

CS 418: Final Project - Classification

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Description: In this code, we will be utilizing regression to determine the poverty and child poverty of a specified county

```
In [110]: # Load libraries
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn import linear_model
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.svm import SVC
from sklearn import metrics
from scipy.cluster.hierarchy import linkage, fcluster
from sklearn.cluster import KMeans, DBSCAN
from sklearn.metrics import mean_squared_error
import math
```

```
In [111]: # Load Election dataset
data_census = pd.read_csv('train_dp_output.csv')
data_census.head()
```

```
Out[111]:
```

Unnamed: 0	CountyId	State	County	TotalPop	Percent_Women	Hispanic	White	Black	Income	...	WorkAtHome	MeanCommute	PrivateWork	PublicWork	
0	0	1001	Alabama	Autauga County	55036.0	51.124718	2.7	75.4	18.9	55317	...	2.5	25.8	74.1	20.1
1	1	1003	Alabama	Baldwin County	203360.0	51.058714	4.4	83.1	9.5	52562	...	5.6	27.0	80.7	12.1
2	2	1007	Alabama	Bibb County	22580.0	45.744021	2.4	74.6	22.0	43404	...	1.5	30.0	76.0	17.1
3	3	1009	Alabama	Blount County	57667.0	50.595661	9.0	87.4	1.5	47412	...	2.1	35.0	83.9	11.1
4	4	1011	Alabama	Bullock County	10478.0	46.401985	0.3	21.6	75.6	29655	...	3.0	29.8	81.4	13.1

5 rows x 25 columns

```
In [112]: #Remove unnamed first column
data_census = data_census.loc[:, ~data_census.columns.str.contains('^Unnamed')]
data_census.head()
```

```
Out[112]:
```

CountyId	State	County	TotalPop	Percent_Women	Hispanic	White	Black	Income	IncomePerCap	...	WorkAtHome	MeanCommute	PrivateWork	Public
0	1001	Alabama	Autauga County	55036.0	51.124718	2.7	75.4	18.9	55317	27824	...	2.5	25.8	74.1
1	1003	Alabama	Baldwin County	203360.0	51.058714	4.4	83.1	9.5	52562	29364	...	5.6	27.0	80.7
2	1007	Alabama	Bibb County	22580.0	45.744021	2.4	74.6	22.0	43404	20911	...	1.5	30.0	76.0
3	1009	Alabama	Blount County	57667.0	50.595661	9.0	87.4	1.5	47412	22021	...	2.1	35.0	83.9
4	1011	Alabama	Bullock County	10478.0	46.401985	0.3	21.6	75.6	29655	20856	...	3.0	29.8	81.4

5 rows x 24 columns

```
In [113]: x_train_full, x_validation_full, y_train, y_validation = train_test_split(data_census[['CountyId', 'State', 'County', 'TotalPop', 'Percent_Women', 'Hispanic', 'White', 'Black', 'Income', 'IncomePerCap', 'Professional', 'Service', 'Production', 'Carpool', 'WorkAtHome', 'PrivateWork', 'PublicWork', 'SelfEmployed', 'Unemployment']], data_census['Poverty Category'], test_size = 0.25, random_state = 0)
```

```
In [114]: # Selecting required variables for x_train
x_train = x_train_full.select_dtypes(include=[np.int64,np.float64])
x_train = x_train.iloc[:,1:17]

# Selecting required variables for x_validation
x_validation = x_validation_full.select_dtypes(include=[np.int64,np.float64])
x_validation = x_validation.iloc[:,1:17]

# Standardizing the data
scaler = StandardScaler()
scaler.fit(x_train)
x_train_scaled = scaler.transform(x_train)
x_validation_scaled = scaler.transform(x_validation)
x_train_scaled_df = pd.DataFrame(x_train_scaled,index = x_train.index,columns=x_train.columns)
x_validation_scaled_df = pd.DataFrame(x_validation_scaled,index = x_validation.index,columns=x_validation.columns)
```

```
In [115]: x_train_scaled_df.head()
```

Out[115]:

	TotalPop	Percent_Women	Hispanic	White	Black	Income	IncomePerCap	Professional	Service	Production	Carpool	WorkAtHome	Private'
1380	-0.118525	0.045865	-0.424669	0.689223	-0.436854	0.351729	0.262281	-0.089405	0.020679	0.311605	-0.525450	-0.722745	0.27
712	-0.204940	0.230015	-0.377088	0.737585	-0.534862	0.566678	0.567576	0.684500	-0.272313	0.465626	-0.828094	-0.486424	0.43
31	0.737568	0.484634	-0.340081	-0.436288	1.075267	0.889286	1.285452	2.232309	-0.778390	-0.903448	-1.197992	-0.452664	0.19
1969	-0.095083	0.500355	0.082856	-0.493443	0.886252	-0.045923	-0.098784	0.123039	-0.591940	0.380059	-1.164364	-0.317624	0.79
655	-0.010013	-0.916455	-0.414095	0.416639	-0.471857	0.251228	0.246021	2.293007	-0.219042	-1.091695	-1.231619	0.087498	-1.14

```
In [116]: x_validation_scaled_df.head()
```

Out[116]:

	TotalPop	Percent_Women	Hispanic	White	Black	Income	IncomePerCap	Professional	Service	Production	Carpool	WorkAtHome	Private'
2054	-0.266679	-1.052672	1.690019	-1.210077	-0.205836	-0.839971	-1.047797	-0.195627	0.287036	-0.184684	-0.794467	-0.081303	-0.35
743	-0.271908	-0.538295	1.272368	-0.572580	-0.597867	0.607557	-0.164433	0.214087	-1.843815	0.499853	0.819632	-0.283863	-0.40
2298	-0.104267	-0.877347	-0.498683	0.829912	-0.513861	0.440793	0.189490	-0.241151	-0.378855	1.030369	-0.491823	0.425100	0.91
1534	0.802903	0.416973	-0.350655	0.315519	-0.058824	0.953482	0.603591	1.048690	-0.432127	-0.338705	-0.760840	-0.182583	1.34
1841	-0.213595	0.389020	-0.466963	0.746378	-0.345847	-0.750760	-0.371559	-1.121278	0.260400	1.150163	-1.298873	1.235343	-0.39

MODELS FOR POVERTY

Classification Model Used: Decision Tree Classifier

MODEL 1

- Variables used: All

```
In [117]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=None,
random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df, y_train)
```

```
Out[117]: DecisionTreeClassifier(class_weight=None, criterion='entropy', max_depth=None,
max_features=None, max_leaf_nodes=None,
min_impurity_decrease=0.0, min_impurity_split=None,
min_samples_leaf=1, min_samples_split=2,
min_weight_fraction_leaf=0.0, presort=False,
random_state=0, splitter='best')
```

```
In [118]: # Show the structure of the decision tree classifier  
print(classifier.tree.__getstate__()['nodes'])  
len(classifier.tree.__getstate__()['nodes'])
```

```
(( 1, 110, 5, -0.36439811, 0.97615296, 1820, 1.820e+03)
( 2, 33, 6, -0.61880383, 0.62753397, 668, 6.680e+02)
( 3, 8, 15, -0.81662986, 0.25363946, 400, 4.000e+02)
( 4, 7, 5, -0.65712106, 0.99403021, 11, 1.100e+01)
( 5, 6, 1, -2.01887672, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( 9, 10, 5, -0.99544594, 0.18567934, 389, 3.890e+02)
( -1, -1, -2, -2., 0., 188, 1.880e+02)
( 11, 26, 1, -0.1501097, 0.30614466, 201, 2.010e+02)
( 12, 19, 11, -0.85778576, 0.57258047, 59, 5.900e+01)
( 13, 14, 4, -0.04832312, 0.97986876, 12, 1.200e+01)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( 15, 18, 3, -0.22305617, 0.954434, 8, 8.000e+00)
( 16, 17, 15, 0.90567267, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( 20, 23, 13, -0.64622402, 0.34246377, 47, 4.700e+01)
( 21, 22, 5, -0.56270739, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 24, 25, 1, -9.28094578, 0.15649106, 44, 4.400e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 43, 4.300e+01)
( 27, 32, 0, -0.26589593, 0.14772109, 142, 1.420e+02)
( 28, 31, 5, -0.80514279, 0.91829583, 9, 9.000e+00)
( 29, 30, 12, 0.48230642, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( -1, -1, -2, -2., 0., 133, 1.330e+02)
( 34, 57, 3, 0.40125085, 0.91324016, 268, 2.680e+02)
( 35, 42, 2, 0.07756955, 0.54356444, 128, 1.280e+02)
( 36, 37, 8, 0.93960863, 0.2786698, 83, 8.300e+01)
( -1, -1, -2, -2., 0., 66, 6.600e+01)
( 38, 41, 0, -0.21912945, 0.78712659, 17, 1.700e+01)
( 39, 40, 12, -1.01664278, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( 43, 56, 15, 0.44818605, 0.83664074, 45, 4.500e+01)
( 44, 45, 3, -0.74844134, 0.96290041, 31, 3.100e+01)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( 46, 47, 8, -1.15128875, 1., 24, 2.400e+01)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( 48, 55, 7, -0.20321456, 0.94945202, 19, 1.900e+01)
( 49, 50, 3, -0.46926175, 0.99572745, 13, 1.300e+01)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( 51, 52, 3, 0.152847, 0.76420451, 9, 9.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( 53, 54, 2, 0.154227, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 14, 1.400e+01)
( 58, 65, 15, -0.61479753, 0.99941106, 140, 1.400e+02)
( 59, 64, 12, -1.23822659, 0.57879462, 29, 2.900e+01)
( 60, 61, 12, -1.74004871, 0.9456603, 11, 1.100e+01)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( 62, 63, 0, -0.28303808, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 18, 1.800e+01)
( 66, 67, 8, -1.01811054, 0.98301338, 111, 1.110e+02)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
( 68, 87, 0, -0.2417232, 0.99555808, 102, 1.020e+02)
( 69, 70, 9, -1.13447905, 0.9456603, 44, 4.400e+01)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 71, 86, 8, 1.04615116, 0.9011702, 41, 4.100e+01)
( 72, 73, 5, -0.80765164, 0.95968689, 34, 3.400e+01)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( 74, 81, 10, 0.76919115, 0.8812909, 30, 3.000e+01)
( 75, 80, 11, 1.37038338, 0.68403844, 22, 2.200e+01)
( 76, 77, 4, -0.3983513, 0.46899559, 20, 2.000e+01)
( -1, -1, -2, -2., 0., 16, 1.600e+01)
( 78, 79, 10, -0.29006105, 1., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 82, 85, 1, -0.27866028, 0.954434, 8, 8.000e+00)
( 83, 84, 7, -1.39442062, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( 88, 89, 4, -0.58736652, 0.91244118, 58, 5.800e+01)
```

```

( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( 90, 91, 10, -1.0634833 , 0.86989269, 55, 5.500e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( 92, 103, 13, -0.44148836, 0.81127812, 52, 5.200e+01)
( 93, 94, 1, -0.13971661, 0.98285869, 26, 2.600e+01)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( 95, 102, 9, 0.68810073, 0.90239328, 22, 2.200e+01)
( 96, 97, 11, -0.30074348, 1. , 14, 1.400e+01)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
( 98, 99, 3, 0.87387767, 0.54356444, 8, 8.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(100, 101, 7, -0.47635734, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 8, 8.000e+00)
(104, 105, 8, -0.81834331, 0.39124356, 26, 2.600e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(106, 109, 2, -0.53833339, 0.24229219, 25, 2.500e+01)
(107, 108, 13, 0.15696979, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 22, 2.200e+01)
(111, 184, 6, -0.16344494, 0.62946985, 1152, 1.152e+03)
(112, 175, 15, 0.60965189, 0.98879645, 233, 2.330e+02)
(113, 160, 1, 0.30589032, 0.95007963, 195, 1.950e+02)
(114, 127, 15, -0.41296521, 0.85545081, 150, 1.500e+02)
(115, 122, 2, 2.04687285, 0.52255937, 51, 5.100e+01)
(116, 121, 5, -0.237886 , 0.34781691, 46, 4.600e+01)
(117, 118, 5, -0.27614586, 0.91829583, 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(119, 120, 2, -0.49868298, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 37, 3.700e+01)
(123, 126, 13, 0.11759755, 0.97095059, 5, 5.000e+00)
(124, 125, 12, 0.13689639, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(128, 157, 7, 0.27478531, 0.9456603 , 99, 9.900e+01)
(129, 150, 5, -0.07879584, 0.87988131, 87, 8.700e+01)
(130, 131, 3, -0.89352673, 0.98636761, 51, 5.100e+01)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(132, 133, 9, -0.09911682, 0.95033767, 46, 4.600e+01)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(134, 149, 7, -0.38530977, 0.98811084, 39, 3.900e+01)
(135, 148, 8, 0.92629081, 0.89603823, 32, 3.200e+01)
(136, 147, 1, 0.25370515, 0.79732651, 29, 2.900e+01)
(137, 138, 1, -0.74069297, 0.69128987, 27, 2.700e+01)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
(139, 146, 14, -0.15886191, 0.85240518, 18, 1.800e+01)
(140, 141, 10, -0.34050165, 0.99403021, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(142, 143, 2, -0.37708841, 0.86312057, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(144, 145, 15, -0.17076641, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(151, 152, 8, 0.10058611, 0.50325833, 36, 3.600e+01)
( -1, -1, -2, -2. , 0. , 24, 2.400e+01)
(153, 154, 0, -0.17305877, 0.91829583, 12, 1.200e+01)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(155, 156, 7, -0.43842085, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(158, 159, 10, -0.97941566, 0.65002242, 12, 1.200e+01)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 10, 1.000e+01)
(161, 164, 4, -0.53836256, 0.91829583, 45, 4.500e+01)
(162, 163, 11, 0.93150157, 0.68403844, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(165, 166, 15, 0.01761042, 0.67229482, 34, 3.400e+01)
( -1, -1, -2, -2. , 0. , 18, 1.800e+01)
(167, 174, 2, -0.0387383 , 0.954434 , 16, 1.600e+01)
(168, 169, 9, -0.17612723, 0.99403021, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(170, 173, 0, -0.16675012, 0.81127812, 8, 8.000e+00)
(171, 172, 2, -0.46167594, 1. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(176, 183, 1, 0.0167781 , 0.74248757, 38, 3.800e+01)

```

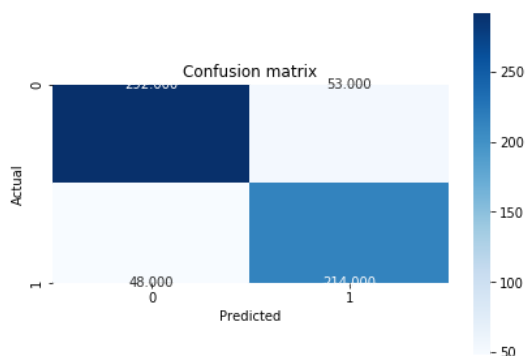
```
(177, 182, 3, -0.60115761, 0.99750255, 17, 1.700e+01)
(178, 179, 13, 1.88147414, 0.68403844, 11, 1.100e+01)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(180, 181, 3, -2.49166489, 1., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 6, 6.000e+00)
(-1, -1, -2, -2., 0., 21, 2.100e+01)
(185, 248, 3, 0.20340708, 0.42654956, 919, 9.190e+02)
(186, 225, 5, 0.40884209, 0.70755255, 311, 3.110e+02)
(187, 222, 7, 1.09421366, 0.97581049, 115, 1.150e+02)
(188, 211, 3, -0.29120237, 0.89233868, 97, 9.700e+01)
(189, 210, 10, 1.13908881, 0.99884554, 50, 5.000e+01)
(190, 195, 5, -0.0108357, 0.99022469, 43, 4.300e+01)
(191, 194, 9, -0.97190148, 0.61938219, 13, 1.300e+01)
(192, 193, 14, -0.52603355, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 10, 1.000e+01)
(196, 197, 2, -0.40616538, 0.98713777, 30, 3.000e+01)
(-1, -1, -2, -2., 0., 6, 6.000e+00)
(198, 205, 12, 0.82771647, 0.99498483, 24, 2.400e+01)
(199, 200, 14, -1.00715506, 0.89603823, 16, 1.600e+01)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(201, 204, 15, -0.35914324, 0.74959526, 14, 1.400e+01)
(202, 203, 4, -0.04132256, 1., 6, 6.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 8, 8.000e+00)
(206, 207, 12, 1.22526383, 0.81127812, 8, 8.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(208, 209, 5, 0.22189638, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(212, 219, 3, 0.1220713, 0.55098444, 47, 4.700e+01)
(213, 218, 5, -0.14284512, 0.36505519, 43, 4.300e+01)
(214, 217, 13, 0.16484424, 0.91829583, 9, 9.000e+00)
(215, 216, 8, -0.04590989, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(-1, -1, -2, -2., 0., 34, 3.400e+01)
(220, 221, 13, -0.84308526, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(223, 224, 14, 0.18298755, 0.30954343, 18, 1.800e+01)
(-1, -1, -2, -2., 0., 17, 1.700e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(226, 231, 3, -1.64313483, 0.35206297, 196, 1.960e+02)
(227, 230, 4, -0.18483411, 0.99572745, 13, 1.300e+01)
(228, 229, 6, 0.23865072, 0.76420451, 9, 9.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(232, 241, 13, 1.46412838, 0.23421651, 183, 1.830e+02)
(233, 240, 6, 6.46178746, 0.13110653, 165, 1.650e+02)
(234, 235, 3, 0.09569213, 0.09501725, 164, 1.640e+02)
(-1, -1, -2, -2., 0., 138, 1.380e+02)
(236, 239, 5, 0.67156962, 0.39124356, 26, 2.600e+01)
(237, 238, 14, 0.13234319, 1., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 22, 2.200e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(242, 245, 2, -0.09689223, 0.76420451, 18, 1.800e+01)
(243, 244, 0, 0.08241302, 0.37123233, 14, 1.400e+01)
(-1, -1, -2, -2., 0., 13, 1.300e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(246, 247, 6, 1.75836253, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(249, 294, 6, 0.46895152, 0.20870728, 608, 6.080e+02)
(250, 277, 5, -0.04208556, 0.33652891, 321, 3.210e+02)
(251, 276, 0, 0.22905742, 0.5957611, 90, 9.000e+01)
(252, 259, 11, -0.65522492, 0.54356444, 88, 8.800e+01)
(253, 254, 0, -0.24291433, 0.9612366, 13, 1.300e+01)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(255, 258, 9, -0.2959212, 0.72192809, 10, 1.000e+01)
(256, 257, 0, -0.16584516, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(260, 273, 13, 0.86567023, 0.40217919, 75, 7.500e+01)
(261, 262, 5, -0.35362484, 0.30954343, 72, 7.200e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(263, 272, 8, -0.31226623, 0.25253077, 71, 7.100e+01)
(264, 265, 7, -0.93918261, 0.49123734, 28, 2.800e+01)
```

```
( -1, -1, -2, -2.      , 0.      ,      1, 1.000e+00)
(266, 271, 0, -0.0534066 , 0.38094659, 27, 2.700e+01)
(267, 268, 14, 3.10769963, 0.23519338, 26, 2.600e+01)
( -1, -1, -2, -2.      , 0.      ,      24, 2.400e+01)
(269, 270, 13, -0.14225928, 1.      ,      2, 2.000e+00)
( -1, -1, -2, -2.      , 0.      ,      1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      ,      1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      ,      1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      ,      43, 4.300e+01)
(274, 275, 14, 0.38556501, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.      , 0.      ,      2, 2.000e+00)
( -1, -1, -2, -2.      , 0.      ,      1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      ,      2, 2.000e+00)
(278, 293, 9, -0.24458093, 0.19590927, 231, 2.310e+02)
(279, 292, 7, 2.1412611 , 0.48303068, 67, 6.700e+01)
(280, 289, 6, 0.14754854, 0.39124356, 65, 6.500e+01)
(281, 288, 7, 0.5327535 , 0.72192809, 20, 2.000e+01)
(282, 283, 2, -0.48017946, 0.89049164, 13, 1.300e+01)
( -1, -1, -2, -2.      , 0.      ,      4, 4.000e+00)
(284, 287, 15, -0.38605422, 0.99107606, 9, 9.000e+00)
(285, 286, 14, 1.00595847, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2.      , 0.      ,      5, 5.000e+00)
( -1, -1, -2, -2.      , 0.      ,      1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      ,      3, 3.000e+00)
( -1, -1, -2, -2.      , 0.      ,      7, 7.000e+00)
(290, 291, 9, -0.26169436, 0.15374218, 45, 4.500e+01)
( -1, -1, -2, -2.      , 0.      ,      44, 4.400e+01)
( -1, -1, -2, -2.      , 0.      ,      1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      ,      2, 2.000e+00)
( -1, -1, -2, -2.      , 0.      ,      164, 1.640e+02)
( -1, -1, -2, -2.      , 0.      ,      287, 2.870e+02)]
```

Out[118]: 295

```
In [119]: y_pred = classifier.predict(x_validation_scaled_df)
```

```
In [120]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [121]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8336079077429983, 0.1663920922570017, array([0.85882353, 0.80149813]), array([0.84637681, 0.81679389]), array([0.852
55474, 0.80907372])]
```

