtypes('float64')
int_features_df = train_df.select_dtypes('int64')
obj_features_df = train_df.select_dtypes('object')
```

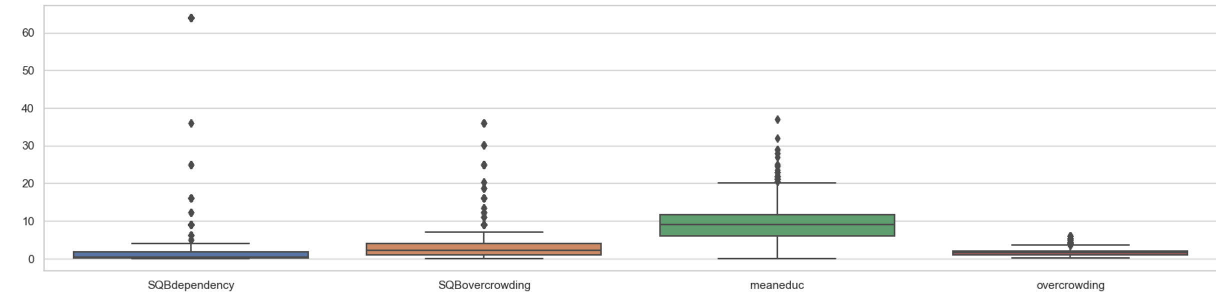
In [282…

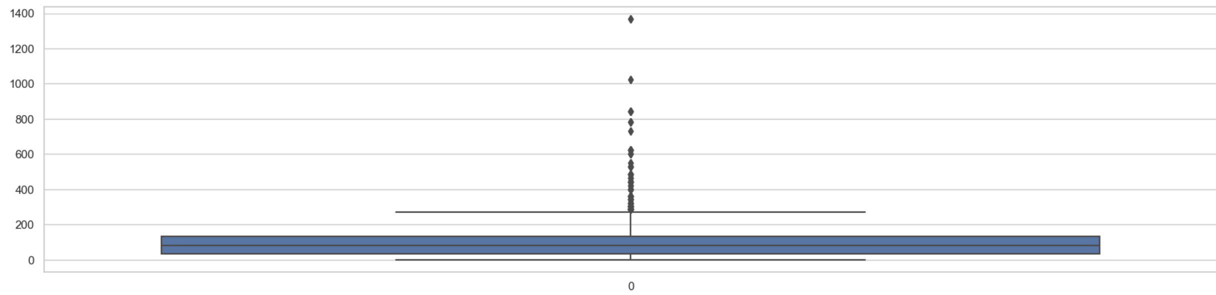
```
# boxplot of float features
sns.set_theme(style='whitegrid')
fig, ax = plt.subplots(nrows=2, ncols=1, figsize=(20, 10))

df1 = float_features_df[float_features_df.columns.difference(['SQBmeaned'])]
sns.boxplot(data=df1, ax=ax[0])

sns.boxplot(data=train_df['SQBmeaned'], ax=ax[1])

plt.show()
```



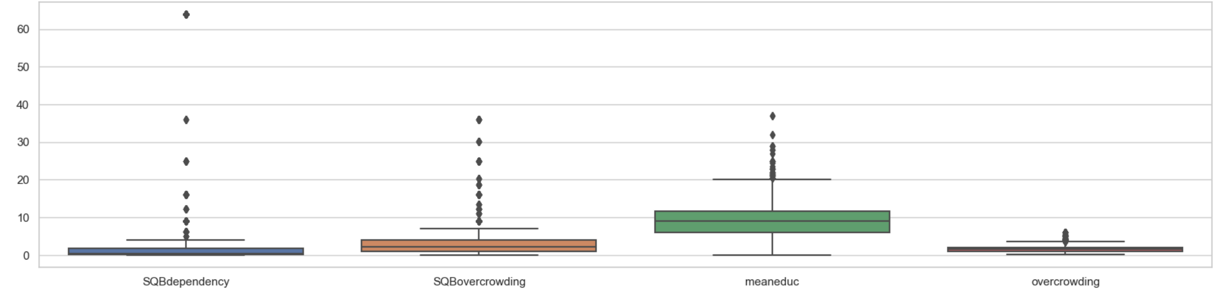

In [283…

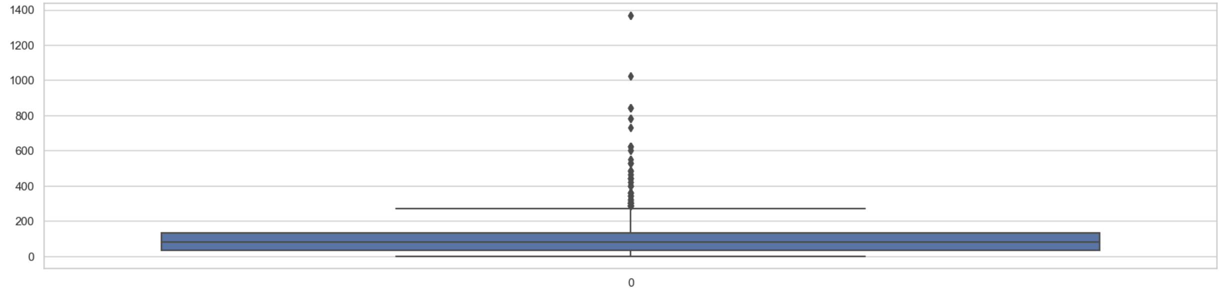
```
fig, ax = plt.subplots(nrows=2, ncols=1, figsize=(20, 10))

df1 = float_features_df[float_features_df.columns.difference(['SQBmeaned'])]
sns.boxplot(data=df1, ax=ax[0])

sns.boxplot(data=train_df['SQBmeaned'], ax=ax[1])

