loan-approval-brainalytics

January 27, 2021

[352]:
```
# This Python 3 environment comes with many helpful analytics libraries␣
↪installed
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/
↪docker-python
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list␣
↪all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that␣
↪gets preserved as output when you create a version using "Save & Run All"
# You can also write temporary files to /kaggle/temp/, but they won't be saved␣
↪outside of the current session
```

```
/kaggle/input/cleanedtest/test_cleaned.csv
/kaggle/input/cleaneddata/cleaned.csv
```

1 Import libraries and Data Loading

[353]:
```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import matplotlib.pyplot as plt
import seaborn as sns

from scipy import stats
from scipy.stats import randint
```

```
# prep
from sklearn.model_selection import RandomizedSearchCV, GridSearchCV,␣
↪train_test_split
from sklearn import preprocessing
from sklearn.datasets import make_classification
from sklearn.preprocessing import binarize, LabelEncoder, MinMaxScaler

# models
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier, ExtraTreesClassifier

# Validation libraries
from sklearn import metrics
from sklearn.metrics import accuracy_score, mean_squared_error,␣
↪precision_recall_curve
from sklearn.model_selection import cross_val_score

#Neural Network
from sklearn.neural_network import MLPClassifier


#Bagging
from sklearn.ensemble import BaggingClassifier, AdaBoostClassifier
from sklearn.neighbors import KNeighborsClassifier

#Naive bayes
from sklearn.naive_bayes import GaussianNB

#Stacking
from mlxtend.classifier import StackingClassifier

# Input data files are available in the "../input/" directory.
# For example, running this (by clicking run or pressing Shift+Enter) will list␣
↪the files in the input directory

from subprocess import check_output
print(check_output(["ls", "../input"]).decode("utf8"))

# Any results you write to the current directory are saved as output.

#reading in CSV's from a file path
train_df = pd.read_csv('../input/cleaneddata/cleaned.csv')
test_df = pd.read_csv('../input/cleanedtest/test_cleaned.csv')

#Pandas: whats the data row count?
print(train_df.shape)
```

```python
#Pandas: whats the distribution of the data?
print(train_df.describe())

#Pandas: What types of data do i have?
print(train_df.info())
```

```
cleaneddata
cleanedtest

(55058, 18)
                 V1            V2            V3            V4            V5  \
count  55058.000000  55058.000000  55058.000000  55058.000000  55058.000000
mean       0.573286  10027.907806      1.439954      1.669512      3.737023
std        0.494604     73.491892      0.762256      0.794189      0.784929
min        0.000000  10001.000000      1.000000      1.000000      1.000000
25%        0.000000  10002.000000      1.000000      1.000000      4.000000
50%        1.000000  10005.000000      1.000000      1.000000      4.000000
75%        1.000000  10014.000000      2.000000      2.000000      4.000000
max        1.000000  10722.000000      3.000000      3.000000      4.000000

                 V6            V8            V9           V11            V12  \
count  5.505800e+04  55058.000000  55058.000000  55058.000000   55058.000000
mean   5.816138e+03      0.702822      0.649152      4.125940     362.943487
std    1.916309e+05      0.457020      0.477240      2.300028    2531.983287
min    0.000000e+00      0.000000      0.000000      1.000000       0.000000
25%    1.650000e+03      0.000000      0.000000      2.000000       0.000000
50%    2.500000e+03      1.000000      1.000000      3.000000       0.000000
75%    4.000000e+03      1.000000      1.000000      7.000000     350.000000
max    3.838384e+07      1.000000      1.000000      7.000000  545436.500000

                  V13           V14           V15           V16           V17  \
count   55058.000000  55058.000000  55058.000000  55058.000000  55058.000000
mean    39679.828544      3.937974     19.180887   1103.277562     50.061263
std     23845.980055      0.906746      3.284822    426.066515     11.817311
min      5000.000000      1.000000     11.990000    118.000000     30.000000
25%     30000.000000      4.000000     19.180000   1103.000000     40.000000
50%     40000.000000      4.000000     19.180000   1103.000000     50.000000
75%     40000.000000      4.000000     19.180000   1103.000000     60.000000
max    300000.000000      6.000000     37.000000  13556.000000     71.000000

                V18
count  55058.000000
mean       0.014675
std        0.120251
min        0.000000
25%        0.000000
```

```
50%          0.000000
75%          0.000000
max          1.000000
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 55058 entries, 0 to 55057
Data columns (total 18 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   V1      55058 non-null  int64
 1   V2      55058 non-null  int64
 2   V3      55058 non-null  int64
 3   V4      55058 non-null  int64
 4   V5      55058 non-null  int64
 5   V6      55058 non-null  float64
 6   V7      55058 non-null  object
 7   V8      55058 non-null  int64
 8   V9      55058 non-null  int64
 9   V10     55058 non-null  object
 10  V11     55058 non-null  int64
 11  V12     55058 non-null  float64
 12  V13     55058 non-null  int64
 13  V14     55058 non-null  int64
 14  V15     55058 non-null  float64
 15  V16     55058 non-null  int64
 16  V17     55058 non-null  int64
 17  V18     55058 non-null  int64
dtypes: float64(3), int64(13), object(2)
memory usage: 7.6+ MB
None
```

[354]:
```
train_df.isnull().sum().max()
```

[354]: 0

[355]:
```
test_df.isnull().sum().max()
```

[355]: 13765

1.1 What do summary statistics look like?

[356]:
```
train_df.describe
```

[356]:
```
<bound method NDFrame.describe of          V1      V2   V3   V4   V5        V6     V7
V8   V9    V10  V11     V12      V13  \
0        1  10003    1    3    4    4200.0   B004    1    1  S133     3     0.0    69000
1        1  10005    1    1    4   12000.0   B009    0    1  S133     3     0.0   180000
```

```
2        1  10001   1   3   4   4000.0  B002   1   1  S133    3    0.0    61000
3        1  10097   3   3   4   3000.0  B003   0   1  S133    2    0.0    60000
4        0  10001   1   1   4   4000.0  B002   1   0  S133    2    0.0    40000
…     ..    …  ..  ..  ..      …    …   ..  ..   …   …    …      …
55053    1  10002   1   1   4   6850.0  B001   1   1  S122    7    0.0    50000
55054    1  10001   1   2   4   3400.0  B004   1   1  S122    7  761.8    20000
55055    1  10005   1   3   4   4500.0  B002   1   1  S122    7    0.0    81000
55056    0  10037   2   1   4    500.0  B008   0   0  S122    7  200.0    40000
55057    0  10010   1   2   4   1550.0  B001   1   0  S122    7    0.0    40000

       V14    V15   V16  V17  V18
0        5  14.85  1636   57    0
1        5  14.85  4268   44    0
2        4  14.85  1693   57    0
3        5  13.99  1396   31    0
4        4  19.18  1103   52    0
…     …    …    …   …   …
55053    3  19.18  1103   36    0
55054    4  18.15   589   41    0
55055    4  13.75  2203   49    0
55056    4  19.18  1103   66    0
55057    4  19.18  1103   37    0

[55058 rows x 18 columns]>
```

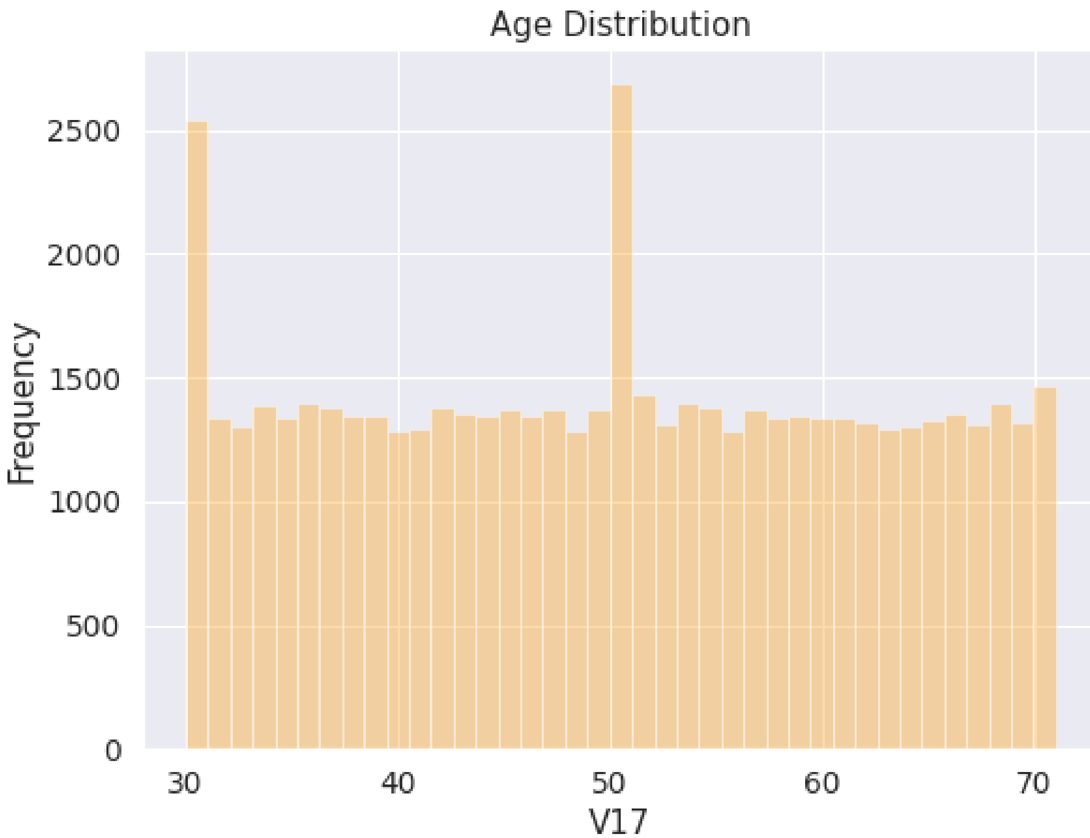
[357]:
```
train_df['age_range'] = pd.cut(train_df['V17'], [0,20,30,65,100],␣
↪labels=["0-20", "21-30", "31-65", "66-100"], include_lowest=True)
```