MODEL 2

-Variables Used: Hispanic, White, Black, Percent_Women

```
In [122]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=None, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Hispanic', 'White', 'Black', 'Percent Women']], y_train)

Out[122]: DecisionTreeClassifier(class_weight=None, criterion='entropy', max_depth=None,
max_features=None, max_leaf_nodes=None,
min_impurity_decrease=0.0, min_impurity_split=None,
min_samples_leaf=1, min_samples_split=2,
min_weight_fraction_leaf=0.0, presort=False,
random_state=0, splitter='best')
```



```
In [123]: # Show the structure of the decision tree classifier
print(classifier.tree.__getstate__()['nodes'])
len(classifier.tree.__getstate__()['nodes'])
```

```
( ( 1, 234, 1, -2.51633614e-01, 0.97615296, 1820, 1.820e+03)
  ( 2, 67, 0, -3.05717692e-01, 0.89440709, 569, 5.690e+02)
  ( 3, 40, 2, 1.36229038e+00, 0.52424171, 203, 2.030e+02)
  ( 4, 5, 3, -1.68634611e+00, 0.82465783, 58, 5.800e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  ( 6, 7, 0, -5.14543146e-01, 0.75683363, 55, 5.500e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 7, 7.000e+00)
  ( 8, 9, 0, -4.93396252e-01, 0.81127812, 48, 4.800e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (10, 11, 0, -4.59032580e-01, 0.75537541, 46, 4.600e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 6, 6.000e+00)
  (12, 39, 0, -3.16291109e-01, 0.81127812, 40, 4.000e+01)
  (13, 24, 0, -3.48011449e-01, 0.86312057, 35, 3.500e+01)
  (14, 15, 1, -4.71460015e-01, 0.68403844, 22, 2.200e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 9, 9.000e+00)
  (16, 23, 3, 6.80638671e-01, 0.89049164, 13, 1.300e+01)
  (17, 22, 1, -2.97797158e-01, 0.99107606, 9, 9.000e+00)
  (18, 21, 1, -3.72538134e-01, 0.86312057, 7, 7.000e+00)
  (19, 20, 0, -3.90305206e-01, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (25, 38, 1, -2.84607574e-01, 0.99572745, 13, 1.300e+01)
  (26, 27, 0, -3.37438002e-01, 0.99403021, 11, 1.100e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (28, 29, 2, -5.80365956e-01, 0.954434, 8, 8.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (30, 31, 0, -3.29507917e-01, 1., 6, 6.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (32, 33, 2, 3.40208150e-01, 0.97095059, 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (34, 35, 3, 7.18093038e-01, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (36, 37, 3, 9.12261993e-01, 1., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
  (41, 64, 3, 2.23444796e+00, 0.33560377, 145, 1.450e+02)
  (42, 43, 1, -1.19468892e+00, 0.28339789, 142, 1.420e+02)
  (-1, -1, -2, -2.00000000e+00, 0., 59, 5.900e+01)
  (44, 49, 1, -1.10016358e+00, 0.41728069, 83, 8.300e+01)
  (45, 46, 1, -1.17930108e+00, 1., 4, 4.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (47, 48, 1, -1.13533580e+00, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (50, 63, 2, 2.20585835e+00, 0.34037329, 79, 7.900e+01)
  (51, 52, 1, -9.33095515e-01, 0.42881096, 57, 5.700e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (53, 62, 3, 5.08113533e-01, 0.37123233, 56, 5.600e+01)
  (54, 61, 1, -5.48399270e-01, 0.54356444, 32, 3.200e+01)
  (55, 60, 0, -4.03522000e-01, 0.78712659, 17, 1.700e+01)
  (56, 57, 2, 1.72982001e+00, 1., 8, 8.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (58, 59, 3, -1.40942304e+00, 0.72192809, 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 9, 9.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 15, 1.500e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 24, 2.400e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 22, 2.200e+01)
  (65, 66, 3, 2.71024764e+00, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (68, 93, 1, -1.60356605e+00, 0.98052637, 366, 3.660e+02)
  (69, 70, 1, -2.66532767e+00, 0.47782074, 107, 1.070e+02)
  (-1, -1, -2, -2.00000000e+00, 0., 55, 5.500e+01)
  (71, 72, 3, -4.13547301e+00, 0.74441318, 52, 5.200e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (73, 80, 2, -5.52363694e-01, 0.68007705, 50, 5.000e+01)
  (74, 75, 3, -2.52684936e-01, 0.97986876, 12, 1.200e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
  (76, 77, 3, 9.45005268e-02, 0.86312057, 7, 7.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (78, 79, 2, -5.59364259e-01, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (81, 92, 0, 2.53853786e+00, 0.48546076, 38, 3.800e+01)
  (82, 87, 2, -2.96843126e-01, 0.59167278, 28, 2.800e+01)
  (83, 86, 2, -3.66848767e-01, 0.954434, 8, 8.000e+00)
  (84, 85, 0, 6.69682253e-01, 0.65002242, 6, 6.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (88, 89, 3, 1.17517602e+00, 0.28639696, 20, 2.000e+01)
```

```
( -1, -1, -2, -2.00000000e+00, 0. , 18, 1.800e+01)
( 90, 91, 3, 1.60772109e+00, 1. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 10, 1.000e+01)
( 94, 191, 2, 6.79735482e-01, 0.99326866, 259, 2.590e+02)
( 95, 158, 1, -6.03355855e-01, 0.94360163, 180, 1.800e+02)
( 96, 103, 3, -8.71416360e-01, 0.9946938 , 105, 1.050e+02)
( 97, 102, 1, -6.58312500e-01, 0.78712659, 17, 1.700e+01)
( 98, 99, 0, 1.59485835e+00, 0.56650951, 15, 1.500e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 8, 8.000e+00)
(100, 101, 0, 1.73759973e+00, 0.86312057, 7, 7.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(104, 143, 0, 1.57106811e+00, 1. , 88, 8.800e+01)
(105, 106, 3, -5.89974433e-01, 0.98423999, 61, 6.100e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(107, 142, 2, 4.59217727e-01, 0.96889771, 58, 5.800e+01)
(108, 141, 2, 3.57709557e-01, 0.98410953, 54, 5.400e+01)
(109, 122, 0, 1.15606052e+00, 0.95804202, 50, 5.000e+01)
(110, 111, 2, -4.47355241e-01, 0.99901027, 27, 2.700e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 6, 6.000e+00)
(112, 117, 3, -2.14307145e-02, 0.95871188, 21, 2.100e+01)
(113, 116, 2, 2.03697167e-01, 0.86312057, 7, 7.000e+00)
(114, 115, 0, 3.10185235e-01, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(118, 119, 3, 3.26171204e-01, 0.74959526, 14, 1.400e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 8, 8.000e+00)
(120, 121, 2, 6.01856168e-02, 1. , 6, 6.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(123, 140, 2, -1.14828475e-01, 0.75537541, 23, 2.300e+01)
(124, 131, 2, -3.63348484e-01, 0.83147439, 19, 1.900e+01)
(125, 130, 2, -5.66364825e-01, 0.43949699, 11, 1.100e+01)
(126, 127, 0, 1.32259220e+00, 0.91829583, 3, 3.000e+00)
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(128, 129, 1, -6.78096861e-01, 1. , 2, 2.000e+00)
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( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 8, 8.000e+00)
(132, 133, 0, 1.19835424e+00, 1. , 8, 8.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(134, 139, 0, 1.45211691e+00, 0.91829583, 6, 6.000e+00)
(135, 136, 2, -2.47839183e-01, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(137, 138, 1, -8.12190980e-01, 1. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(144, 149, 3, -2.80101612e-01, 0.91829583, 27, 2.700e+01)
(145, 148, 2, -3.98351297e-01, 0.97095059, 10, 1.000e+01)
(146, 147, 0, 1.72438300e+00, 0.59167278, 7, 7.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 6, 6.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(150, 157, 1, -1.26723164e+00, 0.67229482, 17, 1.700e+01)
(151, 156, 1, -1.31339520e+00, 0.91829583, 9, 9.000e+00)
(152, 153, 2, -3.00343409e-01, 0.59167278, 7, 7.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(154, 155, 3, 1.53303474e-01, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 8, 8.000e+00)
(159, 188, 2, -3.08217118e-02, 0.77215514, 75, 7.500e+01)
(160, 187, 0, 1.03975266e+00, 0.91134238, 49, 4.900e+01)
(161, 186, 3, 5.52072912e-01, 0.97095059, 40, 4.000e+01)
(162, 185, 3, 4.29486752e-01, 0.93526914, 37, 3.700e+01)
(163, 184, 3, 3.59205782e-01, 0.95968689, 34, 3.400e+01)
(164, 183, 3, 2.48031855e-01, 0.92836207, 32, 3.200e+01)
(165, 182, 1, -2.99995422e-01, 0.95755348, 29, 2.900e+01)
(166, 175, 1, -4.01115566e-01, 0.91829583, 27, 2.700e+01)
(167, 174, 3, -1.08705569e-01, 1. , 14, 1.400e+01)
(168, 169, 3, -1.73463947e+00, 0.94566603, 11, 1.100e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(170, 171, 1, -4.45080847e-01, 0.76420451, 9, 9.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
(172, 173, 3, -3.92284498e-01, 1. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(176, 181, 3, -7.47281998e-01, 0.61938219, 13, 1.300e+01)
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(177, 178, 0, 7.38409579e-01, 0.91829583, 6, 6.000e+00)
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(179, 180, 2, -5.62864542e-01, 0.91829583, 3, 3.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 7, 7.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 9, 9.000e+00)
(189, 190, 3, 1.20992571e+00, 0.23519338, 26, 2.600e+01)
(-1, -1, -2, -2.00000000e+00, 0. , 25, 2.500e+01)
(-1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(192, 193, 1, -1.54201466e+00, 0.92650445, 79, 7.900e+01)
(-1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(194, 231, 3, 9.81427640e-01, 0.89974376, 76, 7.600e+01)
(195, 210, 3, 3.64726126e-01, 0.94216317, 64, 6.400e+01)
(196, 207, 0, -1.52402788e-01, 0.77934984, 26, 2.600e+01)
(197, 206, 1, -4.16503415e-01, 0.9612366 , 13, 1.300e+01)
(198, 199, 0, -2.66067281e-01, 1. , 10, 1.000e+01)
(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(200, 201, 0, -2.23773517e-01, 0.954434 , 8, 8.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(202, 203, 3, -1.49059111e+00, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(204, 205, 3, -4.73782159e-02, 0.91829583, 3, 3.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(208, 209, 1, -1.52223033e+00, 0.39124356, 13, 1.300e+01)
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(-1, -1, -2, -2.00000000e+00, 0. , 12, 1.200e+01)
(211, 222, 2, 1.27828372e+00, 0.9919924 , 38, 3.800e+01)
(212, 219, 2, 9.00253236e-01, 0.89603823, 16, 1.600e+01)
(213, 218, 2, 8.26747298e-01, 0.98522814, 7, 7.000e+00)
(214, 215, 3, 5.69401383e-01, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(216, 217, 0, -1.70906313e-01, 0.91829583, 3, 3.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(220, 221, 1, -1.02542257e+00, 0.50325833, 9, 9.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 8, 8.000e+00)
(223, 226, 1, -1.19249070e+00, 0.84535094, 22, 2.200e+01)
(224, 225, 2, 2.48938107e+00, 0.91829583, 6, 6.000e+00)
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(227, 230, 3, 6.94357693e-01, 0.54356444, 16, 1.600e+01)
(228, 229, 2, 1.50930226e+00, 0.91829583, 6, 6.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 10, 1.000e+01)
(232, 233, 0, -2.97787607e-01, 0.41381685, 12, 1.200e+01)
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(235, 590, 2, -4.75357503e-01, 0.8583965 , 1251, 1.251e+03)
(236, 301, 0, -5.27759939e-01, 0.78227879, 727, 7.270e+02)
(237, 244, 3, -2.74823800e-01, 0.98729273, 83, 8.300e+01)
(238, 239, 1, 4.36423078e-01, 0.54356444, 16, 1.600e+01)
(-1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(240, 243, 3, -1.04385036e+00, 0.35335934, 15, 1.500e+01)
(241, 242, 3, -1.48526710e+00, 0.91829583, 3, 3.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 12, 1.200e+01)
(245, 264, 2, -5.87366521e-01, 0.9998393 , 67, 6.700e+01)
(246, 263, 3, 3.27786058e-01, 0.84535094, 22, 2.200e+01)
(247, 262, 2, -5.94367087e-01, 0.93666738, 17, 1.700e+01)
(248, 251, 1, 9.64006484e-01, 0.98522814, 14, 1.400e+01)
(249, 250, 3, -6.32225601e-02, 0.65002242, 6, 6.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
(252, 253, 1, 9.94782180e-01, 0.954434 , 8, 8.000e+00)
(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(254, 255, 3, -1.86567768e-01, 1. , 6, 6.000e+00)
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(256, 261, 1, 1.05193704e+00, 0.97095059, 5, 5.000e+00)
(257, 260, 2, -6.01367652e-01, 0.91829583, 3, 3.000e+00)
(258, 259, 3, 1.30642133e-02, 1. , 2, 2.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
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(265, 300, 3, 5.69548637e-01, 0.9564574, 45, 4.500e+01)
(266, 267, 3, -1.86274275e-01, 0.98370826, 40, 4.000e+01)
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(268, 295, 2, -5.17360866e-01, 0.99777247, 36, 3.600e+01)
(269, 272, 0, -5.64766973e-01, 0.99679163, 30, 3.000e+01)
(270, 271, 2, -5.52363694e-01, 0.72192809, 5, 5.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(273, 274, 0, -5.54193556e-01, 0.99884554, 25, 2.500e+01)
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(275, 276, 0, -5.48906833e-01, 0.99403021, 22, 2.200e+01)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(277, 278, 1, 8.80472451e-01, 1., 20, 2.000e+01)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(279, 294, 0, -5.33046663e-01, 0.99107606, 18, 1.800e+01)
(280, 281, 2, -5.73365390e-01, 0.98522814, 14, 1.400e+01)
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(282, 283, 3, 1.70958757e-01, 0.99403021, 11, 1.100e+01)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(284, 289, 0, -5.38333386e-01, 0.99107606, 9, 9.000e+00)
(285, 288, 0, -5.43620110e-01, 0.72192809, 5, 5.000e+00)
(286, 287, 3, 2.44838186e-01, 1., 2, 2.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
(290, 293, 1, 9.33230788e-01, 0.81127812, 4, 4.000e+00)
(291, 292, 2, -5.34862280e-01, 1., 2, 2.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
(296, 297, 3, 3.60646889e-01, 0.65002242, 6, 6.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
(298, 299, 0, -5.56836903e-01, 1., 2, 2.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
(302, 395, 3, -1.59858726e-02, 0.73478135, 644, 6.440e+02)
(303, 394, 3, -8.35833400e-02, 0.59446347, 264, 2.640e+02)
(304, 339, 3, -3.29270348e-01, 0.64330713, 232, 2.320e+02)
(305, 326, 3, -6.89514697e-01, 0.49802789, 128, 1.280e+02)
(306, 325, 3, -7.20750839e-01, 0.65654028, 59, 5.900e+01)
(307, 308, 3, -1.30683821e+00, 0.58515699, 57, 5.700e+01)
(-1, -1, -2, -2.00000000e+00, 0., 14, 1.400e+01)
(309, 322, 3, -8.90007615e-01, 0.69312742, 43, 4.300e+01)
(310, 317, 0, -1.65619589e-01, 0.87086447, 24, 2.400e+01)
(311, 312, 3, -1.00466239e+00, 0.67229482, 17, 1.700e+01)
(-1, -1, -2, -2.00000000e+00, 0., 9, 9.000e+00)
(313, 314, 3, -9.63850170e-01, 0.954434, 8, 8.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
(318, 321, 3, -1.17615390e+00, 0.98522814, 7, 7.000e+00)
(319, 320, 3, -1.26688617e+00, 0.81127812, 4, 4.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
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(-1, -1, -2, -2.00000000e+00, 0., 18, 1.800e+01)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(327, 338, 1, 8.14524531e-01, 0.31933739, 69, 6.900e+01)
(328, 329, 1, 6.21077269e-01, 0.43275016, 45, 4.500e+01)
(-1, -1, -2, -2.00000000e+00, 0., 20, 2.000e+01)
(330, 333, 1, 6.73835605e-01, 0.63430955, 25, 2.500e+01)
(331, 332, 3, -5.44446319e-01, 1., 6, 6.000e+00)
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(341, 350, 0, -7.01797754e-03, 0.99403021, 22, 2.200e+01)
(342, 343, 3, -2.19914623e-01, 0.89049164, 13, 1.300e+01)
(-1, -1, -2, -2.00000000e+00, 0., 6, 6.000e+00)
(344, 345, 0, -2.87214160e-01, 0.98522814, 7, 7.000e+00)
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(346, 347, 1, 3.68276894e-01, 0.97095059, 5, 5.000e+00)
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(348, 349, 3, -1.71203136e-01, 0.91829583, 3, 3.000e+00)
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(356, 383, 1, 9.06851619e-01, 0.65937588, 82, 8.200e+01)
(357, 358, 3, -2.17208207e-01, 0.53283506, 66, 6.600e+01)
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(359, 360, 3, -2.15997823e-01, 0.71206405, 41, 4.100e+01)
( -1, -1, -2, -2.00000000e+00, 0, , 1, 1.000e+00)
(361, 364, 0, -4.27312240e-01, 0.66901584, 40, 4.000e+01)
(362, 363, 2, -6.01367652e-01, 0.30954343, 18, 1.800e+01)
( -1, -1, -2, -2.00000000e+00, 0, , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0, , 17, 1.700e+01)
(365, 366, 3, -2.01109126e-01, 0.84535094, 22, 2.200e+01)
( -1, -1, -2, -2.00000000e+00, 0, , 4, 4.000e+00)
(367, 382, 3, -1.02596603e-01, 0.91829583, 18, 1.800e+01)
(368, 381, 0, -8.89621414e-02, 0.98522814, 14, 1.400e+01)
(369, 370, 3, -1.91255122e-01, 1, , 12, 1.200e+01)
( -1, -1, -2, -2.00000000e+00, 0, , 1, 1.000e+00)
(371, 372, 3, -1.75111115e-01, 0.99403021, 11, 1.100e+01)
( -1, -1, -2, -2.00000000e+00, 0, , 2, 2.000e+00)
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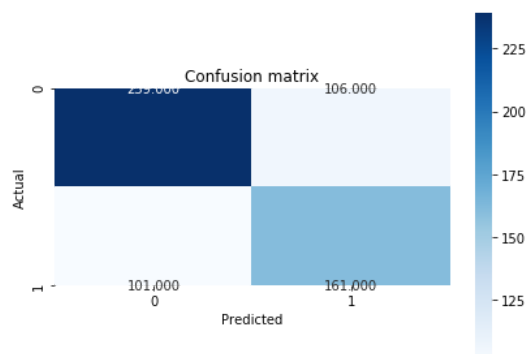
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( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(857, 858, 1, -1.79090887e-01, 1. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(860, 861, 3, -9.17615533e-01, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(865, 878, 2, 5.53725362e-01, 0.88654089, 23, 2.300e+01)
(866, 873, 0, -3.24221194e-01, 0.98869941, 16, 1.600e+01)
(867, 868, 1, 1.02286924e-01, 0.91829583, 9, 9.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(869, 872, 3, 8.20690542e-01, 1. , 6, 6.000e+00)
(870, 871, 3, -2.11198699e+00, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(874, 877, 1, 4.51320540e-02, 0.59167278, 7, 7.000e+00)
(875, 876, 3, 4.84935328e-01, 1. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 7, 7.000e+00)]
```

Out[123]: 879

```
In [124]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'White', 'Black', 'Percent_Women']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [125]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.6589785831960461, 0.3410214168039539, array([0.70294118, 0.60299625]), array([0.69275362, 0.61450382]), array([0.69781022, 0.60869565])]
```

MODEL 3

-Variables Used: Unemployment, Income, SelfEmployed

```
In [126]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=N
one, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Unemployment', 'Income', 'SelfEmployed']], y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```

```
[ ( 1, 192, 1, -0.36439811, 0.97615296, 1820, 1.820e+03)
  ( 2, 47, 1, -0.72862309, 0.62753397, 668, 6.680e+02)
  ( 3, 8, 1, -0.99544594, 0.23373142, 367, 3.670e+02)
  ( 4, 7, 0, -1.2472055, 0.04484961, 203, 2.030e+02)
  ( 5, 6, 0, -1.5701372, 1., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 201, 2.010e+02)
  ( 9, 38, 2, 1.22119701, 0.39959571, 164, 1.640e+02)
  (10, 11, 1, -0.99367499, 0.32275696, 153, 1.530e+02)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (12, 37, 1, -0.77514738, 0.29747225, 152, 1.520e+02)
  (13, 36, 1, -0.77562702, 0.35764671, 118, 1.180e+02)
  (14, 15, 2, -0.61466122, 0.32676598, 117, 1.170e+02)
  (-1, -1, -2, -2., 0., 38, 3.800e+01)
  (16, 21, 0, -0.21113288, 0.43180499, 79, 7.900e+01)
  (17, 18, 0, -0.33223227, 0.84535094, 11, 1.100e+01)
  (-1, -1, -2, -2., 0., 5, 5.000e+00)
  (19, 20, 1, -0.92918295, 1., 6, 6.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (22, 25, 2, -0.56401685, 0.32275696, 68, 6.800e+01)
  (23, 24, 0, 0.32708667, 1., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (26, 31, 1, -0.83218664, 0.26676499, 66, 6.600e+01)
  (27, 30, 1, -0.97294012, 0.14372617, 49, 4.900e+01)
  (28, 29, 1, -0.97434211, 0.65002242, 6, 6.000e+00)
  (-1, -1, -2, -2., 0., 5, 5.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 43, 4.300e+01)
  (32, 35, 1, -0.82768548, 0.52255937, 17, 1.700e+01)
  (33, 34, 0, 0.56928542, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 14, 1.400e+01)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 34, 3.400e+01)
  (39, 40, 1, -0.9232429, 0.9456603, 11, 1.100e+01)
  (-1, -1, -2, -2., 0., 4, 4.000e+00)
  (41, 42, 1, -0.89726901, 0.98522814, 7, 7.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (43, 44, 2, 1.9428792, 0.97095059, 5, 5.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (45, 46, 0, -1.05882865, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (48, 69, 0, -0.60134205, 0.88411512, 301, 3.010e+02)
  (49, 50, 2, -0.57667792, 0.81127812, 44, 4.400e+01)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (51, 68, 0, -0.73589692, 0.74959526, 42, 4.200e+01)
  (52, 65, 1, -0.4867411, 0.83376491, 34, 3.400e+01)
  (53, 64, 2, 3.3862437, 0.9456603, 22, 2.200e+01)
  (54, 55, 0, -1.71814758, 0.98194079, 19, 1.900e+01)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (56, 57, 0, -1.20683903, 0.96407876, 18, 1.800e+01)
  (-1, -1, -2, -2., 0., 4, 4.000e+00)
  (58, 59, 0, -0.97809571, 1., 14, 1.400e+01)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (60, 61, 1, -0.62387887, 0.9456603, 11, 1.100e+01)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (62, 63, 1, -0.50718078, 0.76420451, 9, 9.000e+00)
  (-1, -1, -2, -2., 0., 7, 7.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (66, 67, 2, -0.032251, 0.41381685, 12, 1.200e+01)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 11, 1.100e+01)
  (-1, -1, -2, -2., 0., 8, 8.000e+00)
  (70, 137, 0, 0.12525433, 0.77040588, 257, 2.570e+02)
  (71, 122, 0, 0.01761042, 0.89603823, 112, 1.120e+02)
  (72, 113, 0, -0.09003348, 0.82381163, 93, 9.300e+01)
  (73, 86, 1, -0.55680424, 0.90311617, 69, 6.900e+01)
  (74, 85, 1, -0.63007718, 0.74959526, 28, 2.800e+01)
  (75, 80, 0, -0.19767739, 0.954434, 16, 1.600e+01)
  (76, 79, 0, -0.33223227, 0.72192809, 10, 1.000e+01)
  (77, 78, 0, -0.4264207, 1., 4, 4.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 6, 6.000e+00)
  (81, 84, 2, -0.14620083, 0.91829583, 6, 6.000e+00)
  (82, 83, 2, -0.62732229, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 12, 1.200e+01)
  (87, 96, 1, -0.47087635, 0.96495677, 41, 4.100e+01)
  (88, 91, 0, -0.26495483, 0.9612366, 13, 1.300e+01)
```