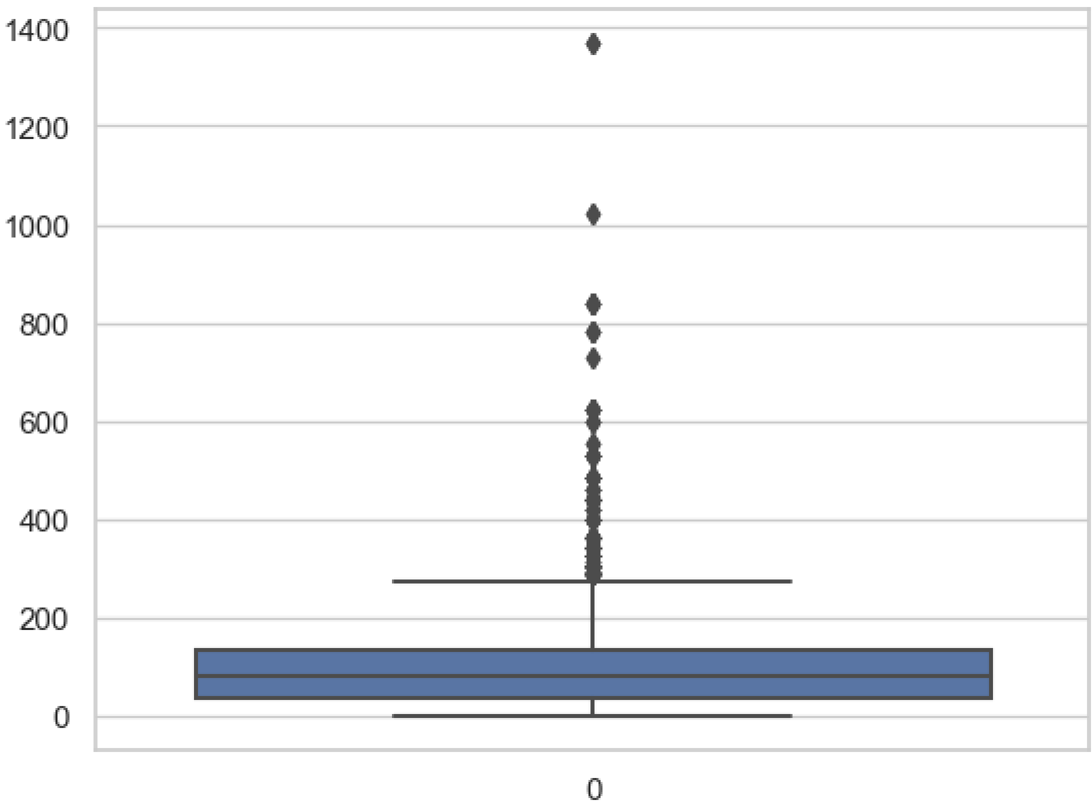
plt.show()
```




In [284…

```
sns.boxplot(data=float_features_df['SQBmeaned'])
plt.show()
```




In [285…

```
# There are certain int features which are one hot encoded. Let's differentiate them

def get_binary_features(df):
  binary_features_cols = []
  nonbinary_features_cols = []

  for col in df.columns:
    if df[col].min() == 0 and df[col].max() == 1:
      binary_features_cols.append(col)
    else:
      nonbinary_features_cols.append(col)

  return binary_features_cols, nonbinary_features_cols
```

```
x, y = get_binary_features(int_features_df)

print(x)
print(y)

print("No. of binary features: {}".format(len(x)))
print("No. of non-binary features: {}".format(len(y)))
```

```
['hacdor', 'hacapo', 'v14a', 'refrig', 'v18q', 'paredblolad', 'paredzocalo', 'paredp
reb', 'pareddes', 'paredmad', 'paredzinc', 'paredfibras', 'paredother', 'pisomosce
r', 'pisocemento', 'pisoother', 'pisonatur', 'pisonotiene', 'pisomadera', 'techozin
c', 'techoentrepiso', 'techocane', 'techootro', 'cielorazo', 'abastaguadentro', 'aba
staguafuera', 'abastaguano', 'public', 'planpri', 'noelec', 'coopele', 'sanitario1',
'sanitario2', 'sanitario3', 'sanitario5', 'sanitario6', 'energcocinar1', 'energcocin
ar2', 'energcocinar3', 'energcocinar4', 'elimbasu1', 'elimbasu2', 'elimbasu3', 'elim
basu4', 'elimbasu6', 'epared1', 'epared2', 'epared3', 'etecho1', 'etecho2', 'etecho
3', 'eviv1', 'eviv2', 'eviv3', 'dis', 'male', 'female', 'estadocivil1', 'estadocivil
2', 'estadocivil3', 'estadocivil4', 'estadocivil5', 'estadocivil6', 'estadocivil7',
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co6', 'parentesco7', 'parentesco8', 'parentesco9', 'parentesco10', 'parentesco11',
'parentesco12', 'instlevel1', 'instlevel2', 'instlevel3', 'instlevel4', 'instlevel
5', 'instlevel6', 'instlevel7', 'instlevel8', 'instlevel9', 'tipovivi1', 'tipovivi
2', 'tipovivi3', 'tipovivi4', 'tipovivi5', 'computer', 'television', 'mobilephone',
'lugar1', 'lugar2', 'lugar3', 'lugar4', 'lugar5', 'lugar6', 'area1', 'area2']
['rooms', 'r4h1', 'r4h2', 'r4h3', 'r4m1', 'r4m2', 'r4m3', 'r4t1', 'r4t2', 'r4t3', 't
amhog', 'tamviv', 'escolari', 'hhsize', 'elimbasu5', 'hogar_nin', 'hogar_adul', 'hog
ar_mayor', 'hogar_total', 'bedrooms', 'qmobilephone', 'age', 'SQBescolari', 'SQBag
e', 'SQBhogar_total', 'SQBedjefe', 'SQBhogar_nin', 'agesq', 'Target']
No. of binary features: 101
No. of non-binary features: 29
```

In [286…