[358]:
```
#test_df['age_range'] = pd.cut(test_df['V17'], [0,20,30,65,100],␣
↪labels=["0-20", "21-30", "31-65", "66-100"], include_lowest=True)
```

[359]:
```
fig,ax = plt.subplots(figsize=(8, 6))
sns.distplot(train_df['V17'].dropna(),ax=ax, kde=False, color='#ffa726')
plt.title('Age Distribution')
plt.ylabel("Frequency")
```

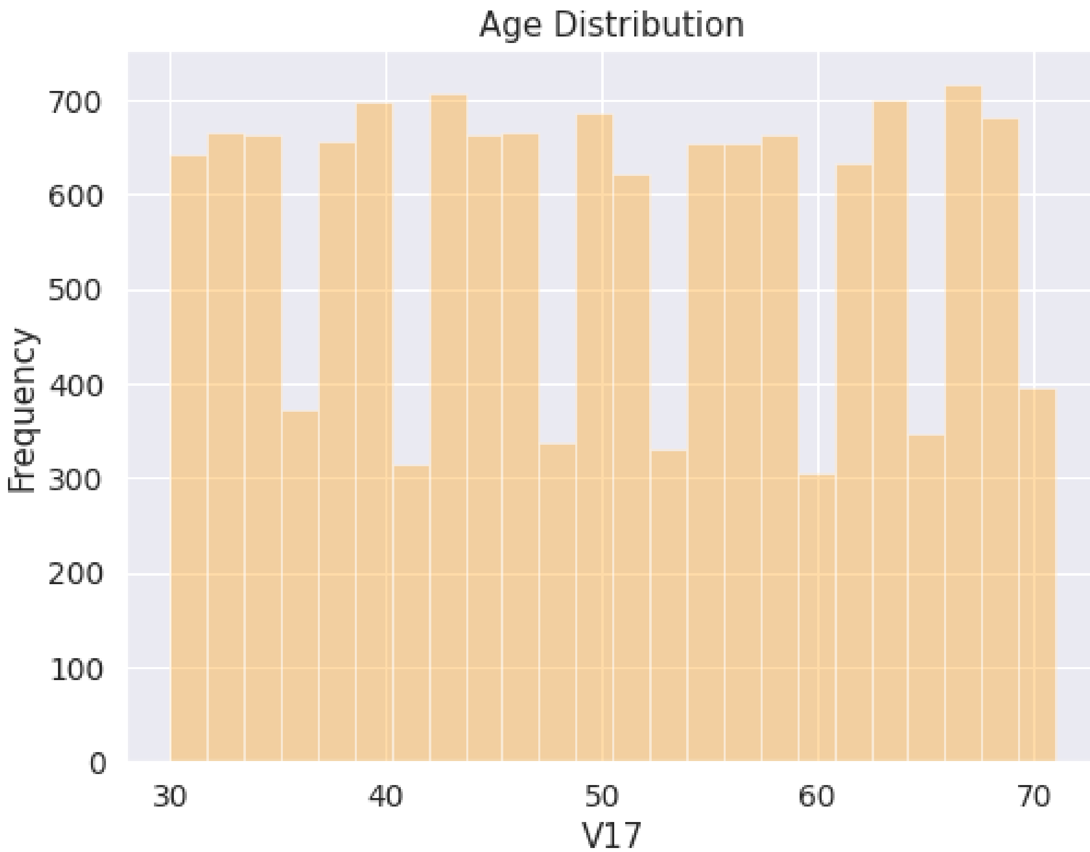
```
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in a
future version. Please adapt your code to use either `displot` (a figure-level
function with similar flexibility) or `histplot` (an axes-level function for
histograms).
  warnings.warn(msg, FutureWarning)
```

[359]:
```
Text(0, 0.5, 'Frequency')
```



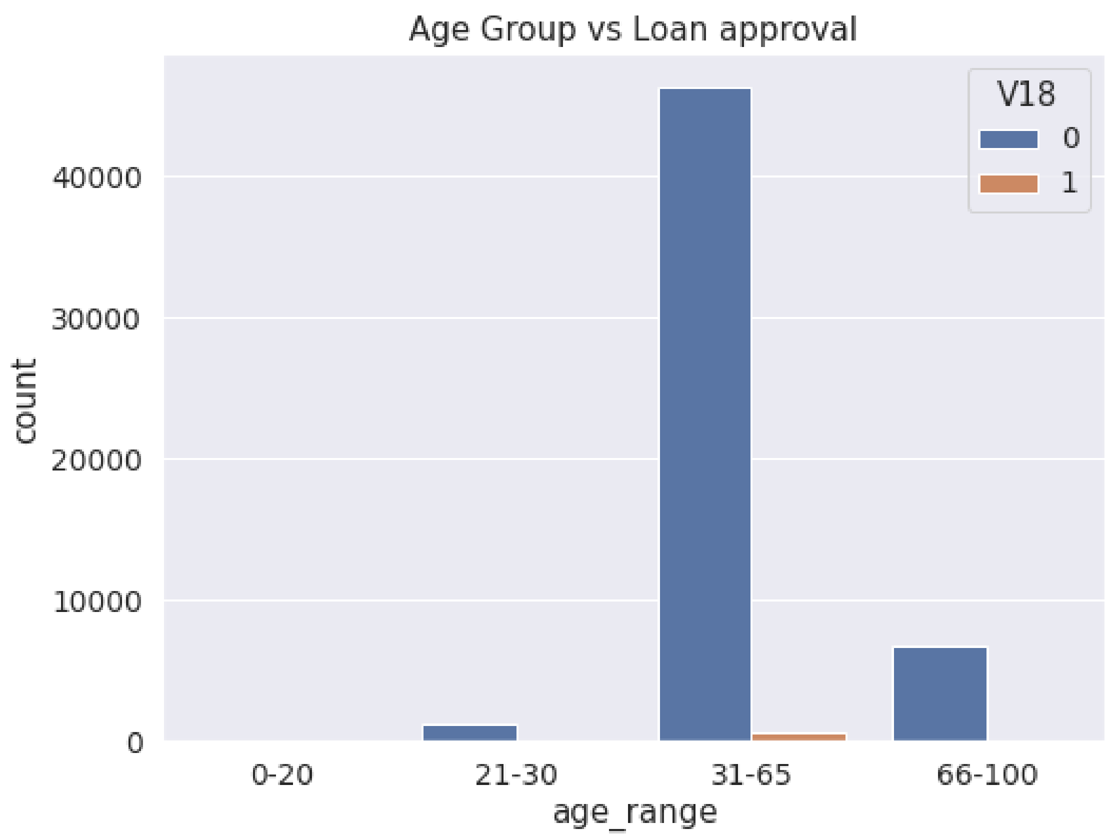
[360]:
```
fig,ax = plt.subplots(figsize=(8, 6))
sns.distplot(test_df['V17'].dropna(),ax=ax, kde=False, color='#ffa726')
plt.title('Age Distribution')
plt.ylabel("Frequency")
```

[360]:
```
Text(0, 0.5, 'Frequency')
```



[361]:
```
fig,ax = plt.subplots(figsize=(8, 6))
sns.countplot(data = train_df, x = 'age_range', hue='V18')
plt.title('Age Group vs Loan approval')
```

[361]: Text(0.5, 1.0, 'Age Group vs Loan approval')