```
( 89, 90, 0, -0.57443106, 0.54356444, 8, 8.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( 92, 95, 2, -0.58933902, 0.72192809, 5, 5.000e+00)
( 93, 94, 2, -1.0324772, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 97, 98, 0, -0.46678716, 0.86312057, 28, 2.800e+01)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( 99, 102, 2, -0.53869465, 0.95871188, 21, 2.100e+01)
(100, 101, 0, -0.13039994, 0.50325833, 9, 9.000e+00)
( -1, -1, -2, -2., 0., 8, 8.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(103, 104, 2, -0.37410046, 0.97986876, 12, 1.200e+01)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
(105, 112, 0, -0.1842219, 0.99107606, 9, 9.000e+00)
(106, 107, 0, -0.39950971, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(108, 109, 2, -0.20950628, 1., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(110, 111, 1, -0.45534366, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
(114, 115, 2, -0.39942265, 0.41381685, 24, 2.400e+01)
( -1, -1, -2, -2., 0., 12, 1.200e+01)
(116, 121, 2, -0.19684519, 0.65002242, 12, 1.200e+01)
(117, 118, 0, -0.0631225, 1., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(119, 120, 1, -0.45530677, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 8, 8.000e+00)
(123, 136, 1, -0.44733751, 0.98194079, 19, 1.900e+01)
(124, 135, 2, 0.524837, 0.99679163, 15, 1.500e+01)
(125, 126, 1, -0.65774825, 0.99572745, 13, 1.300e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(127, 134, 1, -0.4746765, 0.9456603, 11, 1.100e+01)
(128, 133, 1, -0.58355293, 0.76420451, 9, 9.000e+00)
(129, 130, 2, -0.57667792, 1., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(131, 132, 2, 0.107021, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
(138, 191, 2, 2.12013447, 0.63099957, 145, 1.450e+02)
(139, 164, 1, -0.49596478, 0.60190895, 143, 1.430e+02)
(140, 163, 1, -0.57137766, 0.44569318, 97, 9.700e+01)
(141, 162, 1, -0.57399717, 0.5801955, 65, 6.500e+01)
(142, 161, 1, -0.59823704, 0.54356444, 64, 6.400e+01)
(143, 160, 1, -0.6006352, 0.61938219, 52, 5.200e+01)
(144, 145, 1, -0.70438322, 0.57700425, 51, 5.100e+01)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
(146, 147, 1, -0.69327793, 0.65002242, 42, 4.200e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(148, 159, 2, 0.1196821, 0.54356444, 40, 4.000e+01)
(149, 158, 2, 0.01839336, 0.69128987, 27, 2.700e+01)
(150, 153, 1, -0.65874442, 0.61938219, 26, 2.600e+01)
(151, 152, 1, -0.67280135, 0.91829583, 9, 9.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
(154, 155, 1, -0.61834466, 0.32275696, 17, 1.700e+01)
( -1, -1, -2, -2., 0., 12, 1.200e+01)
(156, 157, 0, 0.44818605, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 13, 1.300e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 12, 1.200e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 32, 3.200e+01)
(165, 182, 2, 0.2589541, 0.82805573, 46, 4.600e+01)
(166, 181, 0, 1.3631593, 0.63945713, 37, 3.700e+01)
(167, 176, 0, 0.44818605, 0.5813215, 36, 3.600e+01)
(168, 169, 1, -0.43604772, 0.83664074, 15, 1.500e+01)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
(170, 171, 0, 0.23289824, 0.99107606, 9, 9.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
(172, 173, 2, -1.09578264, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(174, 175, 1, -0.37229359, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
```

```
(177, 180, 1, -0.48537599, 0.27619543, 21, 2.100e+01)
(178, 179, 0, 0.75766227, 1, 2, 2.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 19, 1.900e+01)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(183, 190, 2, 1.46175778, 0.91829583, 9, 9.000e+00)
(184, 189, 0, 1.32279283, 0.81127812, 8, 8.000e+00)
(185, 188, 1, -0.4881431, 0.59167278, 7, 7.000e+00)
(186, 187, 0, 0.71729583, 1, 2, 2.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 5, 5.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 2, 2.000e+00)
(193, 386, 1, 0.00513972, 0.62946985, 1152, 1.152e+03)
(194, 209, 0, -0.62825301, 0.946344, 321, 3.210e+02)
(195, 208, 1, -0.02064971, 0.34918437, 61, 6.100e+01)
(196, 199, 1, -0.35004604, 0.28639696, 60, 6.000e+01)
(197, 198, 1, -0.36078241, 1, 2, 2.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(200, 201, 1, -0.09514021, 0.21639693, 58, 5.800e+01)
(-1, -1, -2, -2, 0, 43, 4.300e+01)
(202, 207, 1, -0.06315246, 0.56650951, 15, 1.500e+01)
(203, 204, 2, 0.33492066, 1, 4, 4.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(205, 206, 1, -0.07244994, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2, 0, 2, 2.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 11, 1.100e+01)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(210, 357, 0, 0.50200799, 0.98762913, 260, 2.600e+02)
(211, 232, 2, -0.77925539, 0.95778002, 216, 2.160e+02)
(212, 213, 0, -0.27841032, 0.96729478, 33, 3.300e+01)
(-1, -1, -2, -2, 0, 5, 5.000e+00)
(214, 215, 1, -0.2055662, 0.86312057, 28, 2.800e+01)
(-1, -1, -2, -2, 0, 10, 1.000e+01)
(216, 217, 0, -0.17076641, 0.99107606, 18, 1.800e+01)
(-1, -1, -2, -2, 0, 4, 4.000e+00)
(218, 231, 1, -0.01268044, 0.98522814, 14, 1.400e+01)
(219, 220, 2, -1.07046044, 0.91829583, 12, 1.200e+01)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(221, 222, 1, -0.19530946, 0.84535094, 11, 1.100e+01)
(-1, -1, -2, -2, 0, 2, 2.000e+00)
(223, 224, 2, -0.99449396, 0.91829583, 9, 9.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(225, 226, 1, -0.18195356, 0.81127812, 8, 8.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(227, 228, 1, -0.08790884, 0.59167278, 7, 7.000e+00)
(-1, -1, -2, -2, 0, 4, 4.000e+00)
(229, 230, 0, -0.0631225, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2, 0, 2, 2.000e+00)
(-1, -1, -2, -2, 0, 1, 1.000e+00)
(-1, -1, -2, -2, 0, 2, 2.000e+00)
(233, 356, 0, 0.3943641, 0.92366365, 183, 1.830e+02)
(234, 323, 1, -0.12520943, 0.93958762, 174, 1.740e+02)
(235, 312, 0, 0.23289824, 0.97886985, 123, 1.230e+02)
(236, 311, 1, -0.12797654, 0.99357048, 106, 1.060e+02)
(237, 310, 1, -0.12875133, 0.99037484, 104, 1.040e+02)
(238, 267, 2, -0.23482846, 0.99305548, 102, 1.020e+02)
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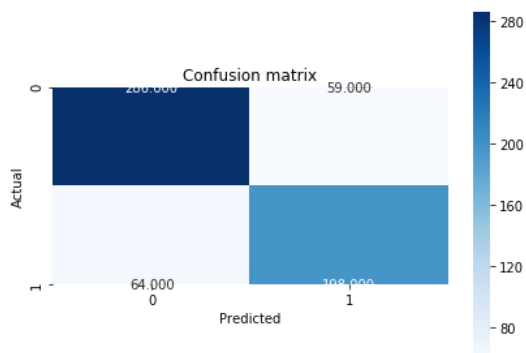
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(508, 535, 2, -0.56401682, 0.92413354, 56, 5.600e+01)
(509, 510, 0, 0.07143238, 0.99107606, 27, 2.700e+01)
( -1, -1, -2, -2, , 0, , 2, 2.000e+00)
(511, 534, 1, 0.43898509, 0.99884554, 25, 2.500e+01)
(512, 529, 1, 0.31468669, 0.98769251, 23, 2.300e+01)
(513, 514, 1, 0.05557485, 0.99750255, 17, 1.700e+01)
( -1, -1, -2, -2, , 0, , 2, 2.000e+00)
(515, 516, 1, 0.09184239, 0.97095059, 15, 1.500e+01)
( -1, -1, -2, -2, , 0, , 2, 2.000e+00)
(517, 518, 1, 0.15493241, 0.99572745, 13, 1.300e+01)
( -1, -1, -2, -2, , 0, , 3, 3.000e+00)
(519, 520, 2, -0.79191649, 0.8812909, 10, 1.000e+01)
( -1, -1, -2, -2, , 0, , 4, 4.000e+00)
(521, 528, 2, -0.61466119, 1, , 6, 6.000e+00)
(522, 523, 1, 0.21676801, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2, , 0, , 1, 1.000e+00)
(524, 525, 0, 0.58274093, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2, , 0, , 2, 2.000e+00)
(526, 527, 0, 0.6231074, 1, , 2, 2.000e+00)
( -1, -1, -2, -2, , 0, , 1, 1.000e+00)
( -1, -1, -2, -2, , 0, , 1, 1.000e+00)
```

```
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(530, 531, 0, 0.50200802, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(532, 533, 0, 0.55582997, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(536, 537, 0, 0.07143238, 0.79732651, 29, 2.900e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(538, 539, 2, -0.33611719, 0.61938219, 26, 2.600e+01)
( -1, -1, -2, -2. , 0. , 10, 1.000e+01)
(540, 541, 1, 0.08490618, 0.81127812, 16, 1.600e+01)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(542, 545, 1, 0.3482978 , 0.99107606, 9, 9.000e+00)
(543, 544, 2, 0.30959846, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(548, 555, 1, 0.2731063 , 0.9612366 , 13, 1.300e+01)
(549, 550, 1, 0.11652498, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(551, 552, 2, 0.01839337, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(553, 554, 0, 1.37661475, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(556, 557, 2, 0.08169882, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(559, 564, 0, 0.31363116, 0.41381685, 60, 6.000e+01)
(560, 563, 1, 0.9127875 , 0.17556503, 38, 3.800e+01)
(561, 562, 1, 0.90872908, 0.35335934, 15, 1.500e+01)
( -1, -1, -2, -2. , 0. , 14, 1.400e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 23, 2.300e+01)
(565, 566, 0, 0.34054215, 0.68403844, 22, 2.200e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(567, 572, 2, -0.8932052 , 0.59167278, 21, 2.100e+01)
(568, 569, 2, -1.0324772 , 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(570, 571, 0, 0.36745313, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(573, 574, 0, 1.87446779, 0.33729007, 16, 1.600e+01)
( -1, -1, -2, -2. , 0. , 14, 1.400e+01)
(575, 576, 0, 3.73132515, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)]
```

Out[126]: 577

```
In [127]: y_pred = classifier.predict(x_validation_scaled_df[['Unemployment', 'Income', 'SelfEmployed']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [128]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.7973640856672158, 0.20263591433278416, array([0.81714286, 0.77042802]), array([0.82898551, 0.75572519]), array([0.82302158, 0.76300578])]
```

MODEL 4

-Variables Used: Hispanic, Black, White, Percent_Women, Unemployment, Income, SelfEmployment

```
In [129]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=1024, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income', 'SelfEmployed']], y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```

```
(( 1, 162, 5, -0.36439811, 0.97615296, 1820, 1.820e+03)
( 2, 41, 5, -0.72862309, 0.62753397, 668, 6.680e+02)
( 3, 8, 5, -0.99544594, 0.23373142, 367, 3.670e+02)
( 4, 7, 4, -1.2472055, 0.04484961, 203, 2.030e+02)
( 5, 6, 6, -1.33634338, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 201, 2.010e+02)
( 9, 36, 3, 1.40783721, 0.39959571, 164, 1.640e+02)
( 10, 17, 3, -1.88811851, 0.34037329, 158, 1.580e+02)
( 11, 12, 0, -0.32422119, 0.86312057, 14, 1.400e+01)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( 13, 16, 3, -2.41706753, 0.98522814, 7, 7.000e+00)
( 14, 15, 4, -0.0631225, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 18, 19, 5, -0.99367499, 0.24988229, 144, 1.440e+02)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 20, 31, 1, -0.55236369, 0.21871039, 143, 1.430e+02)
( 21, 22, 0, -0.51718649, 0.57879462, 29, 2.900e+01)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
( 23, 26, 0, -0.49075289, 0.72192809, 20, 2.000e+01)
( 24, 25, 4, -0.46678717, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 27, 28, 6, 1.19587481, 0.52255937, 17, 1.700e+01)
( -1, -1, -2, -2., 0., 12, 1.200e+01)
( 29, 30, 5, -0.91804075, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 32, 33, 0, 0.47407357, 0.07253718, 114, 1.140e+02)
( -1, -1, -2, -2., 0., 103, 1.030e+02)
( 34, 35, 2, -0.50003746, 0.43949699, 11, 1.100e+01)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 37, 40, 2, 0.43202655, 1., 6, 6.000e+00)
( 38, 39, 6, -1.01981613, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 42, 63, 4, -0.60134205, 0.88411512, 301, 3.010e+02)
( 43, 62, 0, 1.39396292, 0.81127812, 44, 4.400e+01)
( 44, 61, 5, -0.4867411, 0.71206405, 41, 4.100e+01)
( 45, 60, 1, -0.45435581, 0.86312057, 28, 2.800e+01)
( 46, 47, 0, -0.52775994, 0.77934984, 26, 2.600e+01)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( 48, 53, 0, -0.40616538, 0.8812909, 20, 2.000e+01)
( 49, 50, 6, -0.07023427, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 51, 52, 3, -0.01370184, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 54, 55, 4, -1.71814758, 0.61938219, 13, 1.300e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 56, 59, 6, 0.55015922, 0.41381685, 12, 1.200e+01)
( 57, 58, 2, 0.35508732, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 13, 1.300e+01)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 64, 93, 2, 0.33090641, 0.77040588, 257, 2.570e+02)
( 65, 78, 0, 0.06699611, 0.44886449, 128, 1.280e+02)
( 66, 67, 4, 0.42127508, 0.26451737, 89, 8.900e+01)
( -1, -1, -2, -2., 0., 48, 4.800e+01)
( 68, 73, 3, -0.19666116, 0.46121604, 41, 4.100e+01)
( 69, 70, 2, -0.06478115, 0.91829583, 9, 9.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 71, 72, 2, 0.0605199, 1., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 74, 75, 0, -0.14711607, 0.20062232, 32, 3.200e+01)
( -1, -1, -2, -2., 0., 28, 2.800e+01)
( 76, 77, 4, 0.78457326, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 79, 92, 0, 1.12434018, 0.73206669, 39, 3.900e+01)
( 80, 91, 0, 0.84943074, 0.89049164, 26, 2.600e+01)
( 81, 82, 0, 0.10135979, 0.75537541, 23, 2.300e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 83, 84, 6, -0.14620082, 0.59167278, 21, 2.100e+01)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( 85, 90, 4, 0.46164154, 0.84535094, 11, 1.100e+01)
( 86, 87, 5, -0.63483661, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 88, 89, 1, -0.03432199, 0.72192809, 5, 5.000e+00)
```

```
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 13, 1.300e+01)
( 94, 151, 0, -0.32157783, 0.93981545, 129, 1.290e+02)
( 95, 140, 0, -0.42731224, 0.97828239, 104, 1.040e+02)
( 96, 97, 5, -0.70316571, 0.92974322, 84, 8.400e+01)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( 98, 101, 2, 0.47819009, 0.94841039, 79, 7.900e+01)
( 99, 100, 4, 0.48855251, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(102, 103, 2, 0.66504255, 0.92273462, 74, 7.400e+01)
( -1, -1, -2, -2. , 0. , 12, 1.200e+01)
(104, 137, 3, 0.60377565, 0.97280632, 62, 6.200e+01)
(105, 136, 6, 0.42354828, 0.94028596, 56, 5.600e+01)
(106, 123, 4, 0.12525433, 0.97552595, 49, 4.900e+01)
(107, 118, 3, 0.32632785, 0.99498483, 24, 2.400e+01)
(108, 117, 4, 0.01761042, 0.91829583, 18, 1.800e+01)
(109, 116, 3, 0.2421104, 0.99572745, 13, 1.300e+01)
(110, 115, 1, -0.29334284, 0.97095059, 10, 1.000e+01)
(111, 112, 6, -0.04491209, 0.81127812, 8, 8.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(113, 114, 2, 0.78374881, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(119, 120, 3, 0.46107152, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(121, 122, 2, 0.83430892, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(124, 125, 4, 0.24635373, 0.85545081, 25, 2.500e+01)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(126, 131, 5, -0.58956677, 0.96407876, 18, 1.800e+01)
(127, 130, 3, 0.0130094, 0.954434, 8, 8.000e+00)
(128, 129, 6, -0.32345609, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(132, 135, 3, 0.08319494, 0.72192809, 10, 1.000e+01)
(133, 134, 5, -0.52212317, 1. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(138, 139, 0, -0.46696267, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(141, 150, 6, 0.08169882, 0.8812909, 20, 2.000e+01)
(142, 149, 5, -0.41394776, 0.99403021, 11, 1.100e+01)
(143, 148, 4, 0.03106592, 0.81127812, 8, 8.000e+00)
(144, 145, 3, -0.1783067, 1. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(146, 147, 0, -0.3638716, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
(152, 153, 5, -0.69504887, 0.52936087, 25, 2.500e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(154, 161, 6, -0.19684519, 0.41381685, 24, 2.400e+01)
(155, 160, 1, -0.41935298, 0.65002242, 12, 1.200e+01)
(156, 157, 6, -1.07046044, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(158, 159, 0, -0.2581372, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 12, 1.200e+01)
(163, 288, 5, 0.00513972, 0.62946985, 1152, 1.152e+03)
(164, 195, 2, -0.080169, 0.946344, 321, 3.210e+02)
(165, 166, 4, -0.52060911, 0.90294167, 91, 9.100e+01)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(167, 172, 2, -0.81658751, 0.8296071, 84, 8.400e+01)
(168, 171, 2, -2.21248531, 0.23519338, 26, 2.600e+01)
(169, 170, 6, -0.63998336, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 23, 2.300e+01)
(173, 174, 5, -0.26625808, 0.9443872, 58, 5.800e+01)
( -1, -1, -2, -2. , 0. , 15, 1.500e+01)
(175, 194, 0, 0.64324865, 0.99960984, 43, 4.300e+01)
(176, 179, 3, -0.85676593, 0.97402486, 37, 3.700e+01)
```



```
(177, 178, 6, -0.00692882, 0.59167278, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(180, 193, 5, -0.0671371, 0.8812909, 30, 3.000e+01)
(181, 188, 5, -0.16811803, 0.954434, 24, 2.400e+01)
(182, 187, 4, 0.15216531, 0.59167278, 14, 1.400e+01)
(183, 184, 4, -0.37259874, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(185, 186, 3, 0.83138612, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
(189, 190, 0, -0.35858488, 0.8812909, 10, 1.000e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(191, 192, 3, 0.93708783, 0.54356444, 8, 8.000e+00)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
(196, 207, 4, -0.62825301, 0.79359123, 230, 2.300e+02)
(197, 206, 2, 0.69801649, 0.36657801, 57, 5.700e+01)
(198, 201, 5, -0.11270211, 0.65002242, 24, 2.400e+01)
(199, 200, 2, 0.68262866, 0.30954343, 18, 1.800e+01)
( -1, -1, -2, -2., 0., 17, 1.700e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(202, 203, 1, -0.59436709, 1., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(204, 205, 4, -1.13956153, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 33, 3.300e+01)
(208, 235, 3, -0.12427006, 0.87483836, 173, 1.730e+02)
(209, 210, 1, -0.55936426, 0.65654028, 59, 5.900e+01)
( -1, -1, -2, -2., 0., 12, 1.200e+01)
(211, 212, 1, -0.53836256, 0.74673661, 47, 4.700e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(213, 234, 3, -0.36971256, 0.67519144, 45, 4.500e+01)
(214, 215, 3, -1.90580821, 0.77551266, 35, 3.500e+01)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
(216, 219, 3, -1.42005199, 0.84975114, 29, 2.900e+01)
(217, 218, 1, -0.3773496, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
(220, 221, 4, -0.45333166, 0.72192809, 25, 2.500e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(222, 233, 3, -0.3813584, 0.65002242, 24, 2.400e+01)
(223, 232, 6, -0.23482846, 0.55862937, 23, 2.300e+01)
(224, 229, 1, -0.25133947, 0.81127812, 12, 1.200e+01)
(225, 228, 5, -0.33370167, 0.50325833, 9, 9.000e+00)
(226, 227, 2, 0.59909461, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
(230, 231, 3, -1.26712352, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 11, 1.100e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
(236, 255, 2, 0.49577622, 0.94239155, 114, 1.140e+02)
(237, 242, 5, -0.25124191, 0.9985091, 44, 4.400e+01)
(238, 241, 5, -0.35528509, 0.59167278, 14, 1.400e+01)
(239, 240, 3, 0.58937138, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 11, 1.100e+01)
(243, 254, 3, 0.56248966, 0.94807824, 30, 3.000e+01)
(244, 247, 5, -0.16697429, 1., 22, 2.200e+01)
(245, 246, 2, 0.08030428, 0.59167278, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
(248, 249, 0, -0.20791335, 0.91829583, 15, 1.500e+01)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
(250, 251, 5, -0.13332628, 0.99107606, 9, 9.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
(252, 253, 1, -0.53486228, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( -1, -1, -2, -2., 0., 8, 8.000e+00)
(256, 269, 1, -0.52436143, 0.82240423, 70, 7.000e+01)
(257, 268, 1, -0.54536313, 0.57135497, 37, 3.700e+01)
(258, 265, 1, -0.55936426, 0.72192809, 25, 2.500e+01)
(259, 260, 6, -0.86788303, 0.46899559, 20, 2.000e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(261, 264, 5, -0.34986156, 0.29747225, 19, 1.900e+01)
(262, 263, 0, -0.41409545, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
```

```

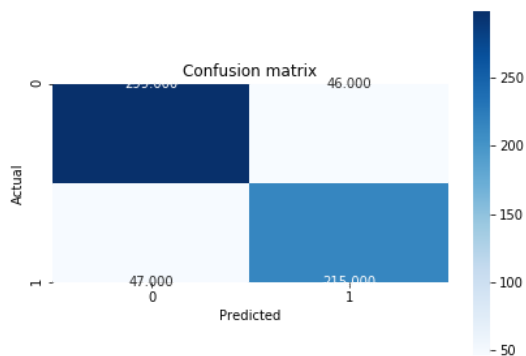
( -1, -1, -2, -2. , 0. , 17, 1.700e+01)
(266, 267, 3, 0.2989339 , 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 12, 1.200e+01)
(270, 287, 5, -0.08798263, 0.96729478, 33, 3.300e+01)
(271, 286, 5, -0.11410411, 1. , 26, 2.600e+01)
(272, 273, 3, 0.21800978, 0.98769251, 23, 2.300e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(274, 275, 3, 0.36425881, 0.93406806, 20, 2.000e+01)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(276, 283, 0, -0.45638922, 1. , 14, 1.400e+01)
(277, 278, 5, -0.28260243, 0.81127812, 8, 8.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(279, 280, 5, -0.17232403, 0.59167278, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(281, 282, 4, -0.00930055, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(284, 285, 0, -0.3506548 , 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(289, 348, 2, -0.29120237, 0.39587247, 831, 8.310e+02)
(290, 331, 5, 0.40887898, 0.80679555, 178, 1.780e+02)
(291, 296, 2, -1.60576433, 0.99871175, 71, 7.100e+01)
(292, 293, 5, 0.02211131, 0.68403844, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(294, 295, 3, 1.16363162, 0.46899559, 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(297, 302, 4, -0.38605423, 0.97986876, 60, 6.000e+01)
(298, 301, 4, -0.77626339, 0.67229482, 17, 1.700e+01)
(299, 300, 2, -1.50464422, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 13, 1.300e+01)
(303, 330, 0, 1.91470492, 0.99960984, 43, 4.300e+01)
(304, 305, 5, 0.09626976, 0.99277445, 40, 4.000e+01)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(306, 309, 0, -0.38501848, 1. , 36, 3.600e+01)
(307, 308, 2, -0.47585656, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(310, 329, 3, 0.73048928, 0.98713777, 30, 3.000e+01)
(311, 328, 3, 0.63934946, 0.99884554, 25, 2.500e+01)
(312, 313, 2, -1.02981916, 0.98522814, 21, 2.100e+01)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(314, 327, 6, 0.4235483 , 0.98869941, 16, 1.600e+01)
(315, 316, 1, -0.57686567, 0.94028596, 14, 1.400e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(317, 322, 3, 0.19713441, 0.89049164, 13, 1.300e+01)
(318, 321, 5, 0.14973025, 0.54356444, 8, 8.000e+00)
(319, 320, 0, 0.6062416 , 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(323, 326, 0, 0.2335278 , 0.97095059, 5, 5.000e+00)
(324, 325, 4, 0.13870983, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(332, 335, 2, -1.93770224, 0.44790786, 107, 1.070e+02)
(333, 334, 5, 0.89404497, 0.97095059, 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(336, 345, 3, 1.05679727, 0.24793584, 97, 9.700e+01)
(337, 342, 4, 1.47080311, 0.14981137, 93, 9.300e+01)
(338, 339, 3, 0.51741213, 0.08728059, 91, 9.100e+01)
( -1, -1, -2, -2. , 0. , 70, 7.000e+01)
(340, 341, 3, 0.53643587, 0.27619543, 21, 2.100e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 20, 2.000e+01)
(343, 344, 2, -0.80779445, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(346, 347, 4, -0.15731093, 1. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(349, 390, 2, 0.50237101, 0.20510748, 653, 6.530e+02)
(350, 375, 5, 0.28941378, 0.35637377, 252, 2.520e+02)
(351, 352, 2, 0.06931296, 0.70246655, 63, 6.300e+01)
( -1, -1, -2, -2. , 0. , 17, 1.700e+01)