```
binary_feat, nonbinary_feat = get_binary_features(int_features_df)

int_features_set1 = int_features_df[binary_feat[:20]]
int_features_set2 = int_features_df[binary_feat[20:40]]
int_features_set3 = int_features_df[binary_feat[40:60]]
int_features_set4 = int_features_df[binary_feat[60:80]]
int_features_set5 = int_features_df[binary_feat[80:]]

fig, ax = plt.subplots(5, 1, figsize=(40, 30))

sns.boxplot(data=int_features_set1, ax=ax[0])
sns.boxplot(data=int_features_set2, ax=ax[1])
sns.boxplot(data=int_features_set3, ax=ax[2])
sns.boxplot(data=int_features_set4, ax=ax[3])
sns.boxplot(data=int_features_set5, ax=ax[4])


plt.show()
```

In [287…

```
# Let's divide our non-binary features as per the mean of the features, so that we c
int_features_df[nonbinary_feat].mean()
```

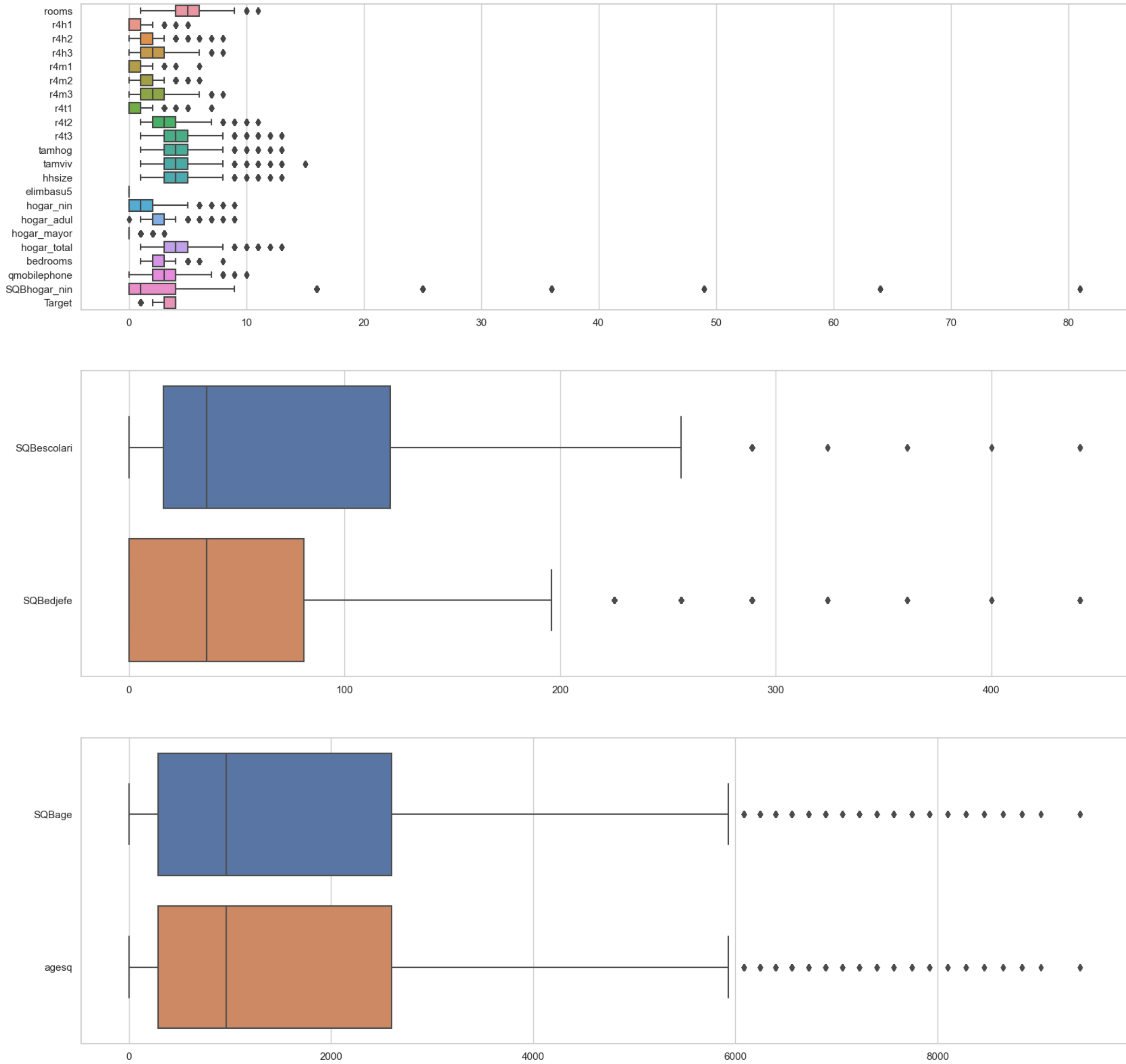
Out[287…

```
rooms              4.955530
r4h1               0.385895
r4h2               1.559171
r4h3               1.945066
r4m1               0.399184
r4m2               1.661714
r4m3               2.060898
r4t1               0.785079
r4t2               3.220885
r4t3               4.005964
tamhog             3.999058
tamviv             4.094590
escolari           7.200272
hhsize             3.999058
elimbasu5          0.000000
hogar_nin          1.406613
hogar_adul         2.592445
hogar_mayor        0.284085
hogar_total        3.999058
bedrooms           2.739981
qmobilephone       2.821492
age               34.303547
SQBescolari       74.222769
SQBage          1643.774302
SQBhogar_total    19.132887
SQBedjefe         53.500262
SQBhogar_nin       3.844826
agesq           1643.774302
Target             3.302292
dtype: float64
```

In [288…