[362]:
```
orig_loan_dataset = train_df.copy()

def understand_variables(dataset):
    print("Type = " +str(type(dataset))+"\n")
    print("Shape = "+str(dataset.shape)+"\n")
    print("Head : \n\n"+str(dataset.head())+"\n\n")
    print(str(dataset.info())+"\n\n")
    print("No.of unique values :\n\n"+str(dataset.nunique(axis=0))+"\n\n")
    print("Description :\n\n"+str(dataset.describe())+"\n\n")

    #print(dataset.describe(exclude=[np.number]))
    #Since no categorical variables, no need to have the above line

    print("Null count :\n\n"+str(dataset.isnull().sum()))

understand_variables(train_df)
```

```
Type = <class 'pandas.core.frame.DataFrame'>

Shape = (55058, 19)
```

Head :

```
   V1     V2  V3  V4  V5       V6    V7  V8  V9   V10  V11  V12     V13  V14  \
0   1  10003   1   3   4   4200.0  B004   1   1  S133    3  0.0   69000    5
1   1  10005   1   1   4  12000.0  B009   0   1  S133    3  0.0  180000    5
2   1  10001   1   3   4   4000.0  B002   1   1  S133    3  0.0   61000    4
3   1  10097   3   3   4   3000.0  B003   0   1  S133    2  0.0   60000    5
4   0  10001   1   1   4   4000.0  B002   1   0  S133    2  0.0   40000    4

     V15   V16  V17  V18 age_range
0  14.85  1636   57    0     31-65
1  14.85  4268   44    0     31-65
2  14.85  1693   57    0     31-65
3  13.99  1396   31    0     31-65
4  19.18  1103   52    0     31-65
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 55058 entries, 0 to 55057
Data columns (total 19 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   V1         55058 non-null  int64
 1   V2         55058 non-null  int64
 2   V3         55058 non-null  int64
 3   V4         55058 non-null  int64
 4   V5         55058 non-null  int64
 5   V6         55058 non-null  float64
 6   V7         55058 non-null  object
 7   V8         55058 non-null  int64
 8   V9         55058 non-null  int64
 9   V10        55058 non-null  object
 10  V11        55058 non-null  int64
 11  V12        55058 non-null  float64
 12  V13        55058 non-null  int64
 13  V14        55058 non-null  int64
 14  V15        55058 non-null  float64
 15  V16        55058 non-null  int64
 16  V17        55058 non-null  int64
 17  V18        55058 non-null  int64
 18  age_range  55058 non-null  category
dtypes: category(1), float64(3), int64(13), object(2)
memory usage: 7.6+ MB
None
```

No.of unique values :

```
V1              2
V2            658
V3              3
V4              3
V5              4
V6           4229
V7             58
V8              2
V9              2
V10            29
V11             7
V12          2737
V13           191
V14             6
V15            72
V16          2033
V17            42
V18             2
age_range       3
dtype: int64


Description :

                V1           V2           V3           V4           V5  \
count  55058.000000  55058.000000  55058.000000  55058.000000  55058.000000
mean       0.573286  10027.907806      1.439954      1.669512      3.737023
std        0.494604     73.491892      0.762256      0.794189      0.784929
min        0.000000  10001.000000      1.000000      1.000000      1.000000
25%        0.000000  10002.000000      1.000000      1.000000      4.000000
50%        1.000000  10005.000000      1.000000      1.000000      4.000000
75%        1.000000  10014.000000      2.000000      2.000000      4.000000
max        1.000000  10722.000000      3.000000      3.000000      4.000000

                V6           V8           V9          V11           V12  \
count  5.505800e+04  55058.000000  55058.000000  55058.000000   55058.000000
mean   5.816138e+03      0.702822      0.649152      4.125940     362.943487
std    1.916309e+05      0.457020      0.477240      2.300028    2531.983287
min    0.000000e+00      0.000000      0.000000      1.000000       0.000000
25%    1.650000e+03      0.000000      0.000000      2.000000       0.000000
50%    2.500000e+03      1.000000      1.000000      3.000000       0.000000
75%    4.000000e+03      1.000000      1.000000      7.000000     350.000000
max    3.838384e+07      1.000000      1.000000      7.000000  545436.500000

                V13           V14           V15           V16           V17  \
count  55058.000000  55058.000000  55058.000000  55058.000000  55058.000000
mean   39679.828544      3.937974     19.180887   1103.277562     50.061263
std    23845.980055      0.906746      3.284822    426.066515     11.817311
```

```
min      5000.000000     1.000000    11.990000    118.000000     30.000000
25%     30000.000000     4.000000    19.180000   1103.000000     40.000000
50%     40000.000000     4.000000    19.180000   1103.000000     50.000000
75%     40000.000000     4.000000    19.180000   1103.000000     60.000000
max    300000.000000     6.000000    37.000000  13556.000000     71.000000

                V18
count  55058.000000
mean       0.014675
std        0.120251
min        0.000000
25%        0.000000
50%        0.000000
75%        0.000000
max        1.000000


Null count :

V1           0
V2           0
V3           0
V4           0
V5           0
V6           0
V7           0
V8           0
V9           0
V10          0
V11          0
V12          0
V13          0
V14          0
V15          0
V16          0
V17          0
V18          0
age_range    0
dtype: int64
```

2 Encoding Data

[363]:
```
labelDict = {}
for feature in train_df:
    le = preprocessing.LabelEncoder()
    le.fit(train_df[feature])
```

```
    le_name_mapping = dict(zip(le.classes_, le.transform(le.classes_)))
    train_df[feature] = le.transform(train_df[feature])
    # Get labels
    labelKey = 'label_' + feature
    labelValue = [*le_name_mapping]
    labelDict[labelKey] =labelValue

for key, value in labelDict.items():
    print(key, value)
```

```
label_V1 [0, 1]
label_V2 [10001, 10002, 10003, 10004, 10005, 10006, 10007, 10008, 10009, 10010,
10011, 10012, 10013, 10014, 10015, 10016, 10017, 10018, 10019, 10020, 10021,
10022, 10023, 10024, 10025, 10026, 10027, 10028, 10029, 10030, 10031, 10032,
10033, 10034, 10035, 10036, 10037, 10038, 10039, 10040, 10041, 10042, 10043,
10044, 10045, 10046, 10047, 10048, 10049, 10050, 10051, 10052, 10053, 10054,
10055, 10056, 10057, 10058, 10059, 10060, 10061, 10062, 10063, 10064, 10065,
10066, 10067, 10068, 10069, 10070, 10071, 10072, 10073, 10074, 10075, 10076,
10077, 10078, 10079, 10080, 10081, 10082, 10083, 10084, 10085, 10086, 10087,
10088, 10089, 10090, 10091, 10092, 10093, 10094, 10095, 10096, 10097, 10098,
10099, 10100, 10101, 10102, 10103, 10104, 10105, 10106, 10107, 10108, 10109,
10110, 10111, 10112, 10113, 10114, 10115, 10116, 10117, 10118, 10119, 10120,
10121, 10122, 10123, 10124, 10125, 10126, 10127, 10128, 10129, 10130, 10131,
10132, 10133, 10134, 10135, 10136, 10137, 10138, 10139, 10140, 10141, 10142,
10143, 10144, 10145, 10146, 10147, 10148, 10149, 10150, 10151, 10152, 10153,
10154, 10155, 10156, 10157, 10158, 10159, 10160, 10161, 10162, 10163, 10164,
10165, 10166, 10167, 10168, 10169, 10170, 10171, 10172, 10173, 10174, 10175,
10176, 10177, 10178, 10179, 10180, 10181, 10182, 10183, 10184, 10185, 10186,
10187, 10188, 10189, 10190, 10191, 10192, 10193, 10194, 10195, 10196, 10197,
10198, 10199, 10200, 10201, 10202, 10203, 10204, 10205, 10206, 10207, 10208,
10209, 10210, 10211, 10212, 10213, 10214, 10215, 10216, 10217, 10218, 10219,
10220, 10221, 10222, 10223, 10224, 10225, 10226, 10227, 10228, 10229, 10230,
10231, 10232, 10233, 10234, 10235, 10236, 10237, 10238, 10239, 10240, 10241,
10242, 10243, 10244, 10245, 10246, 10247, 10248, 10249, 10250, 10251, 10252,
10253, 10254, 10255, 10256, 10257, 10258, 10259, 10260, 10261, 10262, 10263,
10264, 10265, 10266, 10267, 10268, 10269, 10270, 10271, 10272, 10273, 10274,
10275, 10276, 10277, 10278, 10279, 10280, 10281, 10282, 10283, 10284, 10285,
10286, 10287, 10288, 10289, 10290, 10291, 10292, 10293, 10294, 10295, 10296,
10297, 10298, 10299, 10300, 10301, 10302, 10303, 10304, 10305, 10306, 10307,
10308, 10309, 10310, 10311, 10312, 10313, 10314, 10315, 10316, 10317, 10318,
10319, 10320, 10321, 10322, 10323, 10324, 10325, 10326, 10327, 10328, 10329,
10330, 10331, 10332, 10333, 10334, 10335, 10336, 10337, 10338, 10339, 10340,
10341, 10342, 10343, 10344, 10345, 10346, 10347, 10348, 10349, 10350, 10351,
10352, 10353, 10354, 10355, 10356, 10357, 10358, 10359, 10360, 10361, 10362,
10363, 10364, 10365, 10366, 10367, 10368, 10369, 10370, 10371, 10372, 10373,
10374, 10375, 10376, 10377, 10378, 10379, 10380, 10381, 10382, 10383, 10384,
10385, 10386, 10387, 10388, 10389, 10390, 10391, 10392, 10393, 10394, 10395,
```