```

```
(353, 360, 2, 0.20340708, 0.82805573, 46, 4.600e+01)
(354, 359, 2, 0.1154765, 0.97095059, 10, 1.000e+01)
(355, 358, 2, 0.0912956, 0.91829583, 6, 6.000e+00)
(356, 357, 5, 0.20769191, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(361, 362, 2, 0.32211335, 0.65002242, 36, 3.600e+01)
(-1, -1, -2, -2., 0., 11, 1.100e+01)
(363, 372, 5, 0.22757817, 0.79504028, 25, 2.500e+01)
(364, 367, 5, 0.02830963, 0.6098403, 20, 2.000e+01)
(365, 366, 4, 0.32708665, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(368, 371, 3, -1.05676702, 0.32275696, 17, 1.700e+01)
(369, 370, 3, -1.83333188, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 15, 1.500e+01)
(373, 374, 4, -0.2918658, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(376, 377, 4, -1.59704816, 0.17628983, 189, 1.890e+02)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(378, 389, 5, 0.7917358, 0.14854949, 188, 1.880e+02)
(379, 388, 5, 0.78907937, 0.29747225, 76, 7.600e+01)
(380, 381, 5, 0.50901136, 0.24229219, 75, 7.500e+01)
(-1, -1, -2, -2., 0., 36, 3.600e+01)
(382, 385, 5, 0.53760478, 0.39124356, 39, 3.900e+01)
(383, 384, 6, 0.15766537, 1., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(386, 387, 4, 0.50200802, 0.18717626, 35, 3.500e+01)
(-1, -1, -2, -2., 0., 34, 3.400e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 112, 1.120e+02)
(391, 396, 4, -0.03621153, 0.08062777, 401, 4.010e+02)
(392, 393, 3, 0.72441354, 0.02733106, 364, 3.640e+02)
(-1, -1, -2, -2., 0., 352, 3.520e+02)
(394, 395, 3, 0.74690664, 0.41381685, 12, 1.200e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 11, 1.100e+01)
(397, 402, 1, -0.37034905, 0.40597704, 37, 3.700e+01)
(398, 399, 4, 0.32708666, 0.20559251, 31, 3.100e+01)
(-1, -1, -2, -2., 0., 25, 2.500e+01)
(400, 401, 4, 0.40781958, 0.65002242, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(403, 404, 1, -0.30384369, 0.91829583, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)]
```

Out[129]: 405

```
In [130]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income', 'SelfEmployed']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [131]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8467874794069192, 0.15321252059308077, array([0.86416185, 0.82375479]), array([0.86666667, 0.82061069]), array([0.86541245, 0.82217973])]
```

MODEL 5

- Variables Used: Hispanic, Black, White, Percent_Women, Unemployment, Income, SelfEmployed, Professional

```
In [132]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=None, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income', 'SelfEmployed', 'Professional']], y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```

```
(( 1, 160, 5, -0.36439811, 0.97615296, 1820, 1.820e+03)
( 2, 41, 5, -0.72862309, 0.62753397, 668, 6.680e+02)
( 3, 8, 5, -0.99544594, 0.23373142, 367, 3.670e+02)
( 4, 7, 4, -1.2472055, 0.04484961, 203, 2.030e+02)
( 5, 6, 0, 3.92101538, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 201, 2.010e+02)
( 9, 36, 3, 1.40783721, 0.39959571, 164, 1.640e+02)
( 10, 17, 3, -1.88811851, 0.34037329, 158, 1.580e+02)
( 11, 12, 0, -0.32422119, 0.86312057, 14, 1.400e+01)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( 13, 14, 0, -0.16033287, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 15, 16, 5, -0.85709062, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 18, 19, 5, -0.99367499, 0.24988229, 144, 1.440e+02)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 20, 31, 1, -0.55236369, 0.21871039, 143, 1.430e+02)
( 21, 22, 0, -0.51718649, 0.57879462, 29, 2.900e+01)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
( 23, 26, 0, -0.49075289, 0.72192809, 20, 2.000e+01)
( 24, 25, 5, -0.87166405, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 27, 28, 6, 1.19587481, 0.52255937, 17, 1.700e+01)
( -1, -1, -2, -2., 0., 12, 1.200e+01)
( 29, 30, 5, -0.91804075, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 32, 33, 0, 0.47407357, 0.07253718, 114, 1.140e+02)
( -1, -1, -2, -2., 0., 103, 1.030e+02)
( 34, 35, 0, 0.57716462, 0.43949699, 11, 1.100e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( 37, 38, 0, -0.45903258, 1., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 39, 40, 4, -1.07228415, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 42, 65, 4, -0.60134205, 0.88411512, 301, 3.010e+02)
( 43, 44, 2, -0.90012154, 0.81127812, 44, 4.400e+01)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 45, 64, 5, -0.4867411, 0.71206405, 41, 4.100e+01)
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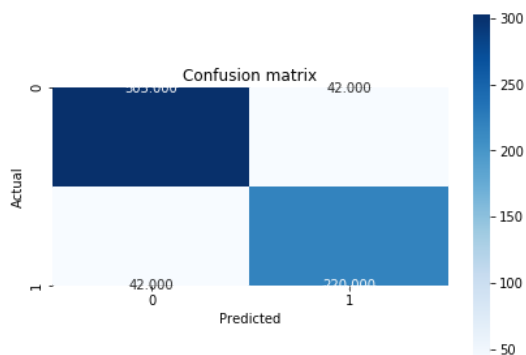


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(-1, -1, -2, -2., 0., 72, 7.200e+01)
(322, 323, 7, 1.92122936, 0.28639696, 20, 2.000e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 19, 1.900e+01)
(325, 326, 5, 1.33906943, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(328, 329, 1, 0.13019125, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(331, 360, 2, 0.50237101, 0.20510748, 653, 6.530e+02)
(332, 349, 5, 0.28941378, 0.35637377, 252, 2.520e+02)
(333, 348, 7, 1.06386453, 0.70246655, 63, 6.300e+01)
(334, 335, 2, 0.1154765, 0.48546076, 57, 5.700e+01)
(-1, -1, -2, -2., 0., 21, 2.100e+01)
(336, 347, 0, 0.24410125, 0.65002242, 36, 3.600e+01)
(337, 346, 5, 0.28188725, 0.52255937, 34, 3.400e+01)
(338, 343, 2, 0.48478489, 0.43949699, 33, 3.300e+01)
(339, 342, 1, -0.58736652, 0.22228483, 28, 2.800e+01)
(340, 341, 2, 0.3924578, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 25, 2.500e+01)
(344, 345, 7, 0.25202342, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 6, 6.000e+00)
(350, 351, 4, -1.59704816, 0.17628983, 189, 1.890e+02)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(352, 357, 7, 2.25507057, 0.14854949, 188, 1.880e+02)
```

```
(353, 354, 4, 0.52891898, 0.05336143, 165, 1.650e+02)
(-1, -1, -2, -2., 0., 159, 1.590e+02)
(355, 356, 4, 0.55582997, 0.65002242, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(358, 359, 5, 0.99447247, 0.55862937, 23, 2.300e+01)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 20, 2.000e+01)
(361, 366, 4, -0.03621153, 0.08062777, 401, 4.010e+02)
(362, 363, 3, 0.72441354, 0.02733106, 364, 3.640e+02)
(-1, -1, -2, -2., 0., 352, 3.520e+02)
(364, 365, 0, -0.17883639, 0.41381685, 12, 1.200e+01)
(-1, -1, -2, -2., 0., 11, 1.100e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(367, 372, 1, -0.37034905, 0.40597704, 37, 3.700e+01)
(368, 371, 5, 0.0917686, 0.20559251, 31, 3.100e+01)
(369, 370, 5, 0.0784127, 0.65002242, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 25, 2.500e+01)
(373, 374, 1, -0.30384369, 0.91829583, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)]
```

Out[132]: 375

```
In [133]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income',
'SelfEmployed', 'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [134]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8616144975288303, 0.13838550247116965, array([0.87826087, 0.83969466]), array([0.87826087, 0.83969466]), array([0.87826087, 0.83969466])]
```

MODEL 6

-Variables Used: Hispanic, Black, White, Unemployment, Income, SelfEmployed, Professional

```
In [135]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=N
one, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed', 'Professional']],
y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```

```
( ( 1, 158, 4, -0.36439811, 0.97615296, 1820, 1.820e+03)
( 2, 43, 4, -0.72862309, 0.62753397, 668, 6.680e+02)
( 3, 8, 4, -0.99544594, 0.23373142, 367, 3.670e+02)
( 4, 7, 3, -1.2472055, 0.04484961, 203, 2.030e+02)
( 5, 6, 6, -0.90124612, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 201, 2.010e+02)
( 9, 36, 5, 1.22119701, 0.39959571, 164, 1.640e+02)
( 10, 35, 1, 3.46595979, 0.32275696, 153, 1.530e+02)
( 11, 34, 4, -0.8283127, 0.29747225, 152, 1.520e+02)
( 12, 31, 4, -0.83218664, 0.40790598, 98, 9.800e+01)
( 13, 14, 4, -0.99367499, 0.33985508, 95, 9.500e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 15, 22, 3, -0.22458837, 0.29980251, 94, 9.400e+01)
( 16, 17, 3, -0.33223227, 0.67229482, 17, 1.700e+01)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( 18, 19, 5, -0.24748955, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 20, 21, 0, -0.50661306, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 23, 30, 4, -0.96054348, 0.17378132, 77, 7.700e+01)
( 24, 29, 4, -0.96205616, 0.50325833, 18, 1.800e+01)
( 25, 26, 2, 0.88486898, 0.32275696, 17, 1.700e+01)
( -1, -1, -2, -2., 0., 15, 1.500e+01)
( 27, 28, 5, 0.27161519, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 59, 5.900e+01)
( 32, 33, 3, 0.56928542, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 54, 5.400e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 37, 38, 4, -0.9232429, 0.9456603, 11, 1.100e+01)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( 39, 40, 1, -0.60136765, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 41, 42, 6, 0.38100752, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 44, 67, 3, -0.60134205, 0.88411512, 301, 3.010e+02)
( 45, 66, 0, 1.39396292, 0.81127812, 44, 4.400e+01)
( 46, 65, 4, -0.4867411, 0.71206405, 41, 4.100e+01)
( 47, 64, 1, -0.45435581, 0.86312057, 28, 2.800e+01)
( 48, 49, 0, -0.52775994, 0.77934984, 26, 2.600e+01)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( 50, 57, 0, -0.40616538, 0.8812909, 20, 2.000e+01)
( 51, 52, 2, 0.8716794, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 53, 54, 2, 0.89146379, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 55, 56, 0, -0.47224937, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 58, 59, 3, -1.71814758, 0.61938219, 13, 1.300e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 60, 63, 5, 0.55015922, 0.41381685, 12, 1.200e+01)
( 61, 62, 4, -0.52994484, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 13, 1.300e+01)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 68, 93, 2, 0.33090641, 0.77040588, 257, 2.570e+02)
( 69, 78, 0, 0.06699611, 0.44886449, 128, 1.280e+02)
( 70, 77, 6, -0.90883344, 0.26451737, 89, 8.900e+01)
( 71, 76, 1, 1.08226788, 0.70246655, 21, 2.100e+01)
( 72, 75, 1, 0.86875069, 0.9456603, 11, 1.100e+01)
( 73, 74, 0, -0.469606, 0.54356444, 8, 8.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( -1, -1, -2, -2., 0., 68, 6.800e+01)
( 79, 92, 0, 1.12434018, 0.73206669, 39, 3.900e+01)
( 80, 91, 0, 0.84943074, 0.89049164, 26, 2.600e+01)
( 81, 82, 0, 0.10135979, 0.75537541, 23, 2.300e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 83, 84, 5, -0.14620082, 0.59167278, 21, 2.100e+01)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( 85, 86, 6, -0.63569066, 0.84535094, 11, 1.100e+01)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( 87, 88, 4, -0.63483661, 1., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
```

```
( 89, 90, 1, -0.03432199, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 13, 1.300e+01)
( 94, 147, 0, -0.32157783, 0.93981545, 129, 1.290e+02)
( 95, 138, 0, -0.42731224, 0.97828239, 104, 1.040e+02)
( 96, 137, 6, 0.25202341, 0.92974322, 84, 8.400e+01)
( 97, 98, 6, -1.56134123, 0.95204028, 78, 7.800e+01)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( 99, 100, 6, -1.40200794, 0.96932538, 73, 7.300e+01)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
(101, 130, 3, 0.48855251, 0.94459118, 69, 6.900e+01)
(102, 103, 2, 0.50017273, 0.98738002, 53, 5.300e+01)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
(104, 113, 2, 0.79693839, 0.96333555, 49, 4.900e+01)
(105, 112, 0, -0.49339624, 0.52255937, 17, 1.700e+01)
(106, 111, 6, -0.40048437, 0.81127812, 8, 8.000e+00)
(107, 108, 4, -0.57200485, 1., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(109, 110, 5, -0.55135575, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
(114, 123, 6, -0.74950016, 0.9971804, 32, 3.200e+01)
(115, 120, 3, 0.12525433, 0.81127812, 16, 1.600e+01)
(116, 117, 0, -0.4960396, 1., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(118, 119, 3, -0.00930055, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(121, 122, 5, -1.0577994, 0.46899559, 10, 1.000e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
(124, 125, 2, 0.89586028, 0.69621226, 16, 1.600e+01)
( -1, -1, -2, -2., 0., 8, 8.000e+00)
(126, 127, 4, -0.63657066, 0.954434, 8, 8.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(128, 129, 5, 0.37290393, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2., 0., 5, 5.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(131, 136, 4, -0.40712222, 0.54356444, 16, 1.600e+01)
(132, 133, 3, 1.01331654, 0.35335934, 15, 1.500e+01)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
(134, 135, 0, -0.49868296, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
(139, 146, 5, 0.08169882, 0.8812909, 20, 2.000e+01)
(140, 145, 4, -0.41394776, 0.99403021, 11, 1.100e+01)
(141, 142, 6, -0.35496058, 0.81127812, 8, 8.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
(143, 144, 4, -0.47312693, 1., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 9, 9.000e+00)
(148, 149, 4, -0.69504887, 0.52936087, 25, 2.500e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
(150, 157, 5, -0.19684519, 0.41381685, 24, 2.400e+01)
(151, 156, 1, -0.41935298, 0.65002242, 12, 1.200e+01)
(152, 153, 4, -0.54359591, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(154, 155, 3, 0.502008, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
( -1, -1, -2, -2., 0., 12, 1.200e+01)
(159, 282, 4, 0.00513972, 0.62946985, 1152, 1.152e+03)
(160, 195, 2, -0.080169, 0.946344, 321, 3.210e+02)
(161, 162, 3, -0.52060911, 0.90294167, 91, 9.100e+01)
( -1, -1, -2, -2., 0., 7, 7.000e+00)
(163, 168, 2, -0.81658751, 0.8296071, 84, 8.400e+01)
(164, 167, 2, -2.21248531, 0.23519338, 26, 2.600e+01)
(165, 166, 6, 0.4568805, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 23, 2.300e+01)
(169, 170, 4, -0.26625808, 0.9443872, 58, 5.800e+01)
( -1, -1, -2, -2., 0., 15, 1.500e+01)
(171, 194, 0, 0.64324865, 0.99960984, 43, 4.300e+01)
(172, 179, 6, -0.41565897, 0.97402486, 37, 3.700e+01)
(173, 178, 4, -0.13849154, 0.91829583, 12, 1.200e+01)
(174, 175, 2, -0.60995066, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
(176, 177, 1, -0.47185722, 0.72192809, 5, 5.000e+00)
```