```
# As we can see our means range from 1-5, 50-100, 10000+. So we will set the ylimit
```

```python
nonbinary_feat_set1 = []
nonbinary_feat_set2 = []
nonbinary_feat_set3 = []

for feature in nonbinary_feat:
  if int_features_df[feature].mean() < 5.0:
    nonbinary_feat_set1.append(feature)
  elif  int_features_df[feature].mean() > 50 and int_features_df[feature].mean() < 1
    nonbinary_feat_set2.append(feature)
  elif int_features_df[feature].mean() > 500:
    nonbinary_feat_set3.append(feature)
  else: continue

fig, ax = plt.subplots(3, 1, figsize=(20, 20))

ax[0].set_ylim(1, 5)
sns.boxplot(data=int_features_df[nonbinary_feat_set1], orient='h', ax=ax[0])

ax[1].set_ylim(50, 100)
sns.boxplot(data=int_features_df[nonbinary_feat_set2], orient='h', ax=ax[1])

ax[2].set_ylim(500, 2000)
sns.boxplot(data=int_features_df[nonbinary_feat_set3], orient='h', ax=ax[2])

plt.show()
```



In [289…

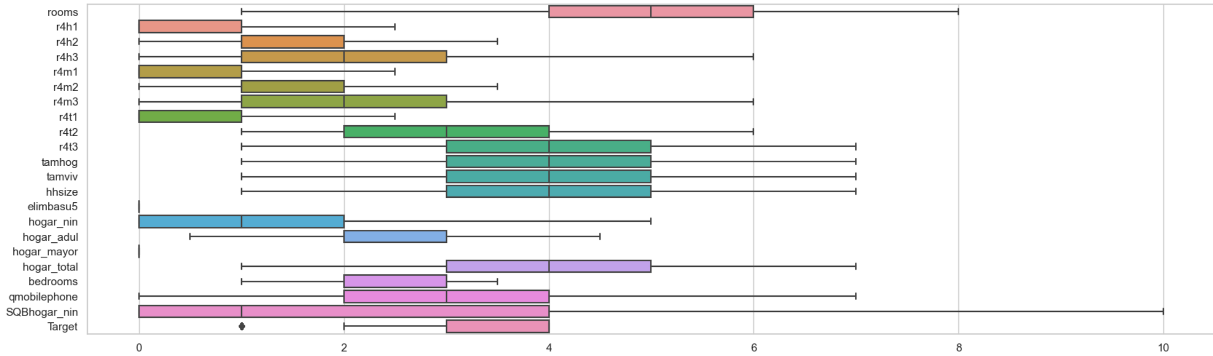
```
from scipy.stats import iqr

def remove_outliers(df):
    for col in df.columns:
        IQR = iqr(df[col])
        Q1 = iqr(df[col], rng=[0, 25])
        Q3 = iqr(df[col], rng=[0, 75])

        upp_lmt = Q3 + (1.5*IQR)
        low_lmt = Q1 - (1.5*IQR)

        for val in df[col]:
            if val < low_lmt:
                df[col].replace(to_replace=val, value=low_lmt, inplace=True)
            elif val > upp_lmt:
                df[col].replace(to_replace=val, value=upp_lmt, inplace=True)
```

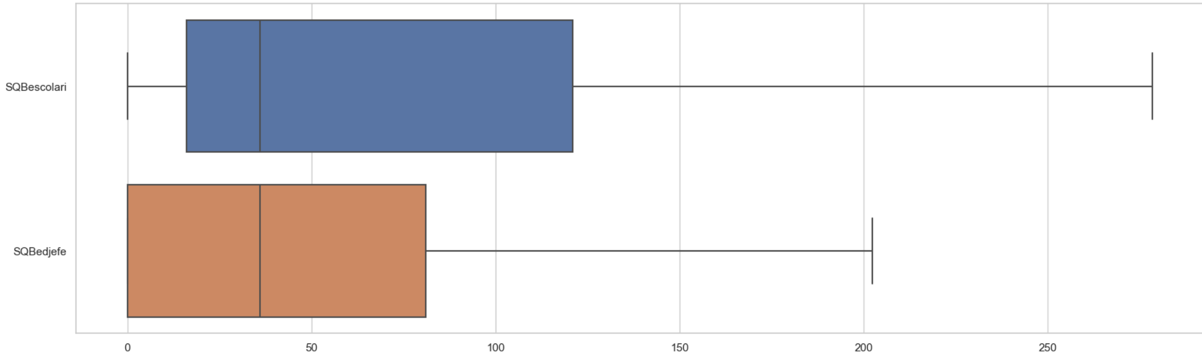
In [290…

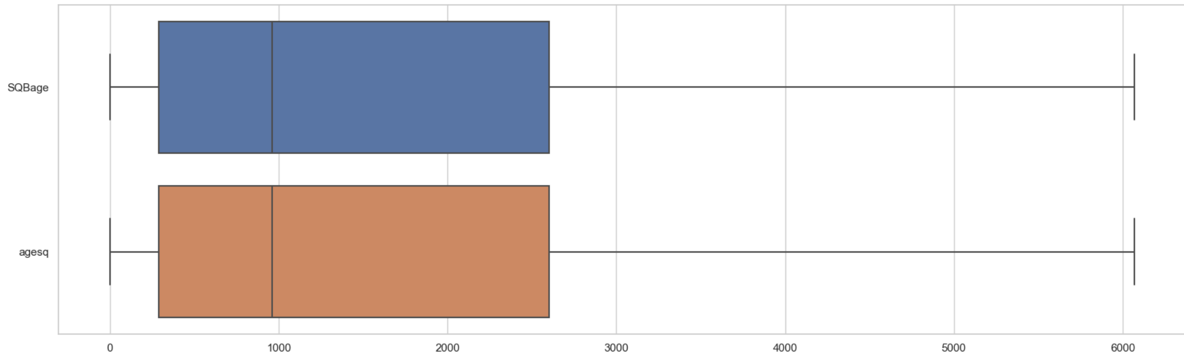
```
nonbinary_features_df = int_features_df[nonbinary_feat]
remove_outliers(nonbinary_features_df)
```

In [291…