10396, 10397, 10398, 10399, 10400, 10401, 10402, 10403, 10404, 10405, 10406, 10407, 10408, 10409, 10410, 10411, 10412, 10413, 10414, 10415, 10416, 10417, 10418, 10419, 10420, 10421, 10422, 10423, 10424, 10425, 10426, 10427, 10428, 10429, 10430, 10431, 10432, 10433, 10434, 10435, 10436, 10437, 10438, 10439, 10440, 10441, 10442, 10443, 10444, 10445, 10446, 10447, 10448, 10449, 10450, 10451, 10452, 10453, 10454, 10455, 10456, 10457, 10458, 10459, 10460, 10461, 10462, 10463, 10464, 10465, 10466, 10467, 10468, 10469, 10470, 10471, 10472, 10473, 10474, 10475, 10476, 10477, 10478, 10479, 10480, 10481, 10482, 10483, 10484, 10485, 10486, 10487, 10488, 10489, 10490, 10491, 10492, 10493, 10494, 10495, 10496, 10497, 10498, 10499, 10500, 10501, 10502, 10503, 10504, 10505, 10506, 10507, 10508, 10509, 10510, 10511, 10512, 10513, 10514, 10515, 10516, 10517, 10518, 10519, 10520, 10521, 10522, 10523, 10524, 10525, 10526, 10527, 10528, 10530, 10531, 10532, 10533, 10534, 10535, 10536, 10537, 10539, 10540, 10541, 10542, 10544, 10545, 10546, 10547, 10548, 10550, 10551, 10552, 10553, 10554, 10555, 10557, 10558, 10559, 10560, 10561, 10562, 10563, 10564, 10565, 10566, 10569, 10570, 10571, 10572, 10573, 10574, 10575, 10576, 10577, 10578, 10579, 10580, 10581, 10582, 10583, 10585, 10588, 10589, 10591, 10592, 10593, 10594, 10597, 10598, 10599, 10600, 10601, 10602, 10603, 10605, 10606, 10607, 10608, 10609, 10610, 10611, 10613, 10615, 10617, 10618, 10619, 10621, 10622, 10624, 10626, 10627, 10628, 10629, 10631, 10633, 10635, 10637, 10638, 10640, 10641, 10642, 10643, 10644, 10645, 10646, 10647, 10648, 10651, 10653, 10654, 10655, 10658, 10659, 10660, 10661, 10662, 10663, 10665, 10668, 10672, 10673, 10676, 10677, 10680, 10682, 10684, 10685, 10686, 10689, 10690, 10692, 10693, 10695, 10699, 10702, 10708, 10712, 10713, 10714, 10715, 10717, 10722]
label_V3 [1, 2, 3]
label_V4 [1, 2, 3]
label_V5 [1, 2, 3, 4]
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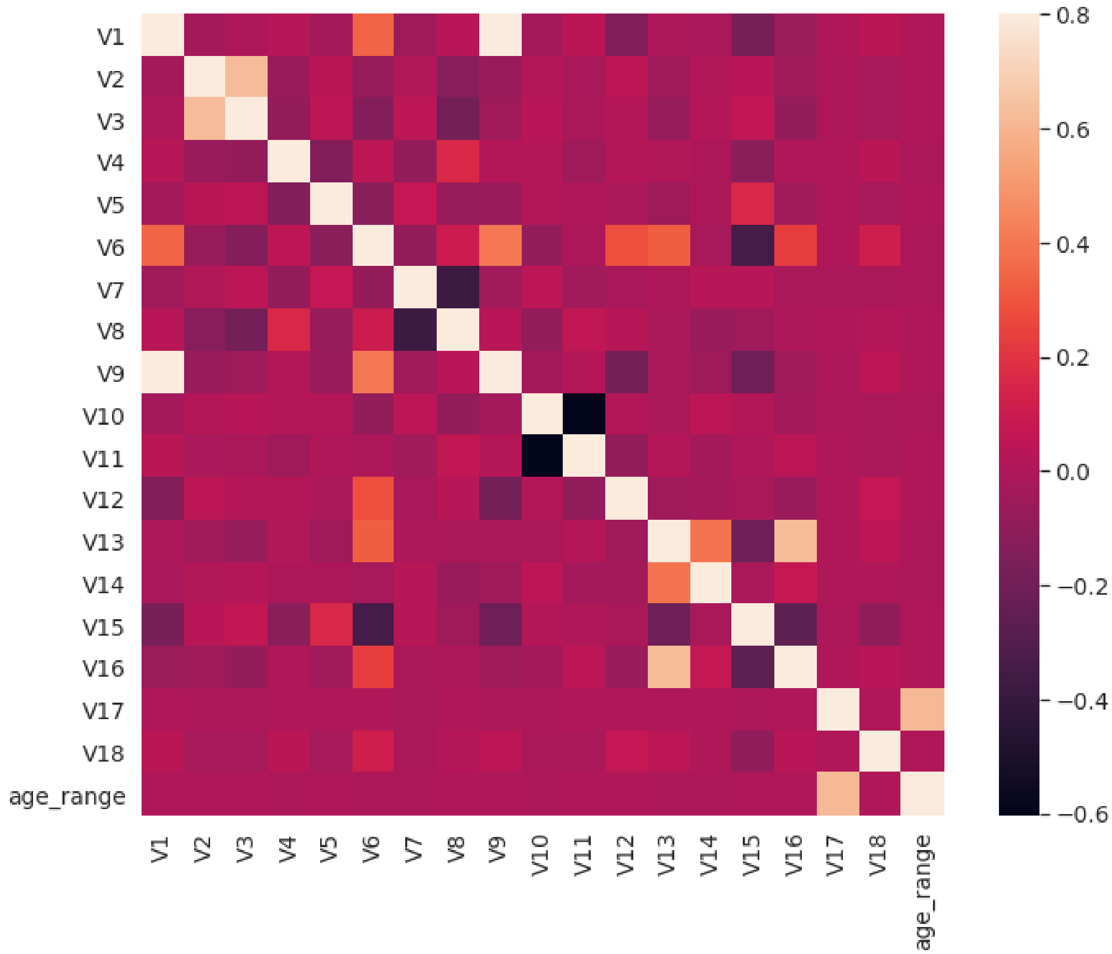
2703, 2705, 2706, 2707, 2708, 2712, 2715, 2718, 2720, 2722, 2724, 2725, 2729,
2730, 2732, 2733, 2734, 2738, 2743, 2745, 2746, 2748, 2753, 2761, 2763, 2769,
2772, 2773, 2774, 2775, 2777, 2779, 2782, 2783, 2788, 2790, 2792, 2796, 2798,
2799, 2808, 2811, 2813, 2818, 2822, 2823, 2827, 2829, 2831, 2833, 2834, 2836,
2841, 2842, 2844, 2845, 2846, 2847, 2857, 2860, 2862, 2863, 2864, 2869, 2871,
2877, 2884, 2886, 2899, 2911, 2916, 2918, 2929, 2931, 2932, 2934, 2938, 2942,
2950, 2951, 2952, 2964, 2973, 2975, 2977, 2982, 2983, 2990, 2992, 2993, 2996,
2998, 2999, 3004, 3014, 3019, 3020, 3025, 3030, 3031, 3032, 3046, 3047, 3051,
3057, 3081, 3087, 3099, 3106, 3116, 3120, 3129, 3133, 3142, 3144, 3148, 3151,
3159, 3167, 3170, 3179, 3197, 3200, 3201, 3219, 3221, 3230, 3231, 3234, 3239,
3247, 3249, 3264, 3279, 3285, 3294, 3296, 3306, 3309, 3316, 3321, 3325, 3328,
3331, 3332, 3336, 3338, 3349, 3355, 3361, 3369, 3373, 3380, 3388, 3394, 3396,
3401, 3406, 3412, 3413, 3417, 3427, 3432, 3435, 3443, 3444, 3451, 3459, 3467,
3471, 3477, 3479, 3481, 3488, 3489, 3494, 3497, 3504, 3505, 3516, 3517, 3518,
3525, 3553, 3557, 3568, 3588, 3590, 3591, 3608, 3620, 3648, 3655, 3682, 3683,
3688, 3704, 3705, 3719, 3726, 3728, 3733, 3740, 3743, 3747, 3748, 3768, 3770,
3787, 3800, 3809, 3819, 3845, 3850, 3877, 3881, 3886, 3899, 3903, 3936, 3949,
3958, 3974, 3997, 4004, 4023, 4028, 4043, 4058, 4061, 4067, 4072, 4078, 4081,
4082, 4098, 4100, 4101, 4108, 4116, 4118, 4138, 4151, 4160, 4163, 4173, 4175,
4194, 4213, 4219, 4232, 4251, 4263, 4268, 4290, 4306, 4315, 4328, 4367, 4406,
4411, 4452, 4477, 4489, 4497, 4509, 4515, 4519, 4537, 4552, 4572, 4582, 4605,
4653, 4668, 4670, 4680, 4719, 4733, 4739, 4778, 4784, 4864, 4896, 4918, 4944,
4980, 4996, 5000, 5053, 5064, 5090, 5115, 5189, 5200, 5218, 5246, 5274, 5280,
5341, 5430, 5464, 5526, 5560, 5583, 5589, 5592, 5617, 5704, 5875, 5980, 5988,
6094, 6267, 6410, 6623, 6670, 6714, 6729, 6932, 7931, 9721, 13556]
label_V17 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46,
47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66,
67, 68, 69, 70, 71]
label_V18 [0, 1]
label_age_range ['21-30', '31-65', '66-100']
```

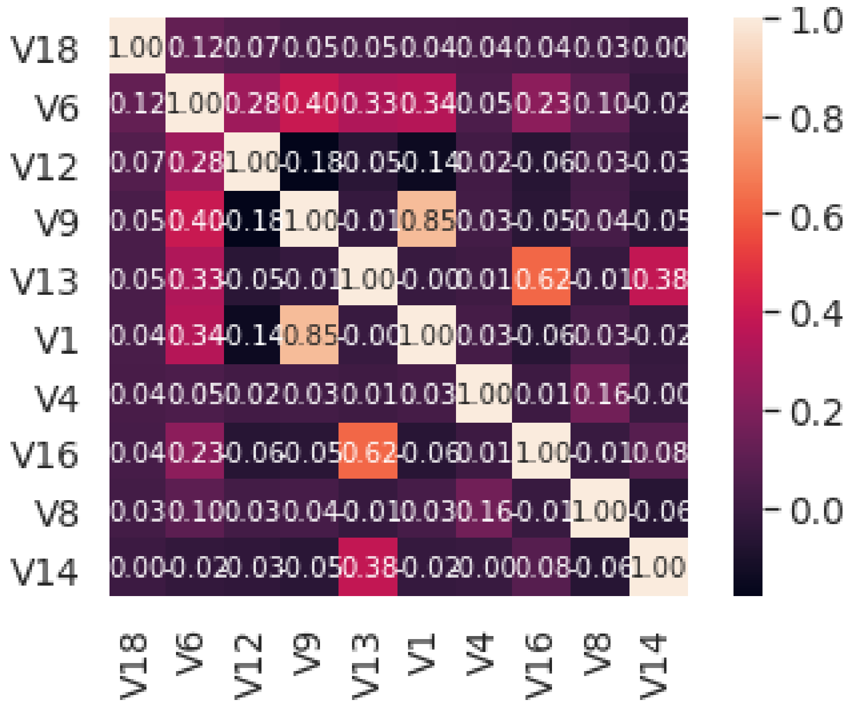
[364]:

```python
corrmat = train_df.corr()
f, ax = plt.subplots(figsize=(12, 9))
sns.heatmap(corrmat, vmax=.8, square=True);
plt.show()
#TREATMENT HEATMAT
k = 10 #number of variables for heatmap
cols = corrmat.nlargest(k, 'V18')['V18'].index
cm = np.corrcoef(train_df[cols].values.T)
sns.set(font_scale=1.25)
hm = sns.heatmap(cm, cbar=True, annot=True, square=True, fmt='.2f',␣
↪annot_kws={'size': 10}, yticklabels=cols.values, xticklabels=cols.values)
```

```
plt.show()
```



V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
V16
V17
V18
age_range
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6



3 Scaling

[365]:
```
scaler = MinMaxScaler()
train_df['V17'] = scaler.fit_transform(train_df[['V17']])
train_df.head()
```

[365]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	\
0	1	2	0	2	3	3383	3	1	1	6	2	0	64	4	16	1185	
1	1	4	0	0	3	3955	8	0	1	6	2	0	161	4	16	1963	
2	1	0	0	2	3	3315	1	1	1	6	2	0	56	3	16	1219	
3	1	96	2	2	3	2829	2	0	1	6	1	0	55	4	7	1009	
4	0	0	0	0	3	3315	1	1	0	6	1	0	35	3	47	757	

	V17	V18	age_range
0	0.658537	0	1
1	0.341463	0	1
2	0.658537	0	1
3	0.024390	0	1
4	0.536585	0	1

4 Train Test Split

[366]:
```
feature_cols =␣
↪['V1','V2','V3','V4','V5','V6','V7','V8','V9','V10','V11','V12','V13','V14','V15','V16','V1
↪]
X = train_df[feature_cols]
y = train_df.V18
# split X and y into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.
↪30,random_state=0)
```

5 Creating a XGB model for Feature Importance

[367]:
```
import xgboost as xgb

clf_xgBoost = xgb.XGBClassifier(
    max_depth = 4,
    subsample = 0.8,
    colsample_bytree = 0.7,
    colsample_bylevel = 0.7,
    scale_pos_weight = 9,
    min_child_weight = 0,
    reg_alpha = 4,
    n_jobs = 4,
    objective = 'binary:logistic'
)
# Fit the models
clf_xgBoost.fit(X, y)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The
use of label encoder in XGBClassifier is deprecated and will be removed in a
future release. To remove this warning, do the following: 1) Pass option
use_label_encoder=False when constructing XGBClassifier object; and 2) Encode
your labels (y) as integers starting with 0, i.e. 0, 1, 2, …, [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)
```

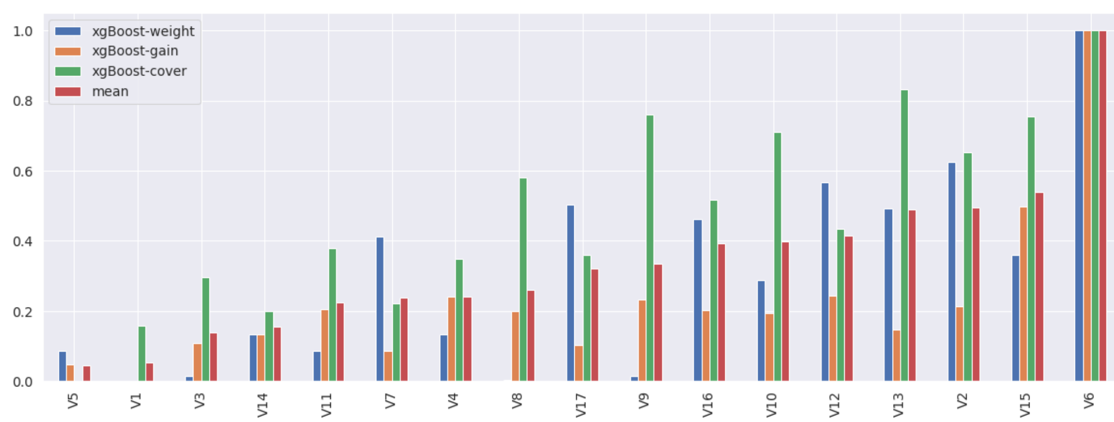
```
[18:27:57] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the
default evaluation metric used with the objective 'binary:logistic' was changed
from 'error' to 'logloss'. Explicitly set eval_metric if you'd like to restore
the old behavior.
```

[367]:
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=0.7,
              colsample_bynode=1, colsample_bytree=0.7, gamma=0, gpu_id=-1,
              importance_type='gain', interaction_constraints='',
              learning_rate=0.300000012, max_delta_step=0, max_depth=4,
```

```
                  min_child_weight=0, missing=nan, monotone_constraints='()',
                  n_estimators=100, n_jobs=4, num_parallel_tree=1, random_state=0,
                  reg_alpha=4, reg_lambda=1, scale_pos_weight=9, subsample=0.8,
                  tree_method='exact', validate_parameters=1, verbosity=None)
```

[368]:
```python
from sklearn import preprocessing

# Get xgBoost importances
importance_dict = {}
for import_type in ['weight', 'gain', 'cover']:
    importance_dict['xgBoost-'+import_type] = clf_xgBoost.get_booster().
 ↪get_score(importance_type=import_type)

# MinMax scale all importances
importance_df = pd.DataFrame(importance_dict).fillna(0)
importance_df = pd.DataFrame(
    preprocessing.MinMaxScaler().fit_transform(importance_df),
    columns=importance_df.columns,
    index=importance_df.index
)

# Create mean column
importance_df['mean'] = importance_df.mean(axis=1)

# Plot the feature importances
importance_df.sort_values('mean').plot(kind='bar', figsize=(20, 7))
```