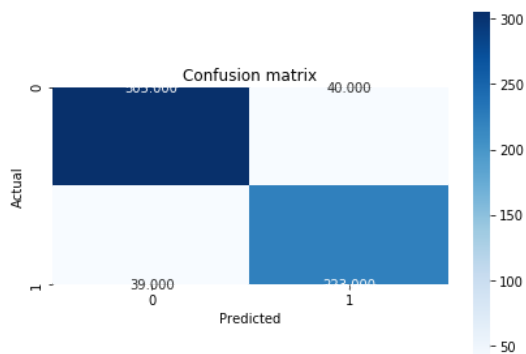
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( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(180, 193, 4, -0.0671371, 0.85545081, 25, 2.500e+01)
(181, 188, 4, -0.14133244, 0.94945202, 19, 1.900e+01)
(182, 183, 2, -0.72865695, 0.65002242, 12, 1.200e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(184, 187, 0, -0.3506548, 0.43949699, 11, 1.100e+01)
(185, 186, 3, 0.20598726, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 8, 8.000e+00)
(189, 192, 3, 0.09834336, 0.86312057, 7, 7.000e+00)
(190, 191, 5, -0.81723863, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(196, 207, 3, -0.62825301, 0.79359123, 230, 2.300e+02)
(197, 206, 2, 0.69801649, 0.36657801, 57, 5.700e+01)
(198, 201, 4, -0.11270211, 0.65002242, 24, 2.400e+01)
(199, 200, 2, 0.68262866, 0.30954343, 18, 1.800e+01)
( -1, -1, -2, -2. , 0. , 17, 1.700e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(202, 203, 3, -1.13956153, 1. , 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(204, 205, 2, 0.6320686, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 33, 3.300e+01)
(208, 233, 2, 0.48918141, 0.87483836, 173, 1.730e+02)
(209, 210, 0, -0.45903258, 0.98115223, 62, 6.200e+01)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(211, 226, 6, 0.02440442, 0.95755348, 58, 5.800e+01)
(212, 213, 3, -0.30532129, 0.83900406, 41, 4.100e+01)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(214, 215, 3, -0.25149935, 0.89805879, 35, 3.500e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(216, 225, 2, 0.39465606, 0.81127812, 32, 3.200e+01)
(217, 224, 5, 0.14500428, 0.93211157, 23, 2.300e+01)
(218, 223, 0, -0.2449204, 0.81127812, 20, 2.000e+01)
(219, 222, 0, -0.35329816, 1. , 10, 1.000e+01)
(220, 221, 6, -0.33978596, 0.86312057, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
(227, 230, 6, 0.63897571, 0.93666738, 17, 1.700e+01)
(228, 229, 4, -0.03083266, 0.46899559, 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(231, 232, 6, 1.2611343, 0.86312057, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(234, 241, 1, -0.55936426, 0.76959448, 111, 1.110e+02)
(235, 236, 5, -0.86788303, 0.34511731, 31, 3.100e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(237, 240, 4, -0.35362484, 0.2108423, 30, 3.000e+01)
(238, 239, 1, -0.56636482, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 28, 2.800e+01)
(242, 281, 6, 0.70726141, 0.8654699, 80, 8.000e+01)
(243, 270, 0, -0.44845913, 0.82635417, 77, 7.700e+01)
(244, 261, 6, -0.15769076, 0.93893201, 45, 4.500e+01)
(245, 246, 1, -0.54536313, 0.99679163, 30, 3.000e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(247, 260, 0, -0.4775361, 0.97511906, 27, 2.700e+01)
(248, 259, 6, -0.37772247, 0.99863596, 23, 2.300e+01)
(249, 256, 4, -0.15808266, 0.94945202, 19, 1.900e+01)
(250, 253, 2, 0.76396444, 0.74959526, 14, 1.400e+01)
(251, 252, 6, -0.44600816, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(254, 255, 2, 0.93982556, 0.43949699, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(257, 258, 2, 0.95301515, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(262, 263, 6, 0.32030912, 0.56650951, 15, 1.500e+01)
( -1, -1, -2, -2. , 0. , 8, 8.000e+00)
(264, 269, 4, -0.07543841, 0.86312057, 7, 7.000e+00)
```

```
(265, 268, 6, 0.37342022, 0.65002242, 6, 6.000e+00)
(266, 267, 3, -0.22458836, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(271, 272, 0, -0.41409545, 0.54356444, 32, 3.200e+01)
(-1, -1, -2, -2., 0., 14, 1.400e+01)
(273, 274, 5, -0.38676155, 0.76420451, 18, 1.800e+01)
(-1, -1, -2, -2., 0., 8, 8.000e+00)
(275, 280, 4, -0.08942153, 0.97095059, 10, 1.000e+01)
(276, 277, 0, -0.32157783, 0.91829583, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(278, 279, 1, -0.40185158, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(283, 336, 2, -0.29120237, 0.39587247, 831, 8.310e+02)
(284, 319, 4, 0.40887898, 0.80679555, 178, 1.780e+02)
(285, 318, 6, 1.24595964, 0.99871175, 71, 7.100e+01)
(286, 307, 3, 0.44818605, 0.98937558, 66, 6.600e+01)
(287, 306, 4, 0.32372591, 0.91829583, 48, 4.800e+01)
(288, 289, 3, -0.80317435, 0.95871188, 42, 4.200e+01)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(290, 305, 4, 0.26941682, 0.89974376, 38, 3.800e+01)
(291, 292, 3, -0.41296521, 0.82240423, 35, 3.500e+01)
(-1, -1, -2, -2., 0., 10, 1.000e+01)
(293, 304, 0, 1.55256456, 0.94268319, 25, 2.500e+01)
(294, 301, 0, 0.54808769, 0.99277445, 20, 2.000e+01)
(295, 296, 6, 0.5024043, 0.86312057, 14, 1.400e+01)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(297, 298, 0, -0.22377351, 0.98522814, 7, 7.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(299, 300, 5, -0.55135575, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(302, 303, 3, 0.30017568, 0.65002242, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 6, 6.000e+00)
(308, 311, 1, 0.0811873, 0.85240518, 18, 1.800e+01)
(309, 310, 5, 0.63878684, 0.43949699, 11, 1.100e+01)
(-1, -1, -2, -2., 0., 10, 1.000e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(312, 317, 4, 0.31088652, 0.98522814, 7, 7.000e+00)
(313, 316, 1, 1.92583585, 0.97095059, 5, 5.000e+00)
(314, 315, 6, 0.03957903, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(320, 323, 2, -1.93770224, 0.44790786, 107, 1.070e+02)
(321, 322, 4, 0.89404497, 0.97095059, 10, 1.000e+01)
(-1, -1, -2, -2., 0., 6, 6.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(324, 333, 6, 4.19741917, 0.24793584, 97, 9.700e+01)
(325, 330, 3, 1.47080311, 0.14854949, 94, 9.400e+01)
(326, 327, 6, 1.89088017, 0.08650421, 92, 9.200e+01)
(-1, -1, -2, -2., 0., 72, 7.200e+01)
(328, 329, 6, 1.92122936, 0.28639696, 20, 2.000e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 19, 1.900e+01)
(331, 332, 4, 1.33906943, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(334, 335, 6, 5.12307, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(337, 366, 2, 0.50237101, 0.20510748, 653, 6.530e+02)
(338, 355, 4, 0.28941378, 0.35637377, 252, 2.520e+02)
(339, 354, 6, 1.06386453, 0.70246655, 63, 6.300e+01)
(340, 341, 2, 0.1154765, 0.48546076, 57, 5.700e+01)
(-1, -1, -2, -2., 0., 21, 2.100e+01)
(342, 343, 2, 0.18582097, 0.65002242, 36, 3.600e+01)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(344, 353, 4, 0.28188725, 0.52255937, 34, 3.400e+01)
(345, 350, 2, 0.48478489, 0.43949699, 33, 3.300e+01)
(346, 347, 4, 0.26679729, 0.22228483, 28, 2.800e+01)
(-1, -1, -2, -2., 0., 25, 2.500e+01)
(348, 349, 1, -0.56286454, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(351, 352, 6, 0.25202342, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
```

```
( -1, -1, -2, -2.      , 0.      , 2, 2.000e+00)
( -1, -1, -2, -2.      , 0.      , 1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      , 6, 6.000e+00)
(356, 357, 3, -1.59704816, 0.17628983, 189, 1.890e+02)
( -1, -1, -2, -2.      , 0.      , 1, 1.000e+00)
(358, 363, 6, 2.25507057, 0.14854949, 188, 1.880e+02)
(359, 360, 3, 0.52891898, 0.05336143, 165, 1.650e+02)
( -1, -1, -2, -2.      , 0.      , 159, 1.590e+02)
(361, 362, 3, 0.55582997, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2.      , 0.      , 1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      , 5, 5.000e+00)
(364, 365, 4, 0.99447247, 0.55862937, 23, 2.300e+01)
( -1, -1, -2, -2.      , 0.      , 3, 3.000e+00)
( -1, -1, -2, -2.      , 0.      , 20, 2.000e+01)
(367, 372, 3, -0.03621153, 0.08062777, 401, 4.010e+02)
(368, 369, 0, -0.12068247, 0.02733106, 364, 3.640e+02)
( -1, -1, -2, -2.      , 0.      , 351, 3.510e+02)
(370, 371, 0, -0.11275239, 0.39124356, 13, 1.300e+01)
( -1, -1, -2, -2.      , 0.      , 1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      , 12, 1.200e+01)
(373, 378, 1, -0.37034905, 0.40597704, 37, 3.700e+01)
(374, 375, 3, 0.32708666, 0.20559251, 31, 3.100e+01)
( -1, -1, -2, -2.      , 0.      , 25, 2.500e+01)
(376, 377, 3, 0.40781958, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2.      , 0.      , 1, 1.000e+00)
( -1, -1, -2, -2.      , 0.      , 5, 5.000e+00)
(379, 380, 1, -0.30384369, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2.      , 0.      , 2, 2.000e+00)
( -1, -1, -2, -2.      , 0.      , 4, 4.000e+00)]
```

Out[135]: 381

```
In [136]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed',
'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [137]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8698517298187809, 0.1301482701812191, array([0.88662791, 0.84790875]), array([0.88405797, 0.85114504]), array([0.885
34107, 0.84952381])]
```

Classification Model Used: K-Nearest Neighbors

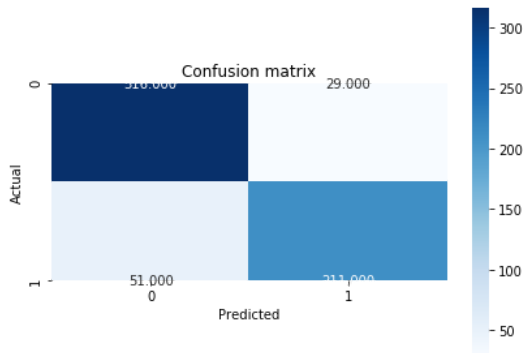
MODEL 1

- Variables: Hispanic, Black, White, Unemployment, Income, SelfEmployed, Professional
- K = 5


```
In [138]: classifier = KNeighborsClassifier(n_neighbors = 5)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed', 'Professional']],
y_train)

Out[138]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=5, p=2,
weights='uniform')

In [139]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed',
'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [140]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8682042833607908, 0.1317957166392092, array([0.86103542, 0.87916667]), array([0.91594203, 0.80534351]), array([0.887
64045, 0.84063745])]
```

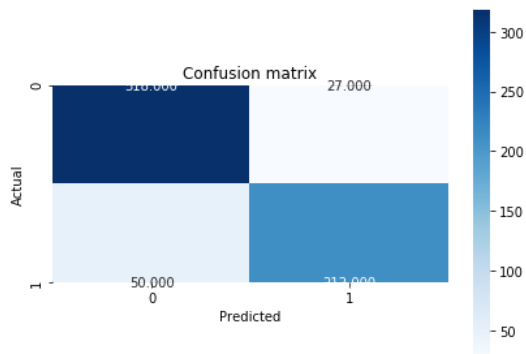
MODEL 2

- Variables: Hispanic, Black, White, Unemployment, Income, SelfEmployed, Professional
- K = 7

```
In [141]: classifier = KNeighborsClassifier(n_neighbors = 7)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed', 'Professional']],
y_train)

Out[141]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=7, p=2,
weights='uniform')
```

```
In [142]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed',
'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [143]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8731466227347611, 0.12685337726523893, array([0.86413043, 0.88702929]), array([0.92173913, 0.80916031]), array([0.89
200561, 0.84630739])]
```

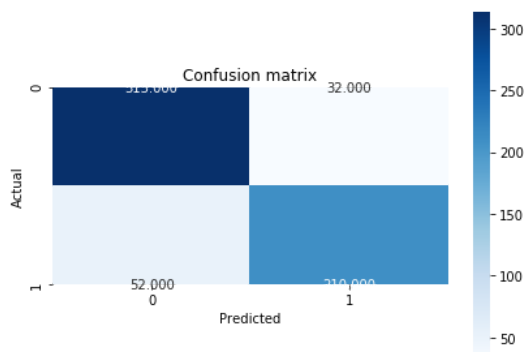
MODEL 3

- Variables: Hispanic, Black, White, Percent_Women, Unemployment, Income, SelfEmployed, Professional
- K = 7

```
In [144]: classifier = KNeighborsClassifier(n_neighbors = 7)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income', 'SelfEmployed',
'Professional']], y_train)
```

```
Out[144]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=7, p=2,
weights='uniform')
```

```
In [145]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income',
'SelfEmployed', 'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [146]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8616144975288303, 0.13838550247116965, array([0.85753425, 0.8677686 ]), array([0.90724638, 0.80152672]), array([0.88169014, 0.83333333])]
```

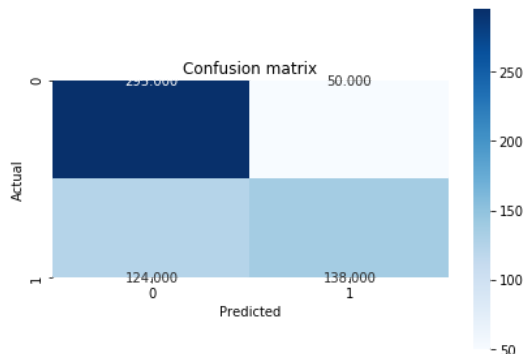
MODEL 4

- Variables: Hispanic, Black, White, Percent_Women
- K = 7

```
In [147]: classifier = KNeighborsClassifier(n_neighbors = 7)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women']], y_train)
```

```
Out[147]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=7, p=2,
weights='uniform')
```

```
In [148]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [149]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.71334431630972, 0.28665568369028005, array([0.70405728, 0.73404255]), array([0.85507246, 0.52671756]), array([0.77225131, 0.61333333])]
```

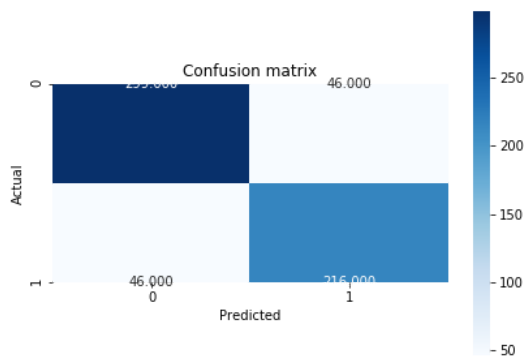
MODEL 5

- Variables: Unemployment, Income, SelfEmployed, Professional
- K = 7

```
In [150]: classifier = KNeighborsClassifier(n_neighbors = 7)
classifier.fit(x_train_scaled_df[['Unemployment', 'Income', 'SelfEmployed', 'Professional']], y_train)
```

```
Out[150]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=7, p=2,
weights='uniform')
```

```
In [151]: y_pred = classifier.predict(x_validation_scaled_df[['Unemployment', 'Income', 'SelfEmployed', 'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [152]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8484349258649094, 0.15156507413509057, array([0.86666667, 0.82442748]), array([0.86666667, 0.82442748]), array([0.86666667, 0.82442748])]
```

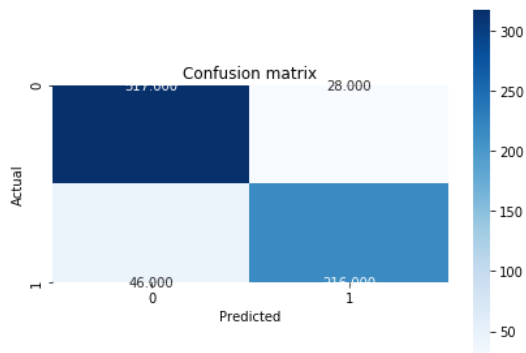
MODEL 6

- Variables: Percent_Women, Unemployment, Income, SelfEmployed, Professional
- K = 7

```
In [153]: classifier = KNeighborsClassifier(n_neighbors = 7)
classifier.fit(x_train_scaled_df[['Percent_Women', 'Unemployment', 'Income', 'SelfEmployed', 'Professional']], y_train)
```

```
Out[153]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=7, p=2,
weights='uniform')
```

```
In [154]: y_pred = classifier.predict(x_validation_scaled_df[['Percent_Women', 'Unemployment', 'Income', 'SelfEmployed', 'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [155]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8780889621087314, 0.12191103789126856, array([0.87327824, 0.8852459 ]), array([0.91884058, 0.82442748]), array([0.89548023, 0.85375494])]
```

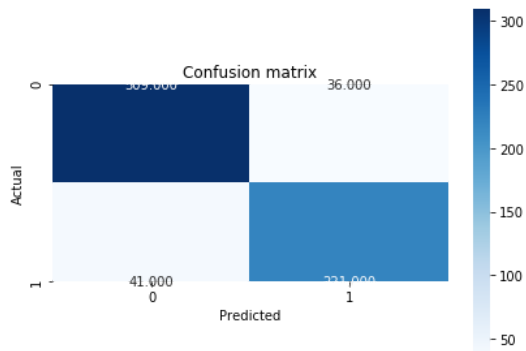
Classification Model Used: Support Vector Machines

MODEL 1

-Variables Used: All

```
In [156]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df, y_train)
y_pred = classifier.predict(x_validation_scaled_df)

In [157]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [158]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

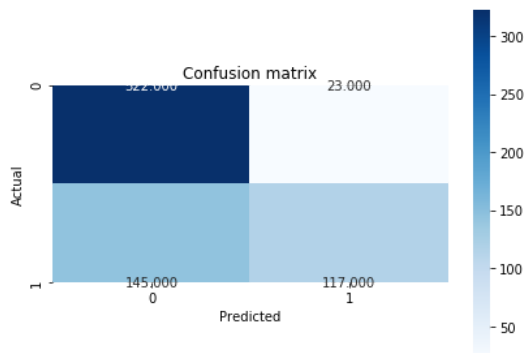
[0.8731466227347611, 0.12685337726523893, array([0.88285714, 0.85992218]), array([0.89565217, 0.84351145]), array([0.8920863, 0.85163776])]
```

MODEL 2

- Variables Used: Hispanic, White, Black

```
In [159]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Hispanic', 'White', 'Black']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'White', 'Black']])
```

```
In [160]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [161]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

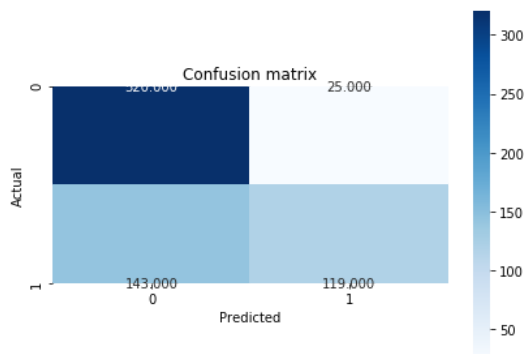
[0.7232289950576606, 0.2767710049423394, array([0.68950749, 0.83571429]), array([0.93333333, 0.44656489]), array([0.79310345, 0.58208955])]
```

MODEL 3

-Variables Used: Hispanic, White, Black, Percent_Women

```
In [162]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Hispanic', 'White', 'Black', 'Percent_Women']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'White', 'Black', 'Percent_Women']])
```

```
In [163]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [164]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

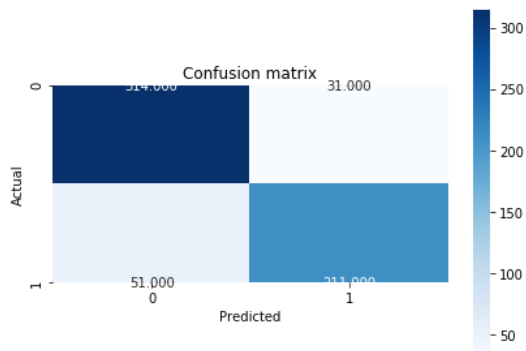
[0.7232289950576606, 0.2767710049423394, array([0.69114471, 0.82638889]), array([0.92753623, 0.45419847]), array([0.79207921, 0.5862069 ])]
```

MODEL 4

-Variables Used: Unemployment, Income, SelfEmployed

```
In [165]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Unemployment', 'Income', 'SelfEmployed']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Unemployment', 'Income', 'SelfEmployed']])
```

```
In [166]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [167]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

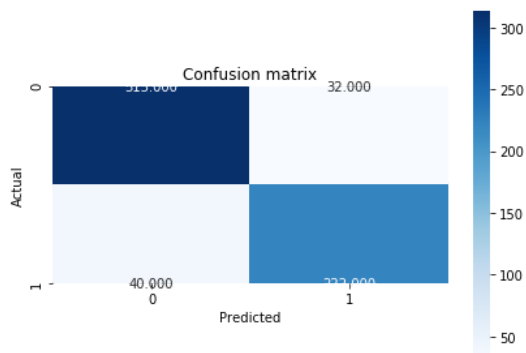
[0.8649093904448105, 0.13509060955518948, array([0.86027397, 0.87190083]), array([0.91014493, 0.80534351]), array([0.88450704, 0.83730159])]
```

MODEL 5

-Variables Used: Unemployment, Income, SelfEmployed, Black, White, Hispanic, Percent_Women

```
In [168]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Unemployment', 'Income', 'SelfEmployed', 'Black', 'White', 'Hispanic', 'Percent_Women']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Unemployment', 'Income', 'SelfEmployed', 'Black', 'White', 'Hispanic', 'Percent_Women']])
```

```
In [169]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [170]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
f1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, f1_score])

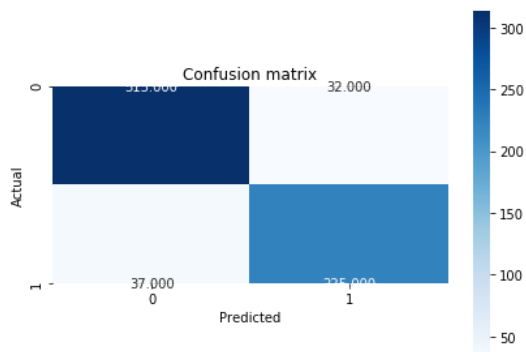
[0.8813838550247117, 0.11861614497528827, array([0.88668555, 0.87401575]), array([0.90724638, 0.84732824]), array([0.89684814, 0.86046512])]
```

MODEL 6

-Variables Used: Unemployment, Income, SelfEmployed, Black, White, Hispanic, Percent_Women, Professional