```
fig, ax = plt.subplots(3, 1, figsize=(20, 20))

ax[0].set_ylim(1, 5)
sns.boxplot(data=nonbinary_features_df[nonbinary_feat_set1], orient='h', ax=ax[0])

ax[1].set_ylim(50, 100)
sns.boxplot(data=nonbinary_features_df[nonbinary_feat_set2], orient='h', ax=ax[1])

ax[2].set_ylim(500, 2000)
sns.boxplot(data=nonbinary_features_df[nonbinary_feat_set3], orient='h', ax=ax[2])

plt.show()
```




In [292…

```
# Mapping the numeric values to 'yes' and 'no'
values = {'yes': 1, 'no': 0}
obj_features_df.replace({'dependency': values, 'edjefe': values, 'edjefa': values},

obj_features_df
```

Out[292…

| | Id | idhogar | dependency | edjefe | edjefa |
|---|---|---|---|---|---|
| **0** | ID_279628684 | 21eb7fcc1 | 0 | 10 | 0 |
| **1** | ID_f29eb3ddd | 0e5d7a658 | 8 | 12 | 0 |
| **2** | ID_68de51c94 | 2c7317ea8 | 8 | 0 | 11 |
| **3** | ID_d671db89c | 2b58d945f | 1 | 11 | 0 |
| **4** | ID_d56d6f5f5 | 2b58d945f | 1 | 11 | 0 |
| **...** | ... | ... | ... | ... | ... |
| **9552** | ID_d45ae367d | d6c086aa3 | .25 | 9 | 0 |
| **9553** | ID_c94744e07 | d6c086aa3 | .25 | 9 | 0 |
| **9554** | ID_85fc658f8 | d6c086aa3 | .25 | 9 | 0 |
| **9555** | ID_ced540c61 | d6c086aa3 | .25 | 9 | 0 |
| **9556** | ID_a38c64491 | d6c086aa3 | .25 | 9 | 0 |

9557 rows × 5 columns

In [293…

```
train_df = pd.concat([float_features_df, int_features_df, obj_features_df], axis=1)
train_df
```

Out[293…

| | meaneduc | overcrowding | SQBovercrowding | SQBdependency | SQBmeaned | hacdor | rooms | h |
|---|---|---|---|---|---|---|---|---|
| **0** | 10.00 | 1.000000 | 1.000000 | 0.0000 | 100.0000 | 0 | 3 | |
| **1** | 12.00 | 1.000000 | 1.000000 | 64.0000 | 144.0000 | 0 | 4 | |
| **2** | 11.00 | 0.500000 | 0.250000 | 64.0000 | 121.0000 | 0 | 8 | |
| **3** | 11.00 | 1.333333 | 1.777778 | 1.0000 | 121.0000 | 0 | 5 | |
| **4** | 11.00 | 1.333333 | 1.777778 | 1.0000 | 121.0000 | 0 | 5 | |
| **...** | ... | ... | ... | ... | ... | ... | ... | |
| **9552** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9553** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9554** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9555** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9556** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |

9557 rows × 140 columns

In [294…

```
train_df.dropna(inplace=True)
train_df
```

Out[294…

| | meaneduc | overcrowding | SQBovercrowding | SQBdependency | SQBmeaned | hacdor | rooms | h |
|---|---|---|---|---|---|---|---|---|
| **0** | 10.00 | 1.000000 | 1.000000 | 0.0000 | 100.0000 | 0 | 3 | |
| **1** | 12.00 | 1.000000 | 1.000000 | 64.0000 | 144.0000 | 0 | 4 | |
| **2** | 11.00 | 0.500000 | 0.250000 | 64.0000 | 121.0000 | 0 | 8 | |
| **3** | 11.00 | 1.333333 | 1.777778 | 1.0000 | 121.0000 | 0 | 5 | |
| **4** | 11.00 | 1.333333 | 1.777778 | 1.0000 | 121.0000 | 0 | 5 | |
| **...** | ... | ... | ... | ... | ... | ... | ... | |
| **9552** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9553** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9554** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9555** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |
| **9556** | 8.25 | 1.250000 | 1.562500 | 0.0625 | 68.0625 | 0 | 6 | |

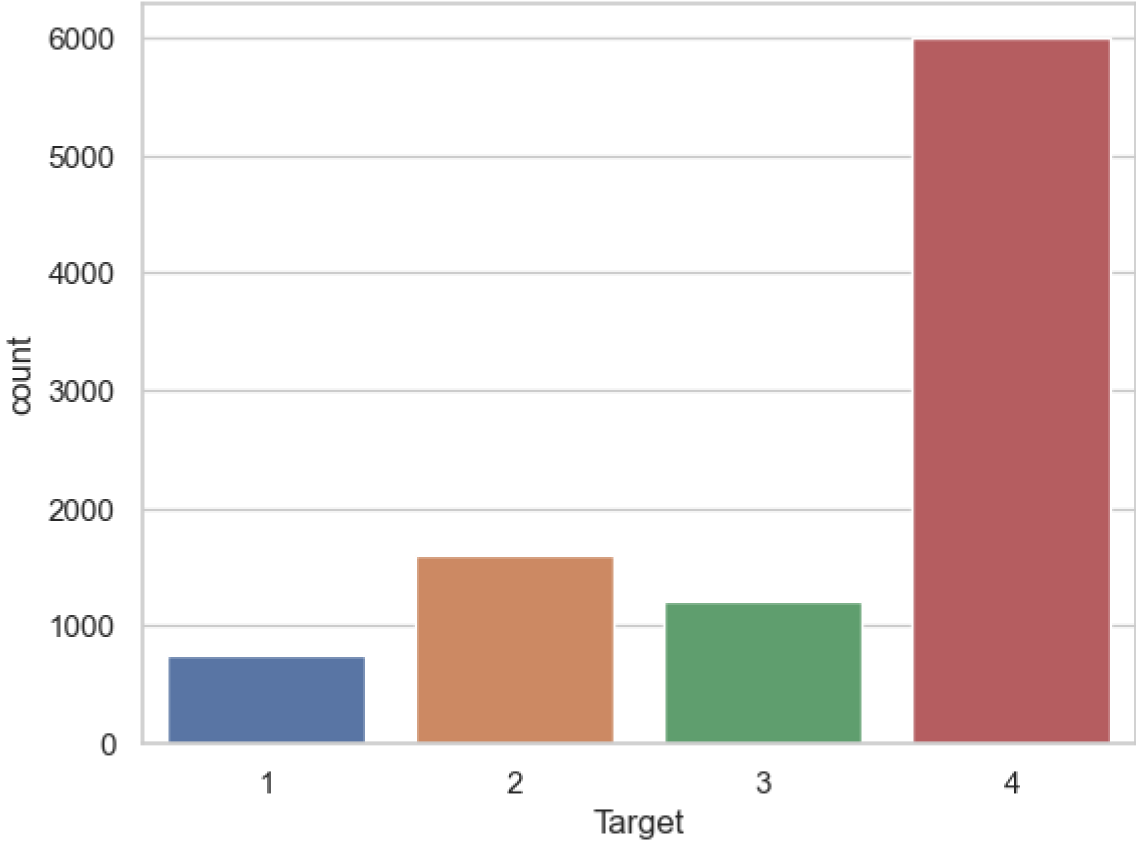
9552 rows × 140 columns

In [295…