[368]: <AxesSubplot:>



6 Logistic Regression on Imbalanced Dataset

[369]:
```
lr = LogisticRegression(solver='liblinear').fit(X_train, y_train)

# Predict on training set
lr_pred = lr.predict(X_test)
```

[370]:
```
accuracy_score(y_test, lr_pred)
```

[370]:
```
0.9863179561690277
```

[371]:
```
predictions = pd.DataFrame(lr_pred)
predictions[0].value_counts()
```

[371]:
```
0    16518
Name: 0, dtype: int64
```

[372]:
```
from sklearn.metrics import *
```

[373]:
```
f1_score(y_test, lr_pred)
```

[373]:
```
0.0
```

7 Random Forest on Imbalanced Dataset

[374]:
```
rfc = RandomForestClassifier(n_estimators=10).fit(X_train, y_train)

# predict on test set
rfc_pred = rfc.predict(X_test)

accuracy_score(y_test, rfc_pred)
```

[374]:
```
0.9862574161520765
```

[375]:
```
f1_score(y_test, rfc_pred)
```

[375]:
```
0.0
```

[376]:
```
pd.DataFrame(confusion_matrix(y_test, rfc_pred))
```

[376]:

	0	1
0	16291	1
1	226	0

8 Trying out SMOTE (More Here: SMOTE)

[377]:
```
from imblearn.over_sampling import SMOTE

# Separate input features and target
y = train_df.V18
X = train_df.drop('V18', axis=1)

# setting up testing and training sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25,␣
↪random_state=27)

sm = SMOTE(random_state=27)
X_train, y_train = sm.fit_sample(X_train, y_train)
```

8.1 Application of SMOTE technique with Logistic Regression

[378]:
```
smote = LogisticRegression(solver='liblinear').fit(X_train, y_train)

smote_pred = smote.predict(X_test)

# Checking accuracy
accuracy_score(y_test, smote_pred)
```

[378]: 0.7529967308390846

[379]:
```
f1_score(y_test, smote_pred)
```

[379]: 0.07205240174672489

[380]:
```
pd.DataFrame(confusion_matrix(y_test, smote_pred))
```

[380]:

	0	1
0	10233	3322
1	78	132

[381]:
```
recall_score(y_test, smote_pred)
```

[381]: 0.6285714285714286

[382]:
```
from sklearn.utils import resample
```

9 Decision Tree on Imbalanced Dataset

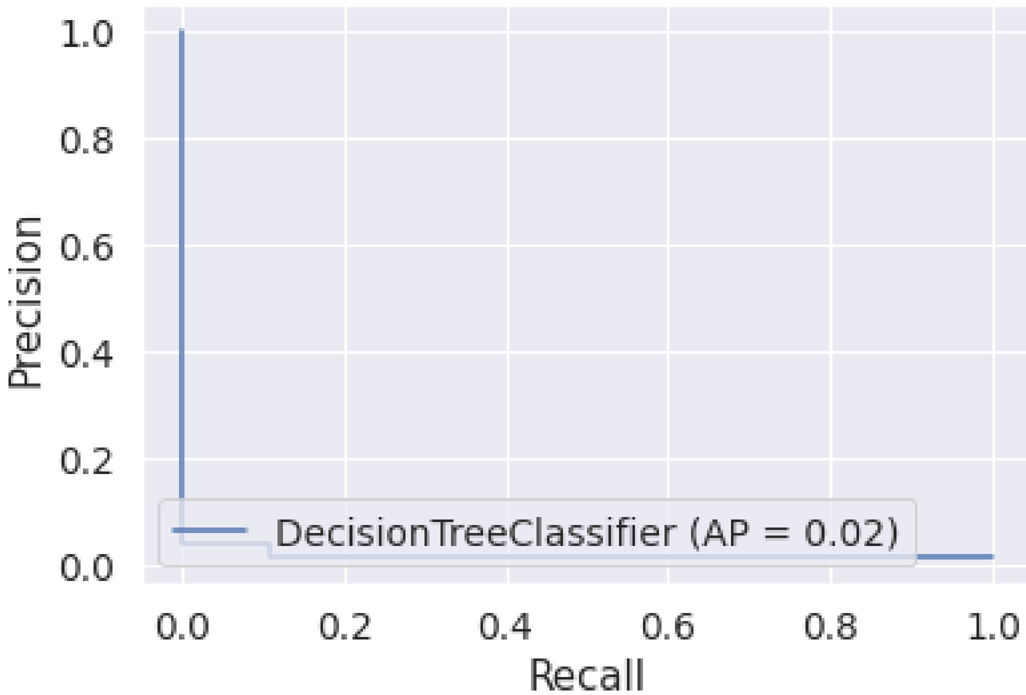
[383]:
```
from sklearn.metrics import␣
↪accuracy_score,f1_score,roc_auc_score,roc_curve,confusion_matrix,log_loss,precision_score,r
dectree=DecisionTreeClassifier().fit(X_train,y_train)
dec_pred=dectree.predict(X_test)
print("Accuracy score of Decision Tree Classifier on Imbalanced Data:
↪",accuracy_score(y_test,dec_pred))
print(classification_report(y_test,dec_pred))
confusion_matrix(y_test,dec_pred)
```

```
Accuracy score of Decision Tree Classifier on Imbalanced Data:
0.9473301852524518
              precision    recall  f1-score   support

           0       0.99      0.96      0.97     13555
           1       0.04      0.11      0.06       210

    accuracy                           0.95     13765
   macro avg       0.51      0.53      0.52     13765
weighted avg       0.97      0.95      0.96     13765
```

[383]:
```
array([[13017,   538],
       [  187,    23]])
```

[384]:
```
plot_precision_recall_curve(dectree,X_test,y_test)
```

[384]:
```
<sklearn.metrics._plot.precision_recall_curve.PrecisionRecallDisplay at
0x7fad75d62450>
```



10 Application of DOWN-SAMPLING technique with Logistic Regression

[385]:
```
data_majority = train_df[train_df.V18==0]
data_minority = train_df[train_df.V18==1]

# Upsample minority class
data_major_downsampled = resample(data_majority,
                                  replace=True,
                                  n_samples=data_minority.shape[0],
                                  random_state=123)

data_downsampled = pd.concat([data_major_downsampled, data_minority])

# Display new class counts
data_downsampled.V18.value_counts()
```

[385]:
```
0    808
1    808
Name: V18, dtype: int64
```

[386]:

```
y_down = data_downsampled.V18
X_down = data_downsampled.drop('V18', axis=1)
X_train_down,X_test_down,y_train_down,y_test_down=train_test_split(X_down,y_down,test_size=0.
↪25,random_state=42)
X_train_down=scaler.fit_transform(X_train_down)
X_test_down=scaler.transform(X_test_down)
logreg_down = LogisticRegression().fit(X_train_down, y_train_down)
log_pred_down = logreg_down.predict(X_test_down)

print("Accuracy score of Logistic Regression on Down-Sampling Data:",␣
↪accuracy_score(y_test_down, log_pred_down) )
print(classification_report(y_test_down,log_pred_down))
confusion_matrix(y_test_down, log_pred_down)
```

```
Accuracy score of Logistic Regression on Down-Sampling Data: 0.7747524752475248
              precision    recall  f1-score   support

           0       0.82      0.72      0.77       207
           1       0.74      0.83      0.78       197

    accuracy                           0.77       404
   macro avg       0.78      0.78      0.77       404
weighted avg       0.78      0.77      0.77       404
```

[386]:

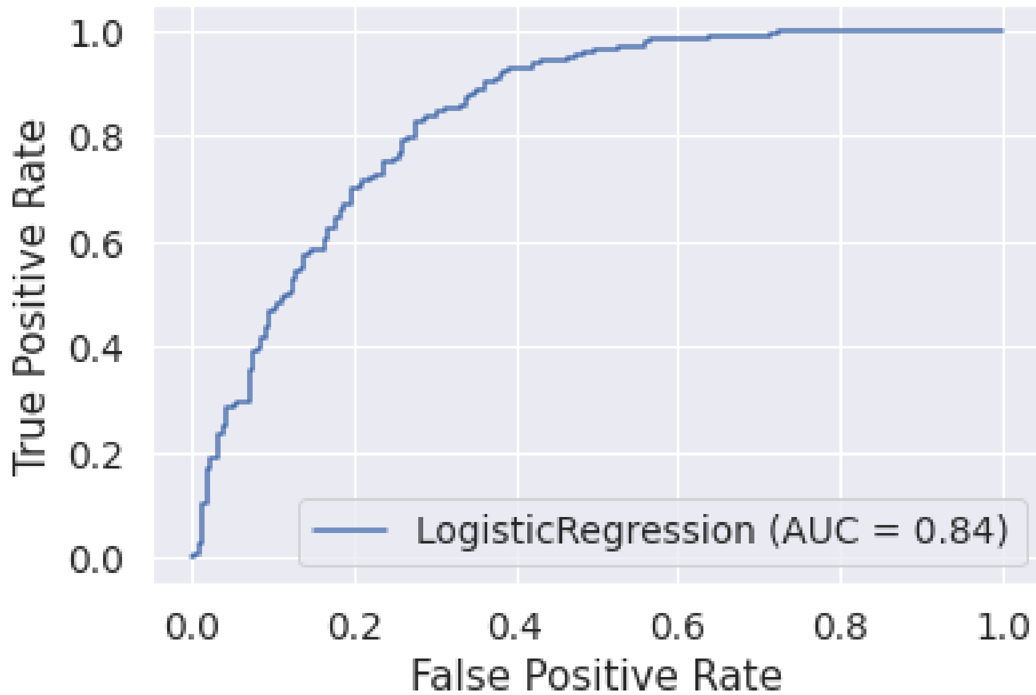
```
array([[150,  57],
       [ 34, 163]])
```