```
In [171]: classifier_poverty = SVC(kernel = 'rbf')
classifier_poverty.fit(x_train_scaled_df[['Unemployment', 'Income', 'SelfEmployed', 'Black', 'White', 'Hispanic', 'Percent_Women', 'Professional']], y_train)
y_pred = classifier_poverty.predict(x_validation_scaled_df[['Unemployment', 'Income', 'SelfEmployed', 'Black', 'White', 'Hispanic', 'Percent_Women', 'Professional']])
```

```
In [172]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [173]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
f1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, f1_score])

[0.886326194398682, 0.11367380560131801, array([0.89428571, 0.87548638]), array([0.90724638, 0.85877863]), array([0.9071942, 0.86705202])]
```


BEST MODELS FOR Poverty Variable

- The best model for Decision Tree classifier is MODEL 6 with accuracy of 0.87. The variables used in this model are Hispanic, Black, White, Unemployment, Income, SelfEmployed, Professional.
- The best model for K-Nearest Neighbors classifier is MODEL 6 with accuracy of 0.88. The variables used in this model are Percent_Women, Unemployment, Income, SelfEmployed, Professional.
- The best model for Support Vector Machines is MODEL 6 with accuracy of 0.89. The variables used in this model are Unemployment, Income, SelfEmployed, Black, White, Hispanic, Percent_Women, Professional.

We could observe that the shared variables for each of the models are Income, Unemployment, and SelfEmployed. The model that performs the best contains additional variables Black, White, Hispanic, Percent_Women, and Professional.

MODELS FOR CHILD POVERTY

Prepare data

```
In [174]: x_train_full, x_validation_full, y_train, y_validation = train_test_split(data_census[['CountyId', 'State', 'County', 'TotalPop', 'Percent_Women', 'Hispanic', 'White', 'Black', 'Income', 'IncomePerCap', 'Professional', 'Service', 'Production', 'Carpool', 'WorkAtHome', 'PrivateWork', 'PublicWork', 'SelfEmployed', 'Unemployment']], data_census['Child_Poverty_Category'], test_size = 0.25, random_state = 0)

In [175]: # Selecting required variables for x_train
x_train = x_train_full.select_dtypes(include=[np.int64, np.float64])
x_train = x_train.iloc[:, 1:17]

x_train.head()

# Selecting required variables for x_validation
x_validation = x_validation_full.select_dtypes(include=[np.int64, np.float64])
x_validation = x_validation.iloc[:, 1:17]

# Standardizing the data
scaler = StandardScaler()
scaler.fit(x_train)
x_train_scaled = scaler.transform(x_train)
x_validation_scaled = scaler.transform(x_validation)
x_train_scaled_df = pd.DataFrame(x_train_scaled, index = x_train.index, columns=x_train.columns)
x_validation_scaled_df = pd.DataFrame(x_validation_scaled, index = x_validation.index, columns=x_validation.columns)
```

Classification Model Used: Decision Tree Classifier

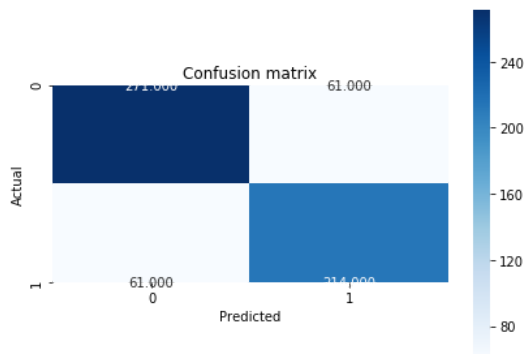
MODEL 1

- Variables Used: All

```
In [176]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=N
one, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df, y_train)
# Show the structure of the decision tree classifier
#print(classifier.tree_.getstate__()[ 'nodes'])
len(classifier.tree_.getstate__()[ 'nodes'])
```

Out[176]: 365

```
In [177]: y_pred = classifier.predict(x_validation_scaled_df)
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [178]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.7990115321252059, 0.20098846787479407, array([0.81626506, 0.77818182]), array([0.81626506, 0.77818182]), array([0.81
626506, 0.77818182])]
```

MODEL 2

-Variables Used: Hispanic, White, Black, Percent_Women

```
In [179]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=None, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Hispanic', 'White', 'Black', 'Percent_Women']], y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```

```
( ( 1, 260, 1, -0.17469436, 0.98612608, 1820, 1.820e+03)
  ( 2, 183, 2, 1.08926845, 0.88884602, 604, 6.040e+02)
  ( 3, 4, 1, -2.63894856, 0.98019627, 369, 3.690e+02)
  (-1, -1, -2, -2., 0., 57, 5.700e+01)
  ( 5, 34, 1, -1.49804938, 0.99988143, 312, 3.120e+02)
  ( 6, 7, 2, -0.60136765, 0.85365767, 61, 6.100e+01)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  ( 8, 9, 2, -0.57336539, 0.81792525, 59, 5.900e+01)
  (-1, -1, -2, -2., 0., 10, 1.000e+01)
  (10, 19, 0, 1.22743124, 0.88864667, 49, 4.900e+01)
  (11, 12, 0, -0.53040332, 0.9456603, 11, 1.100e+01)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (13, 18, 2, 0.93875632, 0.76420451, 9, 9.000e+00)
  (14, 15, 0, 0.03263243, 0.54356444, 8, 8.000e+00)
  (-1, -1, -2, -2., 0., 5, 5.000e+00)
  (16, 17, 1, -1.75524628, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (20, 21, 0, 2.36936295, 0.74248757, 38, 3.800e+01)
  (-1, -1, -2, -2., 0., 15, 1.500e+01)
  (22, 23, 0, 2.41958666, 0.93211157, 23, 2.300e+01)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (24, 25, 3, -4.1205039, 0.81127812, 20, 2.000e+01)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (26, 27, 1, -1.87615085, 0.65002242, 18, 1.800e+01)
  (-1, -1, -2, -2., 0., 9, 9.000e+00)
  (28, 29, 0, 2.49360073, 0.91829583, 9, 9.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (30, 31, 2, -0.55236369, 1., 6, 6.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (32, 33, 0, 2.54911137, 0.81127812, 4, 4.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (35, 44, 0, -0.35329817, 0.99393456, 251, 2.510e+02)
  (36, 37, 1, -0.47146001, 0.74248757, 19, 1.900e+01)
  (-1, -1, -2, -2., 0., 9, 9.000e+00)
  (38, 41, 3, 0.26562937, 0.97095059, 10, 1.000e+01)
  (39, 40, 1, -0.44288258, 0.65002242, 6, 6.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 5, 5.000e+00)
  (42, 43, 0, -0.44845913, 0.81127812, 4, 4.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (45, 168, 2, 0.71123803, 0.98445139, 232, 2.320e+02)
  (46, 125, 1, -0.50883052, 0.96300517, 204, 2.040e+02)
  (47, 122, 1, -0.54400274, 0.9951481, 122, 1.220e+02)
  (48, 121, 0, 2.07066321, 0.98522814, 112, 1.120e+02)
  (49, 120, 0, 2.00722253, 0.99107606, 108, 1.080e+02)
  (50, 51, 3, -5.73297262, 0.98522814, 105, 1.050e+02)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (52, 119, 1, -0.56158885, 0.98025955, 103, 1.030e+02)
  (53, 118, 0, 1.87505454, 0.9891571, 98, 9.800e+01)
  (54, 107, 0, 1.57106811, 0.99351614, 95, 9.500e+01)
  (55, 106, 1, -0.57258016, 0.97244971, 77, 7.700e+01)
  (56, 105, 0, 1.54992121, 0.96261471, 75, 7.500e+01)
  (57, 58, 2, -0.59436709, 0.97255232, 72, 7.200e+01)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (59, 76, 1, -0.82977709, 0.96197806, 70, 7.000e+01)
  (60, 75, 3, 0.94639584, 0.83664074, 30, 3.000e+01)
  (61, 74, 3, 0.41708757, 0.79732651, 29, 2.900e+01)
  (62, 73, 3, 0.29747133, 0.88654089, 23, 2.300e+01)
  (63, 68, 1, -1.17930108, 0.72192809, 20, 2.000e+01)
  (64, 65, 1, -1.37055004, 0.98522814, 7, 7.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (66, 67, 2, 0.09868871, 0.81127812, 4, 4.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (69, 70, 2, 0.07768702, 0.39124356, 13, 1.300e+01)
  (-1, -1, -2, -2., 0., 10, 1.000e+01)
  (71, 72, 0, 1.06089956, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (-1, -1, -2, -2., 0., 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 6, 6.000e+00)
  (-1, -1, -2, -2., 0., 1, 1.000e+00)
  (77, 104, 3, 0.69114012, 0.99819588, 40, 4.000e+01)
  (78, 103, 1, -0.60335585, 0.99777247, 36, 3.600e+01)
  (79, 100, 1, -0.65611419, 0.98999279, 34, 3.400e+01)
  (80, 81, 1, -0.80779445, 1., 28, 2.800e+01)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
  (82, 93, 0, 1.174564, 0.99572745, 26, 2.600e+01)
  (83, 92, 1, -0.69128647, 0.91829583, 18, 1.800e+01)
  (84, 89, 1, -0.74624306, 0.98522814, 14, 1.400e+01)
  (85, 86, 3, 0.32313435, 0.76420451, 9, 9.000e+00)
  (-1, -1, -2, -2., 0., 6, 6.000e+00)
  (87, 88, 1, -0.7682257, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2., 0., 2, 2.000e+00)
```

```
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( 90, 91, 0, -0.05988518, 0.72192809, 5, 5.000e+00)
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( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( 94, 99, 2, -0.36684875, 0.81127812, 8, 8.000e+00)
( 95, 96, 1, -0.73525175, 1. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( 97, 98, 1, -0.67809686, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(101, 102, 0, 1.02124915, 0.65002242, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(108, 109, 0, 1.64243877, 0.91829583, 18, 1.800e+01)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(110, 113, 3, -0.34964634, 0.99572745, 13, 1.300e+01)
(111, 112, 1, -1.21007681, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(114, 117, 1, -1.21667159, 0.81127812, 8, 8.000e+00)
(115, 116, 1, -1.34636921, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(123, 124, 3, 0.54059741, 0.72192809, 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 8, 8.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(126, 167, 1, -0.18348742, 0.85611463, 82, 8.200e+01)
(127, 132, 1, -0.45607217, 0.83049552, 80, 8.000e+01)
(128, 131, 0, -0.19733991, 0.35335934, 15, 1.500e+01)
(129, 130, 0, -0.32686456, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 13, 1.300e+01)
(133, 154, 0, 0.68025568, 0.89049164, 65, 6.500e+01)
(134, 143, 1, -0.3989173 , 0.74014704, 43, 4.300e+01)
(135, 136, 3, -0.82310757, 1. , 8, 8.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(137, 138, 1, -0.41870168, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(139, 140, 3, 0.13658906, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(141, 142, 2, -0.21983692, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(144, 145, 1, -0.24064229, 0.59167278, 35, 3.500e+01)
( -1, -1, -2, -2. , 0. , 21, 2.100e+01)
(146, 151, 0, -0.20791335, 0.94028596, 14, 1.400e+01)
(147, 150, 1, -0.21865965, 0.54356444, 8, 8.000e+00)
(148, 149, 3, -0.08920787, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(152, 153, 3, 0.26381864, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(155, 156, 2, -0.56636482, 1. , 22, 2.200e+01)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(157, 166, 3, -0.10850188, 0.83664074, 15, 1.500e+01)
(158, 165, 2, -0.43335411, 1. , 8, 8.000e+00)
(159, 160, 3, -0.88176554, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(161, 162, 2, -0.52786171, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(163, 164, 1, -0.3197798 , 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(169, 170, 3, 0.28786436, 0.86312057, 28, 2.800e+01)
( -1, -1, -2, -2. , 0. , 10, 1.000e+01)
(171, 172, 2, 0.76024199, 0.99107606, 18, 1.800e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(173, 180, 1, -0.28021105, 0.99679163, 15, 1.500e+01)
(174, 179, 1, -0.46486524, 0.8812909 , 10, 1.000e+01)
(175, 176, 1, -0.66710553, 1. , 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
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(177, 178, 2, 0.83374789, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(181, 182, 3, 0.38071074, 0.72192809, 5, 5.000e+00)
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(-1, -1, -2, -2., 0., 4, 4.000e+00)
(184, 185, 1, -1.58597994, 0.5626665, 235, 2.350e+02)
(-1, -1, -2, -2., 0., 43, 4.300e+01)
(186, 187, 0, -0.55419356, 0.63778696, 192, 1.920e+02)
(-1, -1, -2, -2., 0., 16, 1.600e+01)
(188, 189, 1, -1.56619561, 0.67155148, 176, 1.760e+02)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(190, 255, 2, 2.63289273, 0.65002242, 174, 1.740e+02)
(191, 192, 2, 1.16977495, 0.69709879, 149, 1.490e+02)
(-1, -1, -2, -2., 0., 9, 9.000e+00)
(193, 224, 3, 0.50811353, 0.72192809, 140, 1.400e+02)
(194, 195, 2, 1.19077665, 0.84975114, 58, 5.800e+01)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(196, 201, 0, -0.50661305, 0.81127812, 56, 5.600e+01)
(197, 198, 1, -0.60775241, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(199, 200, 3, 0.45544814, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(202, 203, 0, -0.4643193, 0.75221217, 51, 5.100e+01)
(-1, -1, -2, -2., 0., 9, 9.000e+00)
(204, 215, 1, -0.61654547, 0.8296071, 42, 4.200e+01)
(205, 206, 1, -1.52223033, 0.60518658, 27, 2.700e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(207, 210, 3, -1.71791416, 0.51594693, 26, 2.600e+01)
(208, 209, 3, -2.32870448, 0.91829583, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(211, 212, 3, 0.49689032, 0.28639696, 20, 2.000e+01)
(-1, -1, -2, -2., 0., 18, 1.800e+01)
(213, 214, 0, -0.3638716, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(216, 217, 1, -0.48904614, 0.99679163, 15, 1.500e+01)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(218, 223, 2, 1.53380424, 0.84535094, 11, 1.100e+01)
(219, 220, 3, 0.34881929, 0.72192809, 10, 1.000e+01)
(-1, -1, -2, -2., 0., 6, 6.000e+00)
(221, 222, 3, 0.40029334, 1., 4, 4.000e+00)
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(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(225, 240, 1, -0.87154409, 0.60060858, 82, 8.200e+01)
(226, 227, 0, -0.4299556, 0.82381163, 31, 3.100e+01)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(228, 239, 1, -0.91770765, 0.91829583, 24, 2.400e+01)
(229, 230, 2, 2.188357, 0.84535094, 22, 2.200e+01)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(231, 238, 3, 0.99029136, 0.97095059, 15, 1.500e+01)
(232, 233, 2, 2.32486796, 0.99403021, 11, 1.100e+01)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(234, 237, 1, -1.35076571, 0.86312057, 7, 7.000e+00)
(235, 236, 2, 2.46137881, 0.91829583, 3, 3.000e+00)
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(-1, -1, -2, -2., 0., 2, 2.000e+00)
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(-1, -1, -2, -2., 0., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(241, 242, 1, -0.72645867, 0.39662777, 51, 5.100e+01)
(-1, -1, -2, -2., 0., 18, 1.800e+01)
(243, 244, 1, -0.70667431, 0.53283506, 33, 3.300e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(245, 254, 0, -0.40087865, 0.44886449, 32, 3.200e+01)
(246, 253, 0, -0.41145208, 0.67229482, 17, 1.700e+01)
(247, 252, 3, 1.61129797, 0.54356444, 16, 1.600e+01)
(248, 251, 1, -0.64732113, 0.35335934, 15, 1.500e+01)
(249, 250, 0, -0.4511025, 1., 2, 2.000e+00)
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(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 13, 1.300e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 15, 1.500e+01)
(256, 257, 2, 3.33994961, 0.24229219, 25, 2.500e+01)
(-1, -1, -2, -2., 0., 22, 2.200e+01)
(258, 259, 0, -0.49075289, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(261, 322, 0, -0.53304666, 0.88149186, 1216, 1.216e+03)
(262, 267, 3, -0.39338239, 0.98943402, 91, 9.100e+01)
(263, 264, 1, 0.98598912, 0.59167278, 14, 1.400e+01)
(-1, -1, -2, -2., 0., 9, 9.000e+00)
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(265, 266, 3, -0.98270637, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(268, 297, 2, -0.55236369, 0.9456603, 77, 7.700e+01)
(269, 292, 0, -0.54362011, 1., 42, 4.200e+01)
(270, 271, 1, 0.71780092, 0.9744894, 32, 3.200e+01)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(272, 273, 3, -0.14173291, 0.92936363, 29, 2.900e+01)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(274, 281, 3, 0.08811321, 0.97095059, 25, 2.500e+01)
(275, 276, 1, 0.89586031, 0.91829583, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(277, 280, 2, -0.60136765, 0.72192809, 5, 5.000e+00)
(278, 279, 3, 0.01306421, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(282, 283, 3, 0.18280821, 0.89974376, 19, 1.900e+01)
(-1, -1, -2, -2., 0., 5, 5.000e+00)
(284, 291, 1, 1.03435093, 0.98522814, 14, 1.400e+01)
(285, 288, 1, 0.97499779, 0.99403021, 11, 1.100e+01)
(286, 287, 3, 0.21233317, 0.72192809, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(289, 290, 2, -0.60136765, 0.65002242, 6, 6.000e+00)
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(-1, -1, -2, -2., 0., 5, 5.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(293, 294, 1, 0.97719607, 0.72192809, 10, 1.000e+01)
(-1, -1, -2, -2., 0., 6, 6.000e+00)
(295, 296, 2, -0.59786737, 1., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(298, 299, 2, -0.53836256, 0.72192809, 35, 3.500e+01)
(-1, -1, -2, -2., 0., 8, 8.000e+00)
(300, 317, 2, -0.39135075, 0.82562653, 27, 2.700e+01)
(301, 316, 2, -0.45785609, 0.93666738, 17, 1.700e+01)
(302, 315, 2, -0.47885779, 0.83664074, 15, 1.500e+01)
(303, 304, 1, 0.89586028, 0.91829583, 12, 1.200e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(305, 306, 1, 0.9090499, 0.84535094, 11, 1.100e+01)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(307, 308, 1, 0.91784295, 0.954434, 8, 8.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(309, 314, 0, -0.54890683, 0.86312057, 7, 7.000e+00)
(310, 311, 3, -0.18871226, 1., 4, 4.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(312, 313, 0, -0.55948028, 0.91829583, 3, 3.000e+00)
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(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(318, 319, 3, 0.75711304, 0.46899559, 10, 1.000e+01)
(-1, -1, -2, -2., 0., 8, 8.000e+00)
(320, 321, 2, -0.09382678, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(323, 622, 2, -0.4753575, 0.85423681, 1125, 1.125e+03)
(324, 451, 3, 0.09579572, 0.7626471, 646, 6.460e+02)
(325, 406, 0, -0.4114521, 0.62548664, 339, 3.390e+02)
(326, 405, 3, 0.04525542, 0.73146256, 166, 1.660e+02)
(327, 404, 3, 0.04367012, 0.76683793, 152, 1.520e+02)
(328, 403, 2, -0.52436143, 0.74780616, 150, 1.500e+02)
(329, 338, 2, -0.59436709, 0.77838735, 139, 1.390e+02)
(330, 331, 3, -0.5167377, 0.47983202, 29, 2.900e+01)
(-1, -1, -2, -2., 0., 13, 1.300e+01)
(332, 333, 3, -0.49799383, 0.69621226, 16, 1.600e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(334, 337, 2, -0.60136765, 0.56650951, 15, 1.500e+01)
(335, 336, 3, -0.18422143, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 10, 1.000e+01)
(339, 344, 3, -0.88573155, 0.83218427, 110, 1.100e+02)
(340, 341, 2, -0.55586398, 0.65002242, 6, 6.000e+00)
(-1, -1, -2, -2., 0., 4, 4.000e+00)
(342, 343, 0, -0.47489272, 1., 2, 2.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(345, 348, 1, 0.40125085, 0.77934984, 104, 1.040e+02)
(346, 347, 0, -0.45374586, 0.97095059, 5, 5.000e+00)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(349, 350, 1, 0.6672408, 0.74551784, 99, 9.900e+01)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(351, 400, 2, -0.531362, 0.77496727, 92, 9.200e+01)
(352, 361, 2, -0.58736652, 0.74808811, 89, 8.900e+01)
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(353, 354, 3, -0.30986591, 0.9612366, 13, 1.300e+01)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(355, 356, 1, 0.8716794, 1., 10, 1.000e+01)
(-1, -1, -2, -2., 0., 3, 3.000e+00)
(357, 360, 0, -0.51454315, 0.86312057, 7, 7.000e+00)
(358, 359, 3, -0.00650951, 0.91829583, 3, 3.000e+00)
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(362, 363, 3, -0.74443981, 0.68920199, 76, 7.600e+01)
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(364, 365, 3, -0.48682129, 0.66527352, 75, 7.500e+01)
(-1, -1, -2, -2., 0., 9, 9.000e+00)
(366, 367, 3, -0.43601461, 0.71582593, 66, 6.600e+01)
(-1, -1, -2, -2., 0., 2, 2.000e+00)
(368, 369, 2, -0.58036596, 0.66197606, 64, 6.400e+01)
(-1, -1, -2, -2., 0., 7, 7.000e+00)
(370, 399, 1, 0.93323079, 0.707669, 57, 5.700e+01)
(371, 372, 0, -0.52247322, 0.74441318, 52, 5.200e+01)
(-1, -1, -2, -2., 0., 1, 1.000e+00)
(373, 374, 0, -0.51189977, 0.71401528, 51, 5.100e+01)
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(456, 465, 3, 0.16070911, 0.67694187, 28, 2.800e+01)
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(656, 657, 2, -0.06232425, 0.74959526, 14, 1.400e+01)
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(658, 659, 2, 0.01818223, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(660, 661, 0, -0.48810953, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(666, 671, 0, -0.46960603, 0.65002242, 12, 1.200e+01)
(667, 670, 0, -0.51189977, 0.43949699, 11, 1.100e+01)
(668, 669, 1, 0.76396444, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(673, 686, 3, 0.82934424, 0.97741782, 34, 3.400e+01)
(674, 675, 0, -0.51718649, 0.89049164, 26, 2.600e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(676, 685, 3, 0.65067703, 0.75537541, 23, 2.300e+01)
(677, 678, 3, 0.57964727, 0.89603823, 16, 1.600e+01)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(679, 682, 0, -0.48546617, 1. , 10, 1.000e+01)
(680, 681, 2, 1.05426565, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(683, 684, 1, 0.17043312, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(687, 688, 0, -0.52247322, 0.81127812, 8, 8.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(691, 886, 0, 0.51901071, 0.91105945, 377, 3.770e+02)
(692, 847, 2, 0.31570619, 0.90530948, 374, 3.740e+02)
(693, 710, 3, -1.14301354, 0.87671629, 324, 3.240e+02)
(694, 709, 3, -1.34979284, 1. , 32, 3.200e+01)
(695, 696, 1, 0.10448518, 0.97511906, 27, 2.700e+01)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(697, 708, 3, -1.54161787, 0.99836367, 21, 2.100e+01)
(698, 707, 3, -1.98443788, 0.99107606, 18, 1.800e+01)
(699, 700, 1, 0.20560534, 0.98522814, 14, 1.400e+01)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(701, 706, 1, 0.53754324, 0.97095059, 10, 1.000e+01)
(702, 705, 0, -0.35329816, 0.81127812, 8, 8.000e+00)
(703, 704, 0, -0.39823529, 1. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
```

```
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(711, 744, 2, -0.42635354, 0.84710749, 292, 2.920e+02)
(712, 733, 3, 0.16696493, 0.97552595, 49, 4.900e+01)
(713, 732, 0, -0.15768951, 0.81127812, 28, 2.800e+01)
(714, 727, 0, -0.2449204, 0.88654089, 23, 2.300e+01)
(715, 716, 1, 0.65405124, 0.74248757, 19, 1.900e+01)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(717, 726, 3, 0.03562196, 0.91829583, 12, 1.200e+01)
(718, 719, 0, -0.43788569, 0.99107606, 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(720, 721, 3, -0.96742752, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(722, 723, 3, -0.18017242, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(724, 725, 2, -0.43335411, 0.91829583, 3, 3.000e+00)
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( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(728, 731, 3, -0.18529756, 0.81127812, 4, 4.000e+00)
(729, 730, 3, -0.38244916, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(734, 743, 3, 0.60504445, 0.95871188, 21, 2.100e+01)
(735, 738, 0, -0.35065481, 0.78712659, 17, 1.700e+01)
(736, 737, 0, -0.41938217, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(739, 742, 2, -0.46135637, 0.41381685, 12, 1.200e+01)
(740, 741, 1, 0.62987033, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(745, 752, 1, 0.05832164, 0.80634952, 243, 2.430e+02)
(746, 751, 1, -0.09116033, 0.39845927, 38, 3.800e+01)
(747, 748, 1, -0.11314297, 0.77934984, 13, 1.300e+01)
( -1, -1, -2, -2. , 0. , 8, 8.000e+00)
(749, 750, 3, 0.26619787, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 25, 2.500e+01)
(753, 808, 2, -0.14633101, 0.8527785, 205, 2.050e+02)
(754, 799, 0, -0.03080822, 0.75357256, 134, 1.340e+02)
(755, 770, 1, 0.50237101, 0.69837479, 122, 1.220e+02)
(756, 769, 3, 0.28252339, 0.42881096, 57, 5.700e+01)
(757, 762, 3, 0.18249398, 0.6373875, 31, 3.100e+01)
(758, 759, 0, -0.25285049, 0.26676499, 22, 2.200e+01)
( -1, -1, -2, -2. , 0. , 15, 1.500e+01)
(760, 761, 0, -0.24227704, 0.59167278, 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(763, 768, 1, 0.41004391, 0.99107606, 9, 9.000e+00)
(764, 767, 1, 0.35069078, 0.86312057, 7, 7.000e+00)
(765, 766, 3, 0.22989462, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 26, 2.600e+01)
(771, 788, 0, -0.34801145, 0.85122434, 65, 6.500e+01)
(772, 775, 1, 0.62987033, 0.73676801, 53, 5.300e+01)
(773, 774, 3, 1.37549749, 0.22853814, 27, 2.700e+01)
( -1, -1, -2, -2. , 0. , 26, 2.600e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(776, 779, 3, 0.1165069, 0.9612366, 26, 2.600e+01)
(777, 778, 1, 0.63426685, 0.43949699, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 10, 1.000e+01)
(780, 781, 1, 0.64745644, 0.97095059, 15, 1.500e+01)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(782, 787, 3, 0.39889781, 0.99403021, 11, 1.100e+01)
(783, 786, 1, 0.67383561, 0.86312057, 7, 7.000e+00)
(784, 785, 0, -0.4299556, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(789, 790, 1, 0.51336235, 0.97986876, 12, 1.200e+01)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(791, 798, 2, -0.2058358, 0.99107606, 9, 9.000e+00)
(792, 797, 2, -0.27584144, 0.86312057, 7, 7.000e+00)
```

```

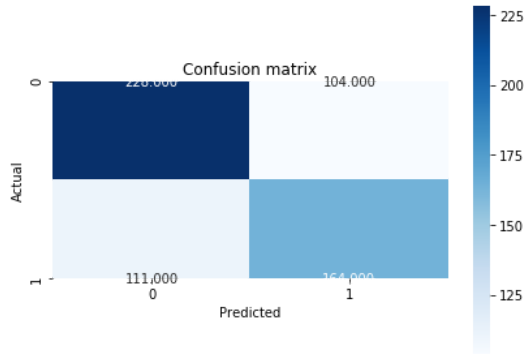
(793, 794, 1, 0.53314671, 1. , 4, 4.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(795, 796, 0, -0.30307433, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(800, 807, 1, 0.19241576, 1. , 12, 1.200e+01)
(801, 806, 3, 0.25338303, 0.91829583, 9, 9.000e+00)
(802, 805, 3, -0.22972 , 0.97095059, 5, 5.000e+00)
(803, 804, 0, 0.30225517, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(-1, -1, -2, -2. , 0. , 4, 4.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(809, 846, 0, 0.00884219, 0.96755948, 71, 7.100e+01)
(810, 815, 1, 0.21220013, 0.94884829, 68, 6.800e+01)
(811, 812, 0, -0.22906024, 0.54356444, 16, 1.600e+01)
(-1, -1, -2, -2. , 0. , 13, 1.300e+01)
(813, 814, 2, 0.07068646, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(816, 843, 3, 0.59312624, 0.99037484, 52, 5.200e+01)
(817, 836, 3, 0.35765332, 0.9456603 , 44, 4.400e+01)
(818, 835, 0, -0.21848679, 0.99901027, 27, 2.700e+01)
(819, 828, 2, -0.06232425, 0.97986876, 24, 2.400e+01)
(820, 821, 1, 0.42763002, 0.9456603 , 11, 1.100e+01)
(-1, -1, -2, -2. , 0. , 4, 4.000e+00)
(822, 827, 3, 0.26420499, 0.98522814, 7, 7.000e+00)
(823, 826, 1, 0.49797447, 0.81127812, 4, 4.000e+00)
(824, 825, 1, 0.4715953 , 1. , 2, 2.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(829, 834, 0, -0.39823529, 0.77934984, 13, 1.300e+01)
(830, 831, 0, -0.43788569, 1. , 6, 6.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(832, 833, 3, 0.29625885, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 7, 7.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(837, 838, 1, 0.2385793 , 0.52255937, 17, 1.700e+01)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(839, 840, 2, 0.0251828 , 0.33729007, 16, 1.600e+01)
(-1, -1, -2, -2. , 0. , 11, 1.100e+01)
(841, 842, 2, 0.0426842 , 0.72192809, 5, 5.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 4, 4.000e+00)
(844, 845, 2, 0.14419238, 0.54356444, 8, 8.000e+00)
(-1, -1, -2, -2. , 0. , 7, 7.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(848, 849, 0, -0.43259896, 0.99884554, 50, 5.000e+01)
(-1, -1, -2, -2. , 0. , 6, 6.000e+00)
(850, 859, 1, -0.0867638 , 0.99403021, 44, 4.400e+01)
(851, 852, 3, -0.46929651, 0.84535094, 11, 1.100e+01)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(853, 858, 0, -0.0519551 , 0.72192809, 10, 1.000e+01)
(854, 857, 1, -0.17029783, 0.50325833, 9, 9.000e+00)
(855, 856, 0, -0.15504615, 1. , 2, 2.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 7, 7.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(860, 873, 3, 0.40007676, 0.9456603 , 33, 3.300e+01)
(861, 862, 2, 0.36821041, 0.99679163, 15, 1.500e+01)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(863, 864, 3, -2.11198699, 0.9612366 , 13, 1.300e+01)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(865, 872, 1, 0.09349386, 0.99403021, 11, 1.100e+01)
(866, 871, 3, 0.15077754, 0.91829583, 9, 9.000e+00)
(867, 868, 0, -0.40087865, 1. , 6, 6.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(869, 870, 2, 0.40321323, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(874, 885, 2, 0.55372536, 0.76420451, 18, 1.800e+01)
(875, 880, 0, -0.337438 , 0.9456603 , 11, 1.100e+01)
(876, 879, 3, 0.82069054, 0.97095059, 5, 5.000e+00)
(877, 878, 2, 0.49072027, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)
(-1, -1, -2, -2. , 0. , 1, 1.000e+00)
(-1, -1, -2, -2. , 0. , 2, 2.000e+00)