```
from collections import Counter
```

```
target_data_comp = Counter(nonbinary_features_df['Target'])
print(f'Target variable composition: {target_data_comp}')

sns.countplot(x='Target', data=nonbinary_features_df)
plt.show()
```

```
Target variable composition: Counter({4: 5996, 2: 1597, 3: 1209, 1: 755})
```



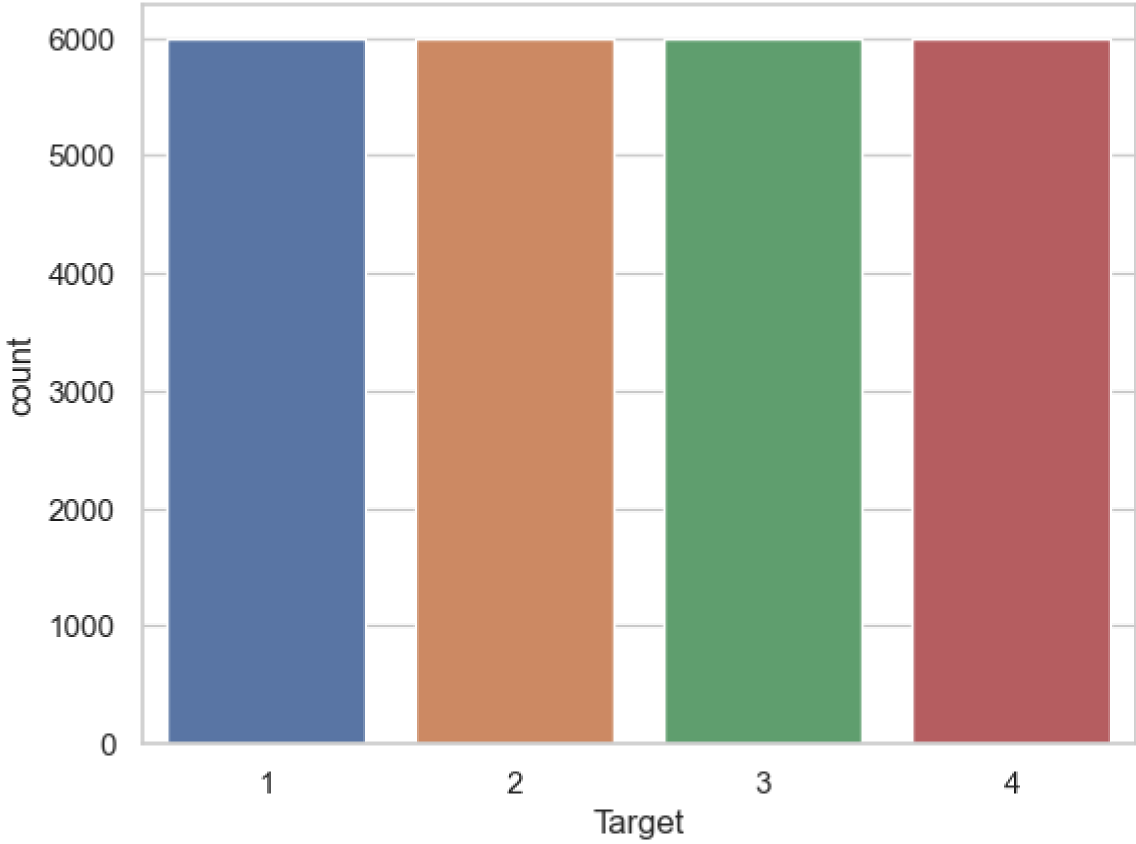

In [296…

```
# As you can see we have imbalance in our dependent variable, hence it's an imbalanc
# Let's use SMOTE for rebalancing

from imblearn.over_sampling import SMOTE
import numpy as np

y = train_df['Target']
X = train_df.drop(['Id', 'idhogar', 'Target'], axis=1)

smote = SMOTE(k_neighbors=2)
X_resampled, y_resampled = smote.fit_resample(X, y)
```

In [297…