[387]:

```
plot_roc_curve(logreg_down,X_test_down,y_test_down)
```

[387]:

```
<sklearn.metrics._plot.roc_curve.RocCurveDisplay at 0x7fad76193610>
```



[388]:
```
plot_precision_recall_curve(logreg_down,X_test_down,y_test_down)
```

[388]:
```
<sklearn.metrics._plot.precision_recall_curve.PrecisionRecallDisplay at
0x7fad757ebb90>
```

11 Application of DOWN-SAMPLING technique with Decision Tree Classifier

[389]:
```
dectree_down=DecisionTreeClassifier()
dectree_down.fit(X_train_down, y_train_down)
dec_pred_down=dectree_down.predict(X_test_down)
print("Accuracy score of Decision Tree Classifier on DOWN-SAMPLING Data:
 ↪",accuracy_score(y_test_down,dec_pred_down))
print(classification_report(y_test_down,dec_pred_down))
print("roc auc score of Decision Tree Classifier:
 ↪",roc_auc_score(y_test_down,dec_pred_down))
confusion_matrix(y_test_down,dec_pred_down)
```

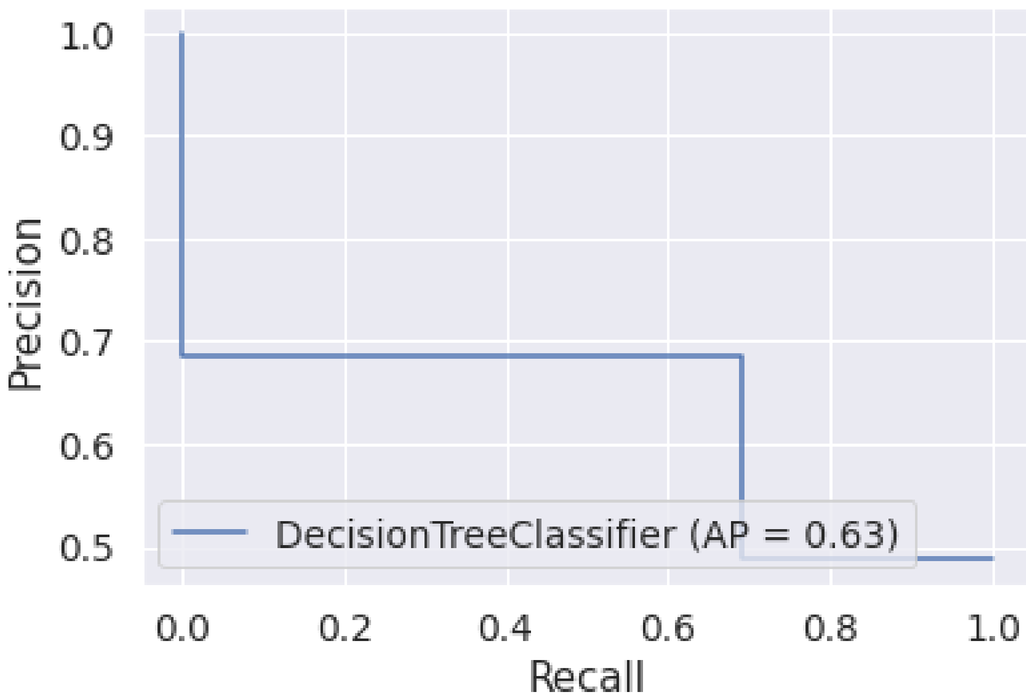
```
Accuracy score of Decision Tree Classifier on DOWN-SAMPLING Data:
0.6955445544554455
              precision    recall  f1-score   support

           0       0.70      0.70      0.70       207
           1       0.69      0.69      0.69       197

    accuracy                           0.70       404
   macro avg       0.70      0.70      0.70       404
```

```
weighted avg       0.70      0.70      0.70       404

roc auc score of Decision Tree Classifier: 0.695419210868339
```

[389]:
```
array([[145,  62],
       [ 61, 136]])
```

[390]:
```
plot_precision_recall_curve(dectree_down, X_test_down,y_test_down)
```

[390]:
```
<sklearn.metrics._plot.precision_recall_curve.PrecisionRecallDisplay at
0x7fad757ebdd0>
```



12 Application of SMOTE technique with Logistic Regression

[391]:
```
from imblearn.over_sampling import SMOTE
oversample = SMOTE(sampling_strategy='auto', k_neighbors=6, random_state=42)
X_smt, y_smt = oversample.fit_resample(X, y)

X_train_smt,X_test_smt,y_train_smt,y_test_smt=train_test_split(X_smt,y_smt,test_size=0.
 ↪3,random_state=42)
X_train_smt=scaler.fit_transform(X_train_smt)
X_test_smt=scaler.transform(X_test_smt)
```

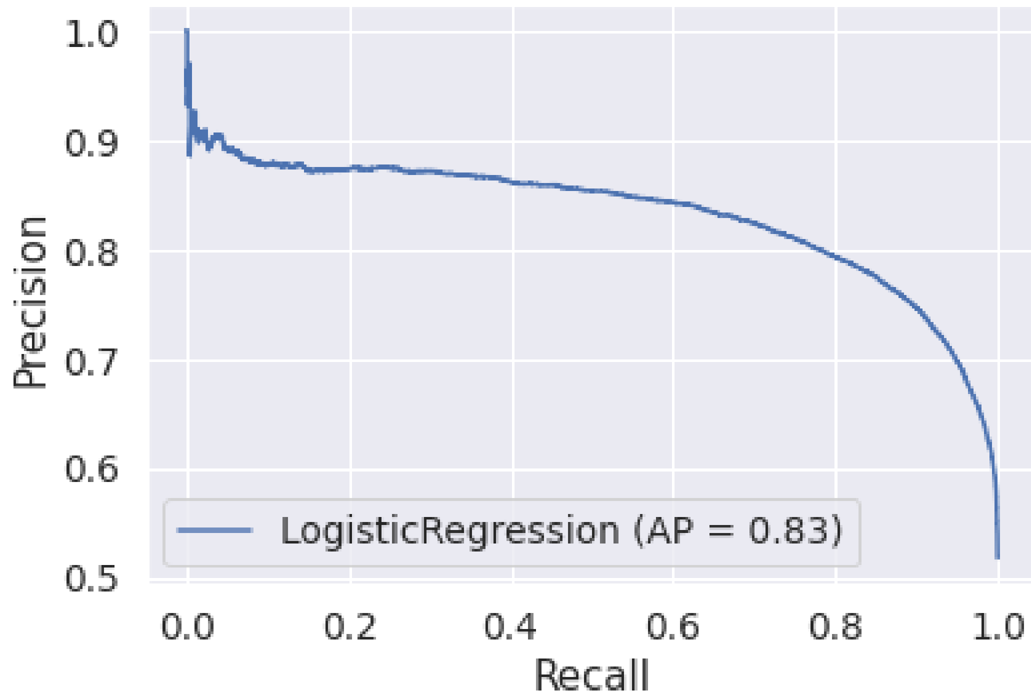
```python
logreg_smote=LogisticRegression()
logreg_smote.fit(X_train_smt,y_train_smt)
logreg_smt_pred=logreg_smote.predict(X_test_smt)
print("Accuracy score of Logistic Regression on SMOTE technique:
 ↪",accuracy_score(y_test_smt,logreg_smt_pred))
print(classification_report(y_test_smt,logreg_smt_pred))
confusion_matrix(y_test_smt,logreg_smt_pred)
```

```
Accuracy score of Logistic Regression on SMOTE technique: 0.8029185867895545
              precision    recall  f1-score   support

           0       0.84      0.76      0.79     16396
           1       0.77      0.85      0.81     16154

    accuracy                           0.80     32550
   macro avg       0.81      0.80      0.80     32550
weighted avg       0.81      0.80      0.80     32550
```