```

```
(881, 884, 3, 0.53372568, 0.65002242, 6, 6.000e+00)
(882, 883, 1, 0.01435636, 1. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)]
```

Out[179]: 887

```
In [180]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'White', 'Black', 'Percent_Women']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [181]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.6457990115321252, 0.35420098846787484, array([0.67256637, 0.6119403 ]), array([0.68674699, 0.59636364]), array([0.67958271, 0.60405157])]
```

MODEL 3

-Variables Used: Unemployment, Income, SelfEmployed

```
In [182]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=N
one, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Unemployment', 'SelfEmployed', 'Income']], y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```

```
[ ( 1, 330, 2, -2.12834463e-01, 0.98612608, 1820, 1.820e+03)
  ( 2, 29, 2, -9.29847062e-01, 0.77786044, 809, 8.090e+02)
  ( 3, 28, 0, 7.17295825e-01, 0.1854148, 248, 2.480e+02)
  ( 4, 27, 0, 6.90384835e-01, 0.34626857, 108, 1.080e+02)
  ( 5, 18, 1, -5.89339018e-01, 0.31166199, 107, 1.070e+02)
  ( 6, 11, 2, -1.00326765e+00, 0.55477816, 31, 3.100e+01)
  ( 7, 10, 0, -1.00500667e+00, 0.25801867, 23, 2.300e+01)
  ( 8, 9, 1, -1.33634338e+00, 1., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 21, 2.100e+01)
  (12, 17, 2, -9.60543483e-01, 0.954434, 8, 8.000e+00)
  (13, 16, 2, -9.79913235e-01, 0.81127812, 4, 4.000e+00)
  (14, 15, 0, 1.11798845e-01, 1., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (19, 20, 1, 6.38786852e-01, 0.17556503, 76, 7.600e+01)
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  (31, 42, 0, -1.19338351e+00, 0.97009651, 138, 1.380e+02)
  (32, 41, 0, -1.34139389e+00, 0.46899559, 20, 2.000e+01)
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  (35, 38, 0, -1.71814758e+00, 0.65002242, 6, 6.000e+00)
  (36, 37, 1, 1.98086250e+00, 1., 2, 2.000e+00)
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  (43, 112, 0, -3.59143242e-01, 0.99252702, 118, 1.180e+02)
  (44, 69, 1, -1.08217545e-01, 0.99792881, 112, 1.120e+02)
  (45, 60, 1, -5.26033551e-01, 0.91829583, 36, 3.600e+01)
  (46, 47, 2, -7.62086630e-01, 0.99800088, 19, 1.900e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (48, 55, 1, -8.04577559e-01, 0.91829583, 15, 1.500e+01)
  (49, 54, 0, -4.12965208e-01, 0.91829583, 6, 6.000e+00)
  (50, 53, 2, -4.76078525e-01, 0.72192809, 5, 5.000e+00)
  (51, 52, 0, -5.34064606e-01, 1., 2, 2.000e+00)
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  (62, 63, 0, -5.20609111e-01, 0.33729007, 16, 1.600e+01)
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  (64, 67, 2, -4.80026245e-01, 0.59167278, 7, 7.000e+00)
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  (74, 75, 0, -1.00500670e+00, 1., 14, 1.400e+01)
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( 92, 95, 0, -7.08985955e-01, 0.9456603, 11, 1.100e+01)
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(116, 135, 0, -9.00334790e-02, 0.60717165, 47, 4.700e+01)
(117, 124, 1, -6.02000087e-01, 0.79504028, 25, 2.500e+01)
(118, 123, 2, -8.24955285e-01, 0.97095059, 5, 5.000e+00)
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(142, 143, 1, -9.43849564e-01, 0.992476, 98, 9.800e+01)
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(156, 175, 2, -3.89043793e-01, 0.9971804, 64, 6.400e+01)
(157, 158, 1, -6.65305555e-01, 0.93058613, 26, 2.600e+01)
( -1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
(159, 174, 1, -3.22510004e-02, 0.97602065, 22, 2.200e+01)
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(168, 171, 2, -4.80321407e-01, 0.97095059, 5, 5.000e+00)
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(185, 202, 0, 1.76104247e-02, 0.95871188, 21, 2.100e+01)
(186, 195, 1, -5.13372481e-01, 0.99750255, 17, 1.700e+01)
(187, 188, 0, -6.31225035e-02, 0.86312057, 7, 7.000e+00)
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(191, 194, 0, -2.27560396e-02, 0.91829583, 3, 3.000e+00)
(192, 193, 2, -3.10642451e-01, 1. , 2, 2.000e+00)
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( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
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(207, 208, 2, -5.64736605e-01, 1. , 6, 6.000e+00)
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(254, 263, 2, -5.65363795e-01, 0.64094418, 43, 4.300e+01)
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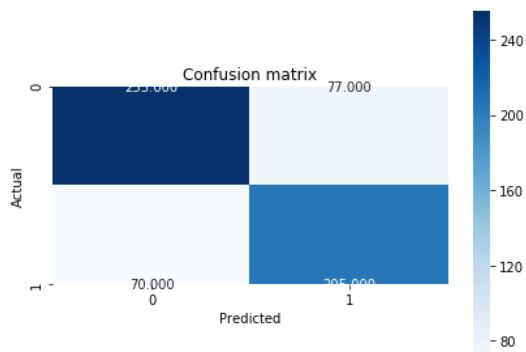
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(515, 520, 0, 6.09651923e-01, 0.91829583, 6, 6.000e+00)
(516, 519, 2, 5.55748474e-02, 0.72192809, 5, 5.000e+00)
(517, 518, 2, -5.52286208e-03, 1., 2, 2.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
(523, 524, 1, -5.13372481e-01, 0.93831535, 124, 1.240e+02)
(-1, -1, -2, -2.00000000e+00, 0., 6, 6.000e+00)
(525, 598, 1, 1.25918031e+00, 0.95285881, 118, 1.180e+02)
(526, 533, 2, -1.71143398e-01, 0.96439862, 113, 1.130e+02)
(527, 532, 2, -2.05639996e-01, 0.61938219, 13, 1.300e+01)
(528, 529, 0, 9.83433574e-02, 1., 4, 4.000e+00)
```

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( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(530, 531, 0, 4.88552511e-01, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 9, 9.000e+00)
(534, 535, 2, -1.49375491e-01, 0.9814539, 100, 1.000e+02)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
(536, 547, 0, -9.00334790e-02, 0.96445906, 95, 9.500e+01)
(537, 546, 1, 1.08192500e+00, 0.68403844, 22, 2.200e+01)
(538, 545, 2, 3.20958793e-01, 0.59167278, 21, 2.100e+01)
(539, 544, 2, 1.37628771e-01, 0.46899559, 20, 2.000e+01)
(540, 541, 2, 9.62328613e-02, 0.68403844, 11, 1.100e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 8, 8.000e+00)
(542, 543, 1, 3.09598464e-01, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 9, 9.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(548, 557, 0, -9.30055184e-03, 0.99335703, 73, 7.300e+01)
(549, 556, 1, 6.13464653e-01, 0.93666738, 17, 1.700e+01)
(550, 555, 1, -1.96845189e-01, 0.83664074, 15, 1.500e+01)
(551, 554, 1, -3.86761546e-01, 0.91829583, 6, 6.000e+00)
(552, 553, 1, -4.88050282e-01, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 9, 9.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(558, 585, 0, 3.40542153e-01, 0.96661863, 56, 5.600e+01)
(559, 568, 2, -7.09372573e-02, 0.89805879, 35, 3.500e+01)
(560, 561, 1, -2.09506281e-01, 0.97095059, 10, 1.000e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(562, 567, 1, 8.16042140e-01, 0.91829583, 6, 6.000e+00)
(563, 564, 2, -1.04659054e-01, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(565, 566, 0, 2.05987263e-01, 1. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(569, 570, 1, -4.37405914e-01, 0.72192809, 25, 2.500e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(571, 576, 2, 1.56297520e-01, 0.65002242, 24, 2.400e+01)
(572, 575, 1, -3.86761561e-01, 0.35335934, 15, 1.500e+01)
(573, 574, 0, 7.14323800e-02, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 12, 1.200e+01)
(577, 584, 0, 2.86720194e-01, 0.91829583, 9, 9.000e+00)
(578, 583, 2, 2.39974812e-01, 0.81127812, 8, 8.000e+00)
(579, 580, 0, 1.76104247e-02, 1. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(581, 582, 0, 1.79076288e-01, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(586, 597, 1, 4.37155471e-02, 0.99836367, 21, 2.100e+01)
(587, 588, 2, -7.52908364e-02, 0.954434, 16, 1.600e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(589, 596, 0, 9.59494591e-01, 1. , 12, 1.200e+01)
(590, 591, 2, -5.18995635e-02, 0.91829583, 9, 9.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(592, 593, 2, 1.88691106e-01, 0.81127812, 8, 8.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
(594, 595, 2, 3.07270840e-01, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 6, 6.000e+00)
(601, 640, 0, -1.16944455e-01, 0.27897003, 518, 5.180e+02)
(602, 639, 2, 1.34157830e+00, 0.1860511, 388, 3.880e+02)
(603, 638, 2, 1.33062053e+00, 0.24363416, 273, 2.730e+02)
(604, 611, 1, -2.85472825e-01, 0.22725656, 272, 2.720e+02)
(605, 606, 0, -2.24588372e-01, 0.06952965, 120, 1.200e+02)
( -1, -1, -2, -2.00000000e+00, 0. , 102, 1.020e+02)
(607, 610, 2, 5.66050619e-01, 0.30954343, 18, 1.800e+01)
(608, 609, 0, -1.97677389e-01, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 15, 1.500e+01)
(612, 613, 2, 5.12848407e-01, 0.324303, 152, 1.520e+02)
( -1, -1, -2, -2.00000000e+00, 0. , 34, 3.400e+01)
(614, 615, 2, 5.15320331e-01, 0.38890223, 118, 1.180e+02)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
(616, 637, 2, 9.92849082e-01, 0.35983402, 117, 1.170e+02)
```

```
(617, 636, 2, 9.82739955e-01, 0.42304882, 93, 9.300e+01)
(618, 635, 2, 8.43388468e-01, 0.38823898, 92, 9.200e+01)
(619, 626, 2, 7.62072444e-01, 0.47825016, 68, 6.800e+01)
(620, 621, 1, -2.60150649e-01, 0.22853814, 54, 5.400e+01)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(622, 625, 2, 5.31664699e-01, 0.1350362, 53, 5.300e+01)
(623, 624, 2, 5.28491765e-01, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 49, 4.900e+01)
(627, 630, 2, 7.81921804e-01, 0.94028596, 14, 1.400e+01)
(628, 629, 1, 1.83933675e-02, 0.81127812, 4, 4.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
(631, 634, 0, -4.26420689e-01, 0.72192809, 10, 1.000e+01)
(632, 633, 2, 8.36526036e-01, 0.50325833, 9, 9.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 8, 8.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 24, 2.400e+01)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 24, 2.400e+01)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 115, 1.150e+02)
(641, 658, 2, 6.31797075e-01, 0.49291578, 130, 1.300e+02)
(642, 651, 2, 5.23252696e-01, 0.74959526, 42, 4.200e+01)
(643, 646, 1, -5.89339018e-01, 0.55477816, 31, 3.100e+01)
(644, 645, 1, -7.28611022e-01, 0.8812909, 10, 1.000e+01)
(-1, -1, -2, -2.00000000e+00, 0., 7, 7.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
(647, 650, 2, 4.55919787e-01, 0.27619543, 21, 2.100e+01)
(648, 649, 2, 4.54148844e-01, 0.46899559, 10, 1.000e+01)
(-1, -1, -2, -2.00000000e+00, 0., 9, 9.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 11, 1.100e+01)
(652, 657, 1, -1.58861917e-01, 0.99403021, 11, 1.100e+01)
(653, 656, 2, 6.24012291e-01, 0.81127812, 8, 8.000e+00)
(654, 655, 0, 5.69285445e-01, 0.59167278, 7, 7.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 6, 6.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
(659, 668, 2, 2.09072626e+00, 0.3146826, 88, 8.800e+01)
(660, 661, 0, 2.73264699e-01, 0.17203695, 78, 7.800e+01)
(-1, -1, -2, -2.00000000e+00, 0., 54, 5.400e+01)
(662, 667, 0, 3.40542153e-01, 0.41381685, 24, 2.400e+01)
(663, 666, 2, 1.01664624e+00, 0.97095059, 5, 5.000e+00)
(664, 665, 2, 7.99409926e-01, 0.91829583, 3, 3.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 19, 1.900e+01)
(669, 670, 0, -6.31225035e-02, 0.8812909, 10, 1.000e+01)
(-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
(671, 672, 2, 2.16263413e+00, 0.54356444, 8, 8.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
(-1, -1, -2, -2.00000000e+00, 0., 7, 7.000e+00)]
```