```
resample_target_comp = Counter(y_resampled)
print(resample_target_comp)

sns.countplot(y_resampled)
plt.show()
```

```
Counter({4: 5991, 2: 5991, 3: 5991, 1: 5991})
```




In [298…

```
resampled_df = pd.concat([X_resampled, y_resampled], axis=1)
resampled_df
```

Out[298…

| | meaneduc | overcrowding | SQBovercrowding | SQBdependency | SQBmeaned | hacdor | rooms |
|---|---|---|---|---|---|---|---|
| **0** | 10.000000 | 1.000000 | 1.000000 | 0.000000 | 100.000000 | 0 | 3 |
| **1** | 12.000000 | 1.000000 | 1.000000 | 64.000000 | 144.000000 | 0 | 4 |
| **2** | 11.000000 | 0.500000 | 0.250000 | 64.000000 | 121.000000 | 0 | 8 |
| **3** | 11.000000 | 1.333333 | 1.777778 | 1.000000 | 121.000000 | 0 | 5 |
| **4** | 11.000000 | 1.333333 | 1.777778 | 1.000000 | 121.000000 | 0 | 5 |
| **...** | ... | ... | ... | ... | ... | ... | ... |
| **23959** | 9.500000 | 1.333333 | 1.777778 | 1.000000 | 90.250000 | 0 | 5 |
| **23960** | 10.502688 | 1.820968 | 3.391291 | 3.336918 | 110.887998 | 0 | 6 |
| **23961** | 8.425882 | 1.518432 | 2.394772 | 0.111111 | 71.017780 | 0 | 4 |
| **23962** | 5.805077 | 1.000000 | 1.000000 | 0.048731 | 33.855842 | 0 | 2 |
| **23963** | 6.000000 | 1.202967 | 1.507416 | 0.695550 | 36.000000 | 0 | 4 |

23964 rows × 138 columns

In [306…

```
resampled_df['Target'].dtype
```

Out[306…

```
dtype('int64')
```

In [320…

```
# Our dataset is now balanced. We can now train our model. Using hyper parameter tun
```

```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier

p_dist = {
  'n_estimators': np.arange(100, 900, 100),
  'criterion': ['gini', 'entropy'],
  'max_depth': np.arange(1, 15, 1),
  'max_features': ['auto', 'sqrt', 'log2']
  }

rand_forest = RandomForestClassifier()

clf = RandomizedSearchCV(rand_forest, p_dist, n_jobs=-1, cv=10, random_state=32, ver
```

In [321…

```
clf.fit(X_resampled, y_resampled)
```

```
Fitting 10 folds for each of 10 candidates, totalling 100 fits
```

Out[321…

```
RandomizedSearchCV(cv=10, estimator=RandomForestClassifier(), n_jobs=-1,
                   param_distributions={'criterion': ['gini', 'entropy'],
                                        'max_depth': array([ 1,  2,  3,  4,  5,  6,
7,  8,  9, 10, 11, 12, 13, 14]),
                                        'max_features': ['auto', 'sqrt',
                                                         'log2'],
                                        'n_estimators': array([100, 200, 300, 400, 5
00, 600, 700, 800])},
                   random_state=32, verbose=1)
```

We have found out our required hyperparameters for the Random Forest classifier. So let's now fit the classifier to our test data with the given hyperparameters.

In [334…

```
print(f'Parameters: {clf.best_params_}\nScore: {clf.best_score_}')
```

```
Parameters: {'n_estimators': 200, 'max_features': 'sqrt', 'max_depth': 12, 'criterio
n': 'entropy'}
Score: 0.8283768037815772
```

In [356…

```
# First we need to make the same transformations to the test dataset as the train da

test_null_count, test_null_percent = null_counter(test_df)

data = {
  'Column_name': test_df.columns,
  'Null_count': test_null_count,
  'Null_percent': test_null_percent
}

null_info_df2 = pd.DataFrame.from_dict(data)

null_info_df2
```

Out[356…

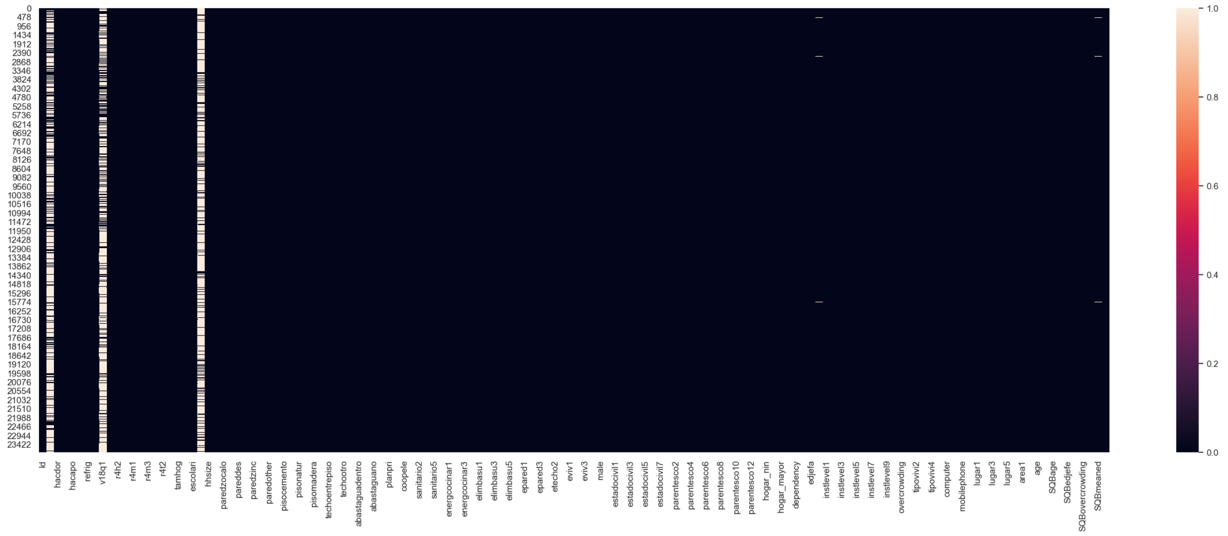
| | Column_name | Null_count | Null_percent |
|---|---|---|---|
| **0** | Id | 0 | 0.00 |
| **1** | v2a1 | 17403 | 72.95 |
| **2** | hacdor | 0 | 0.00 |
| **3** | rooms | 0 | 0.00 |
| **4** | hacapo | 0 | 0.00 |
| **...** | ... | ... | ... |

| | Column_name | Null_count | Null_percent |
|---|---|---|---|
| **137** | SQBhogar_nin | 0 | 0.00 |
| **138** | SQBovercrowding | 0 | 0.00 |
| **139** | SQBdependency | 0 | 0.00 |
| **140** | SQBmeaned | 31 | 0.13 |
| **141** | agesq | 0 | 0.00 |

142 rows × 3 columns

In [357…