[391]:
```
array([[12402,  3994],
       [ 2421, 13733]])
```

[392]:
```python
plot_precision_recall_curve(logreg_smote, X_test_smt,y_test_smt)
```

[392]:
```
<sklearn.metrics._plot.precision_recall_curve.PrecisionRecallDisplay at
0x7fad758ac9d0>
```



13 Application of SMOTE technique with Logistic Regression

[397]:
```
dectree_smote=DecisionTreeClassifier()
dectree_smote.fit(X_train_smt, y_train_smt)
dec_pred_sm=dectree_smote.predict(X_test_smt)
print("Accuracy score of Decision Tree Classifier on SMOTE technique:
 ↪",accuracy_score(y_test_smt,dec_pred_sm))
print(classification_report(y_test_smt,dec_pred_sm))
print("roc auc score of Decision Tree Classifier:
 ↪",roc_auc_score(y_test_smt,dec_pred_sm))
confusion_matrix(y_test_smt,dec_pred_sm)
```

```
Accuracy score of Decision Tree Classifier on SMOTE technique:
0.9627649769585254
              precision    recall  f1-score   support

           0       0.98      0.95      0.96     16396
           1       0.95      0.98      0.96     16154

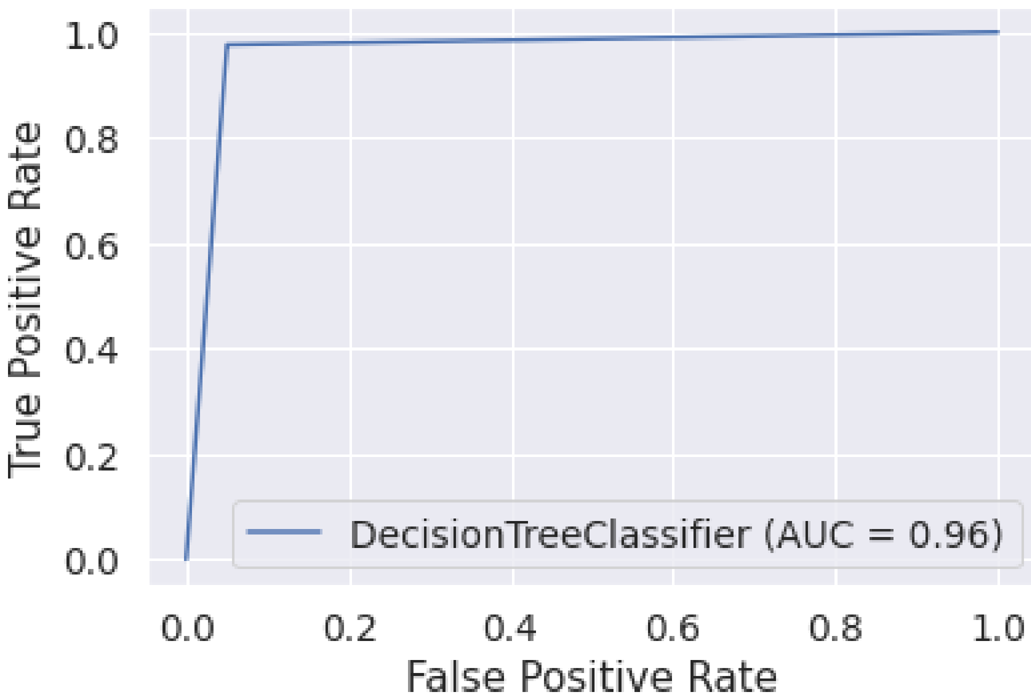
    accuracy                           0.96     32550
   macro avg       0.96      0.96      0.96     32550
weighted avg       0.96      0.96      0.96     32550
```

```
roc auc score of Decision Tree Classifier: 0.962863424233144
```

[397]:
```
array([[15570,   826],
       [  386, 15768]])
```

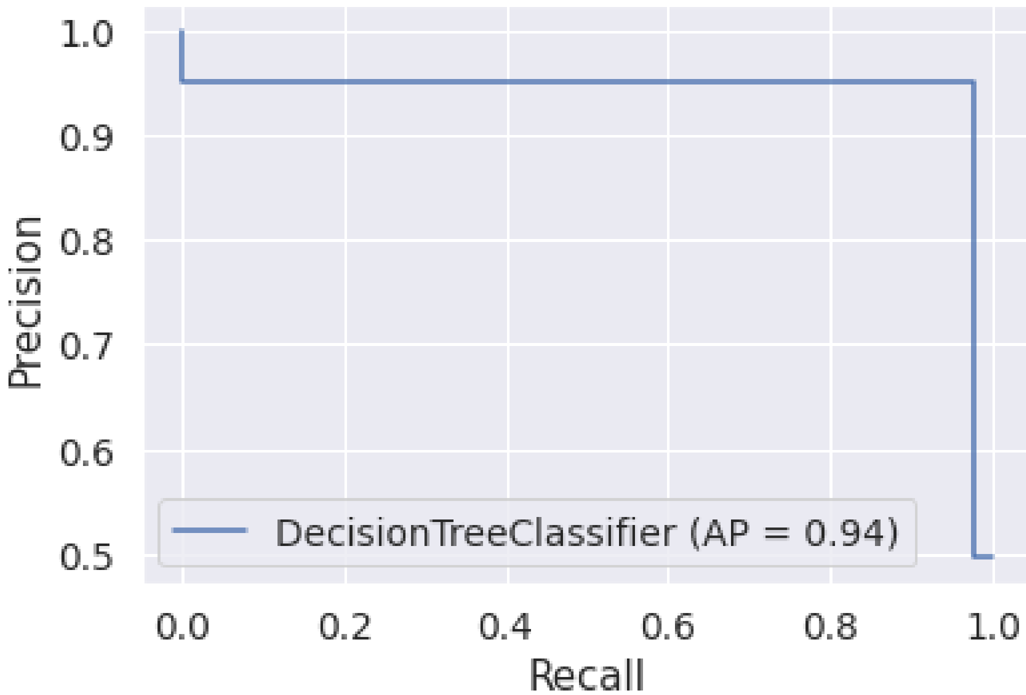
[398]:
```
plot_roc_curve(dectree_smote,X_test_smt,y_test_smt)
```

[398]:
```
<sklearn.metrics._plot.roc_curve.RocCurveDisplay at 0x7fad76054490>
```



[399]:
```
plot_precision_recall_curve(dectree_smote, X_test_smt,y_test_smt)
```

[399]:
```
<sklearn.metrics._plot.precision_recall_curve.PrecisionRecallDisplay at
0x7fad764a9bd0>
```



14 Dumping the model and predicting the test set.

[400]:
```
import pickle
pickle_out = open("dectree_smote.pkl","wb")
pickle.dump(dectree_smote,pickle_out)
pickle_out.close()
```

[401]:
```
test_df['V18'] = test_df['V18'].fillna(0)
```

[402]:
```
test_df.head()
```

[402]:
```
   V1     V2  V3  V4  V5      V6    V7  V8  V9   V10  V11  V12    V13  4  \
0   1  10024   1   1   4  2500.0  B014   1   1  S133    6  0.0  36000  4
1   0  10004   1   1   4   800.0  B022   0   0  S133    6  0.0  39000  4
2   1  10001   1   1   4  2050.0  B043   1   1  S133    3  0.0  24000  4
3   0  10005   1   1   3  1600.0  B001   1   1  S133    6  0.0  37000  4
4   1  10001   1   2   4  1800.0  B001   1   1  S143    6  0.0  40000  4

     V15   V16  V17  V18
0  19.00   934   32  0.0
1  19.20  1090   33  0.0
2  16.75   853   43  0.0
```

```
3  18.50   950   46  0.0
4  19.20  1090   38  0.0
```

[419]:
```
scaler = MinMaxScaler()
test_df['V17'] = scaler.fit_transform(test_df[['V17']])
```

[420]:
```
labelDict1 = {}
for feature1 in test_df:
    le1 = preprocessing.LabelEncoder()
    le1.fit(test_df[feature1])
    le_name_mapping1 = dict(zip(le1.classes_, le1.transform(le1.classes_)))
    test_df[feature1] = le1.transform(test_df[feature1])
    # Get labels
    labelKey1 = 'label_' + feature1
    labelValue1 = [*le_name_mapping1]
    labelDict1[labelKey1] =labelValue1

for key1, value1 in labelDict1.items():
    print(key1, value1)
```

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[421]:
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prediction = dectree_smote.predict(test_df)
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[422]:
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prediction
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[422]:
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array([0, 1, 0, …, 0, 0, 0])
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[423]:
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df = pd.DataFrame (prediction)

## save to xlsx file

filepath = 'New Microsoft Excel Worksheet.xlsx'

df.to_excel(filepath, index=False)
```

[ ]:
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,!/kaggle/working/outputv1.pdf
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[ ]:
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