```
plt.figure(figsize=(30, 10))
sns.heatmap(test_df.isnull())
plt.show()
```



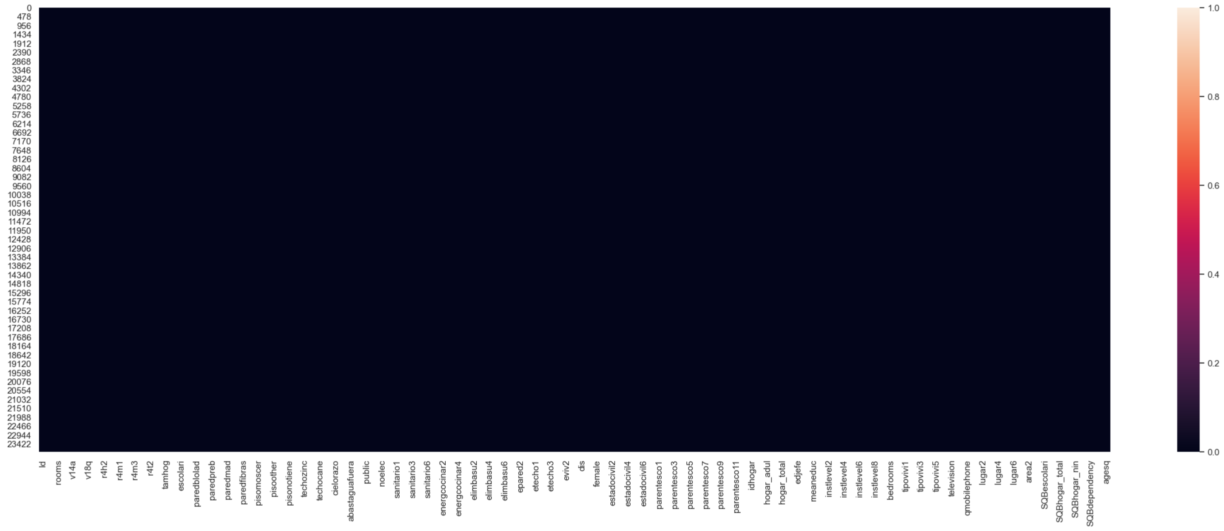
From the above plot we can see that three features have high no. of null values. These features are:

1. v2a1 with 72.95%
2. v18q1 with 75.82%
3. rez_esc with 82.38%

Since these three columns have high no. of missing values, hence, they will not contribute much to the model learning. So it would make no difference if we drop them.

In [358…

```
test_df = test_df.drop(['v2a1', 'v18q1', 'rez_esc'], axis=1)

plt.figure(figsize=(30, 10))
sns.heatmap(test_df.isnull())
plt.show()
```



In [359…

```
test_df.dropna(inplace=True)
```

In [360…

```
# Mapping the numeric values to 'yes' and 'no'
values = {'yes': 1, 'no': 0}
test_df.replace({'dependency': values, 'edjefe': values, 'edjefa': values}, inplace=
```

In [361…

```
test_df.drop(['Id', 'idhogar'], axis=1, inplace=True)
test_df
```

Out[361…

| | hacdor | rooms | hacapo | v14a | refrig | v18q | r4h1 | r4h2 | r4h3 | r4m1 | ... | age | SQBescolari |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | ... | 4 | 0 |
| **1** | 0 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | ... | 41 | 256 |
| **2** | 0 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | ... | 41 | 289 |
| **3** | 0 | 14 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | ... | 59 | 256 |
| **5** | 0 | 3 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | ... | 38 | 256 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **23851** | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 2 | 2 | 1 | ... | 10 | 9 |
| **23852** | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | ... | 54 | 36 |
| **23853** | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | ... | 12 | 16 |
| **23854** | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | ... | 12 | 25 |
| **23855** | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | ... | 51 | 36 |

23825 rows × 137 columns

In [362…

```
model = RandomForestClassifier(n_estimators=200,
                               max_features='sqrt',
                               max_depth=12,
                               criterion='entropy')

model.fit(X_resampled, y_resampled)
```

```
RandomForestClassifier(criterion='entropy', max_depth=12, max_features='sqrt',
```

Out[362…                    n_estimators=200)

In [363…
```
y_predict = model.predict(test_df)

y_predict
```

Out[363… array([2, 4, 1, ..., 1, 1, 2], dtype=int64)

In [365…
```
y_predict_srs = pd.Series(name='Prediction', data=y_predict)
y_predict_srs
```

Out[365…
```
0        2
1        4
2        1
3        1
4        1
        ..
23820    2
23821    2
23822    1
23823    1
23824    2
Name: Prediction, Length: 23825, dtype: int64
```