Out[182]: 673

```
In [183]: y_pred = classifier.predict(x_validation_scaled_df[['Unemployment', 'SelfEmployed', 'Income']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [184]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.7578253706754531, 0.24217462932454692, array([0.78461538, 0.72695035]), array([0.76807229, 0.74545455]), array([0.77625571, 0.73608618])]
```

MODEL 4

-Variables Used: Hispanic, Black, White, Percent_Women, Unemployment, Income, SelfEmployment


```
In [185]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=N
one, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income', 'SelfEmployed'
]], y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```

```
( ( 1, 226, 5, -0.21283446, 0.98612608, 1820, 1.820e+03)
( 2, 25, 5, -0.92984706, 0.77786044, 809, 8.090e+02)
( 3, 24, 4, 0.71729583, 0.1854148, 248, 2.480e+02)
( 4, 5, 0, -0.43788569, 0.34626857, 108, 1.080e+02)
( -1, -1, -2, -2., 0., 59, 5.900e+01)
( 6, 7, 1, -0.58036596, 0.59167278, 49, 4.900e+01)
( -1, -1, -2, -2., 0., 14, 1.400e+01)
( 8, 9, 5, -1.69002646, 0.72192809, 35, 3.500e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 10, 15, 6, -0.8932052, 0.61361902, 33, 3.300e+01)
( 11, 12, 1, 0.41721437, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 13, 14, 4, 0.13870982, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 16, 17, 2, 0.07151122, 0.37123233, 28, 2.800e+01)
( -1, -1, -2, -2., 0., 19, 1.900e+01)
( 18, 23, 1, 0.18269548, 0.76420451, 9, 9.000e+00)
( 19, 22, 1, -0.54536313, 0.54356444, 8, 8.000e+00)
( 20, 21, 5, -1.05414546, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 140, 1.400e+02)
( 26, 87, 4, -0.33223227, 0.90337062, 561, 5.610e+02)
( 27, 58, 1, -0.54536313, 0.97009651, 138, 1.380e+02)
( 28, 57, 3, 0.57191768, 0.82805573, 69, 6.900e+01)
( 29, 52, 5, -0.34761098, 0.88741793, 59, 5.900e+01)
( 30, 41, 2, 0.69801652, 0.96495677, 41, 4.100e+01)
( 31, 36, 1, -0.56636482, 0.94028596, 14, 1.400e+01)
( 32, 33, 2, 0.63426685, 0.54356444, 8, 8.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( 34, 35, 3, -0.57258205, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 37, 40, 4, -0.7897189, 0.91829583, 6, 6.000e+00)
( 38, 39, 6, 1.68965742, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( 42, 51, 0, -0.4299556, 0.82562653, 27, 2.700e+01)
( 43, 50, 1, -0.57686567, 0.98869941, 16, 1.600e+01)
( 44, 49, 2, 0.89805856, 0.89049164, 13, 1.300e+01)
( 45, 46, 2, 0.83870542, 0.98522814, 7, 7.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 47, 48, 4, -0.66861948, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2., 0., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 6, 6.000e+00)
( -1, -1, -2, -2., 0., 3, 3.000e+00)
( -1, -1, -2, -2., 0., 11, 1.100e+01)
( 53, 54, 3, 0.24251702, 0.50325833, 18, 1.800e+01)
( -1, -1, -2, -2., 0., 14, 1.400e+01)
( 55, 56, 5, -0.25397211, 1., 4, 4.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( 59, 60, 3, -0.97095737, 0.99620888, 69, 6.900e+01)
( -1, -1, -2, -2., 0., 8, 8.000e+00)
( 61, 86, 4, -0.35914324, 0.9669853, 61, 6.100e+01)
( 62, 73, 5, -0.53835684, 0.92413354, 56, 5.600e+01)
( 63, 72, 1, 1.86633098, 0.5746357, 22, 2.200e+01)
( 64, 71, 1, -0.30384369, 0.45371634, 21, 2.100e+01)
( 65, 66, 3, -0.45966975, 0.68403844, 11, 1.100e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 67, 68, 3, 0.47076274, 0.46899559, 10, 1.000e+01)
( -1, -1, -2, -2., 0., 8, 8.000e+00)
( 69, 70, 2, 0.57711199, 1., 2, 2.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 74, 79, 4, -0.62825301, 0.99750255, 34, 3.400e+01)
( 75, 76, 2, -0.2516336, 0.77934984, 13, 1.300e+01)
( -1, -1, -2, -2., 0., 2, 2.000e+00)
( 77, 78, 3, 0.36018792, 0.43949699, 11, 1.100e+01)
( -1, -1, -2, -2., 0., 10, 1.000e+01)
( -1, -1, -2, -2., 0., 1, 1.000e+00)
( 80, 85, 5, -0.32912673, 0.86312057, 21, 2.100e+01)
( 81, 82, 3, -0.08400713, 0.99572745, 13, 1.300e+01)
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( 92, 95, 1, -0.5138606, 0.50325833, 27, 2.700e+01)
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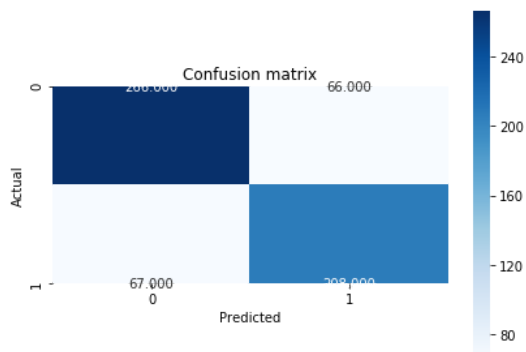
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(360, 369, 3, 0.20661252, 0.99226664, 29, 2.900e+01)
(361, 368, 2, 0.74857658, 0.91829583, 15, 1.500e+01)
(362, 363, 0, -0.43259896, 0.99403021, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(364, 365, 3, -0.18381408, 0.91829583, 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(366, 367, 5, -0.04330308, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 4, 4.000e+00)
(370, 375, 5, -0.12904648, 0.74959526, 14, 1.400e+01)
(371, 372, 6, -0.45006701, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(373, 374, 2, 0.38806127, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(378, 381, 6, -0.36143938, 0.33729007, 16, 1.600e+01)
(379, 380, 5, -0.01109397, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 13, 1.300e+01)
(383, 392, 2, -1.43649805, 0.27897003, 518, 5.180e+02)
(384, 389, 5, 0.90588817, 0.96563613, 23, 2.300e+01)
(385, 386, 0, 2.29534876, 0.72192809, 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 7, 7.000e+00)
(387, 388, 6, -0.032251 , 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(390, 391, 3, 1.03904825, 0.39124356, 13, 1.300e+01)
( -1, -1, -2, -2. , 0. , 12, 1.200e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(393, 396, 0, -0.54362011, 0.20591218, 495, 4.950e+02)
(394, 395, 2, 0.26276021, 1. , 4, 4.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(397, 398, 6, -0.69062775, 0.18688013, 491, 4.910e+02)
( -1, -1, -2, -2. , 0. , 124, 1.240e+02)
(399, 408, 2, -0.50883052, 0.23373142, 367, 3.670e+02)
(400, 407, 2, -0.53740793, 0.54356444, 40, 4.000e+01)
(401, 406, 3, 1.09063745, 0.39845927, 38, 3.800e+01)
(402, 405, 5, 0.5704042 , 0.30337484, 37, 3.700e+01)
(403, 404, 4, -0.22458837, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 32, 3.200e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
(409, 434, 5, 0.8368212 , 0.18181317, 327, 3.270e+02)
(410, 433, 2, 0.83870545, 0.30540057, 165, 1.650e+02)
(411, 426, 5, 0.76207244, 0.39602141, 115, 1.150e+02)
(412, 421, 0, -0.39559193, 0.28017815, 103, 1.030e+02)
(413, 420, 2, 0.83211064, 0.57879462, 29, 2.900e+01)
(414, 415, 0, -0.43259896, 0.49123734, 28, 2.800e+01)
( -1, -1, -2, -2. , 0. , 17, 1.700e+01)
(416, 417, 3, -0.57524276, 0.84535094, 11, 1.100e+01)
( -1, -1, -2, -2. , 0. , 5, 5.000e+00)
(418, 419, 5, 0.59722668, 1. , 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
(422, 423, 3, 0.47907038, 0.10327508, 74, 7.400e+01)
( -1, -1, -2, -2. , 0. , 64, 6.400e+01)
(424, 425, 3, 0.4893057 , 0.46899559, 10, 1.000e+01)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 9, 9.000e+00)
(427, 428, 6, -0.15886191, 0.91829583, 12, 1.200e+01)
( -1, -1, -2, -2. , 0. , 6, 6.000e+00)
(429, 430, 6, 0.24629302, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2. , 0. , 3, 3.000e+00)
(431, 432, 5, 0.77683032, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2. , 0. , 1, 1.000e+00)
( -1, -1, -2, -2. , 0. , 2, 2.000e+00)
( -1, -1, -2, -2. , 0. , 50, 5.000e+01)
( -1, -1, -2, -2. , 0. , 162, 1.620e+02) ]

```

Out[185]: 435

```
In [186]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Percent_Women', 'Unemployment', 'Income', 'SelfEmployed']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [187]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.7808896210873146, 0.21911037891268537, array([0.7987988 , 0.75912409]), array([0.80120482, 0.75636364]), array([0.8 , 0.75774135])]
```

MODEL 5

-Variables Used: Hispanic, Black, White, Unemployment, Income, SelfEmployment

```
In [188]: classifier = DecisionTreeClassifier(criterion = "entropy", splitter="best", min_weight_fraction_leaf=0.0, max_features=None, random_state=0, max_leaf_nodes=None, min_impurity_decrease=0.0, min_impurity_split=None, class_weight=None)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed', 'WorkAtHome', 'PublicWork']], y_train)

# Show the structure of the decision tree classifier
print(classifier.tree_.getstate__()['nodes'])
len(classifier.tree_.getstate__()['nodes'])
```



```
[ ( 1, 216, 4, -2.12834463e-01, 0.98612608, 1820, 1.820e+03)
  ( 2, 19, 4, -9.29847062e-01, 0.77786044, 809, 8.090e+02)
  ( 3, 18, 3, 7.17295825e-01, 0.1854148, 248, 2.480e+02)
  ( 4, 5, 0, -4.37885687e-01, 0.34626857, 108, 1.080e+02)
  (-1, -1, -2, -2.00000000e+00, 0., 59, 5.900e+01)
  ( 6, 7, 1, -5.80365956e-01, 0.59167278, 49, 4.900e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 14, 1.400e+01)
  ( 8, 9, 4, -1.69002646e+00, 0.72192809, 35, 3.500e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (10, 15, 6, -8.57785761e-01, 0.61361902, 33, 3.300e+01)
  (11, 14, 2, -1.03149563e-03, 0.99107606, 9, 9.000e+00)
  (12, 13, 5, -9.94493961e-01, 0.65002242, 6, 6.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (16, 17, 7, -8.82457525e-01, 0.24988229, 24, 2.400e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 23, 2.300e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 140, 1.400e+02)
  (20, 77, 3, -3.32232267e-01, 0.90337062, 561, 5.610e+02)
  (21, 32, 6, -5.70824593e-01, 0.97009651, 138, 1.380e+02)
  (22, 31, 1, -2.37338334e-01, 0.90592822, 28, 2.800e+01)
  (23, 30, 0, 3.15471962e-01, 0.99800088, 19, 1.900e+01)
  (24, 25, 5, -8.17238688e-01, 0.94028596, 14, 1.400e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (26, 29, 1, -4.99859467e-01, 0.81127812, 12, 1.200e+01)
  (27, 28, 1, -5.48863411e-01, 0.98522814, 7, 7.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 9, 9.000e+00)
  (33, 42, 7, -5.75353980e-01, 0.91211563, 110, 1.100e+02)
  (34, 39, 4, -4.49920133e-01, 0.96407876, 18, 1.800e+01)
  (35, 36, 5, 1.29716355e+00, 0.65002242, 12, 1.200e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 8, 8.000e+00)
  (37, 38, 0, -5.56836903e-01, 1., 4, 4.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (40, 41, 3, -8.70451808e-01, 0.65002242, 6, 6.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 5, 5.000e+00)
  (43, 44, 7, -4.41488355e-01, 0.84394912, 92, 9.200e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 9, 9.000e+00)
  (45, 46, 7, -4.02116105e-01, 0.88275868, 83, 8.300e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (47, 54, 5, -1.08217545e-01, 0.84854818, 80, 8.000e+01)
  (48, 51, 5, -5.26033551e-01, 0.98869941, 16, 1.600e+01)
  (49, 50, 4, -8.20527911e-01, 0.59167278, 7, 7.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 6, 6.000e+00)
  (52, 53, 3, -4.12965193e-01, 0.50325833, 9, 9.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 8, 8.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (55, 74, 6, 3.10903049e+00, 0.72813424, 64, 6.400e+01)
  (56, 61, 2, -4.03313830e-01, 0.62924922, 57, 5.700e+01)
  (57, 60, 5, 1.47441888e+00, 1., 8, 8.000e+00)
  (58, 59, 6, -3.51383686e-01, 0.72192809, 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (62, 63, 7, 3.88530514e-02, 0.47543165, 49, 4.900e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 22, 2.200e+01)
  (64, 69, 0, -4.37885687e-01, 0.69128987, 27, 2.700e+01)
  (65, 66, 4, -5.17326847e-01, 1., 8, 8.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (67, 68, 7, 8.60997476e-02, 0.72192809, 5, 5.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (70, 71, 1, -3.63348484e-01, 0.29747225, 19, 1.900e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 16, 1.600e+01)
  (72, 73, 6, 6.61420465e-01, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (75, 76, 6, 4.20623505e+00, 0.98522814, 7, 7.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 4, 4.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 3, 3.000e+00)
  (78, 115, 2, -9.11603272e-02, 0.77265709, 423, 4.230e+02)
  (79, 100, 7, 1.08615482e+00, 0.46121604, 164, 1.640e+02)
  (80, 81, 6, -6.38344854e-01, 0.30954343, 126, 1.260e+02)
  (-1, -1, -2, -2.00000000e+00, 0., 64, 6.400e+01)
  (82, 85, 5, -9.94493961e-01, 0.50861133, 62, 6.200e+01)
  (83, 84, 1, 1.54430506e+00, 0.91829583, 3, 3.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 1, 1.000e+00)
  (-1, -1, -2, -2.00000000e+00, 0., 2, 2.000e+00)
  (86, 87, 5, -3.36117193e-01, 0.41868431, 59, 5.900e+01)
  (-1, -1, -2, -2.00000000e+00, 0., 27, 2.700e+01)
  (88, 89, 4, -7.18403250e-01, 0.62526241, 32, 3.200e+01)
```

```

( -1, -1, -2, -2.00000000e+00, 0. , 11, 1.100e+01)
( 90, 99, 5, 3.72903928e-01, 0.79185835, 21, 2.100e+01)
( 91, 96, 2, -4.84649613e-01, 0.91829583, 15, 1.500e+01)
( 92, 95, 6, -5.03304318e-01, 0.68403844, 11, 1.100e+01)
( 93, 94, 7, 3.88530567e-02, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 8, 8.000e+00)
( 97, 98, 2, -2.42840551e-01, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 6, 6.000e+00)
(101, 110, 3, 4.21275079e-01, 0.78974925, 38, 3.800e+01)
(102, 103, 1, -5.62864542e-01, 0.99679163, 15, 1.500e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(104, 105, 0, -4.22025532e-01, 0.9456603 , 11, 1.100e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(106, 109, 2, -8.38570148e-01, 0.76420451, 9, 9.000e+00)
(107, 108, 7, 1.34601164e+00, 0.91829583, 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 6, 6.000e+00)
(111, 112, 4, -4.59660351e-01, 0.42622866, 23, 2.300e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 17, 1.700e+01)
(113, 114, 6, -4.35784027e-01, 0.91829583, 6, 6.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(116, 211, 7, 1.47987729e+00, 0.89187674, 259, 2.590e+02)
(117, 176, 4, -3.83804739e-01, 0.85209241, 245, 2.450e+02)
(118, 169, 5, 1.01861957e+00, 0.75491602, 175, 1.750e+02)
(119, 148, 3, 1.79076292e-01, 0.69128987, 162, 1.620e+02)
(120, 121, 2, 3.30906406e-01, 0.84185219, 74, 7.400e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 13, 1.300e+01)
(122, 147, 5, 4.74192649e-01, 0.91273416, 61, 6.100e+01)
(123, 124, 0, -5.27759939e-01, 0.9612366 , 52, 5.200e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 6, 6.000e+00)
(125, 128, 5, -6.27322286e-01, 0.98769251, 46, 4.600e+01)
(126, 127, 5, -9.69171733e-01, 0.59167278, 7, 7.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 6, 6.000e+00)
(129, 134, 4, -6.21738970e-01, 0.94182854, 39, 3.900e+01)
(130, 133, 7, -4.80860591e-01, 0.54356444, 16, 1.600e+01)
(131, 132, 4, -6.76084965e-01, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 11, 1.100e+01)
(135, 136, 6, -7.73385406e-01, 0.99863596, 23, 2.300e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
(137, 146, 6, 2.73178883e-01, 0.97095059, 20, 2.000e+01)
(138, 145, 4, -4.20515016e-01, 0.87398105, 17, 1.700e+01)
(139, 144, 7, -7.64340788e-01, 0.72192809, 15, 1.500e+01)
(140, 143, 4, -5.13268411e-01, 0.954434 , 8, 8.000e+00)
(141, 142, 5, -2.09506281e-01, 0.97095059, 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 7, 7.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 9, 9.000e+00)
(149, 154, 2, 2.31494126e-02, 0.51078782, 88, 8.800e+01)
(150, 153, 0, -4.08808738e-01, 1. , 6, 6.000e+00)
(151, 152, 6, -8.13025832e-02, 0.81127812, 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 3, 3.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(155, 158, 1, -5.87366521e-01, 0.42080949, 82, 8.200e+01)
(156, 157, 7, 4.67275009e-02, 1. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
(159, 160, 1, -4.36854392e-01, 0.34351974, 78, 7.800e+01)
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( -1, -1, -2, -2.00000000e+00, 0. , 10, 1.000e+01)
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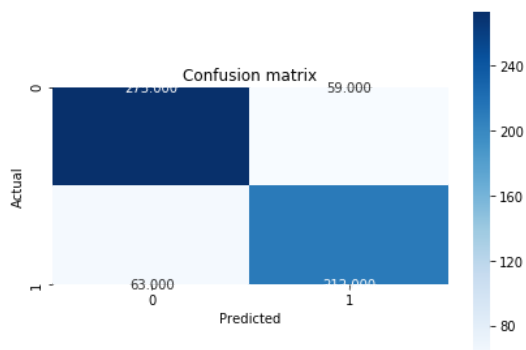
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( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
(401, 402, 7, -4.17865008e-01, 0.72192809, 5, 5.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 4, 4.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 42, 4.200e+01)
(405, 410, 2, -5.08830518e-01, 0.12565805, 174, 1.740e+02)
(406, 409, 2, -5.39606214e-01, 0.59167278, 21, 2.100e+01)
(407, 408, 7, -1.15018877e+00, 0.29747225, 19, 1.900e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 1, 1.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 18, 1.800e+01)
( -1, -1, -2, -2.00000000e+00, 0. , 2, 2.000e+00)
( -1, -1, -2, -2.00000000e+00, 0. , 153, 1.530e+02)]
```

Out[188]: 411

```
In [189]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic','Black','White','Unemployment', 'Income', 'SelfEmployed',
'WorkAtHome', 'PublicWork']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [190]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.7990115321252059, 0.20098846787479407, array([0.8125      , 0.78228782]), array([0.82228916, 0.77090909]), array([0.81736527, 0.77655678])]
```

Classification Model Used: K-Nearest Neighbors

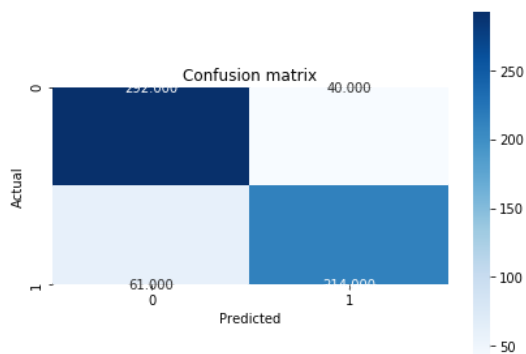
MODEL 1

- Variables Used: All
- K = 13

```
In [191]: classifier = KNeighborsClassifier(n_neighbors = 13)
classifier.fit(x_train_scaled_df, y_train)
```

```
Out[191]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=13, p=2,
weights='uniform')
```

```
In [192]: y_pred = classifier.predict(x_validation_scaled_df)
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [193]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8336079077429983, 0.1663920922570017, array([0.82719547, 0.84251969]), array([0.87951807, 0.77818182]), array([0.85255474, 0.80907372])]
```

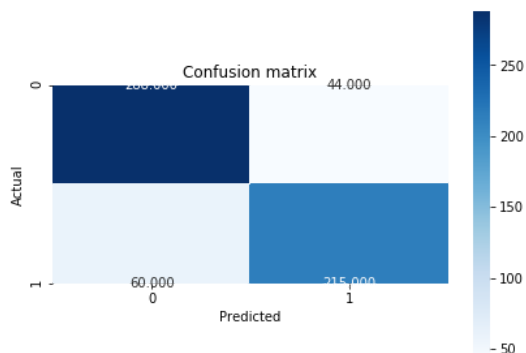
MODEL 2

- Variables Used: Hispanic, Black, White, Unemployment, Income, SelfEmployed, Professional
- K = 13

```
In [194]: classifier = KNeighborsClassifier(n_neighbors = 13)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed', 'Professional']],
y_train)

Out[194]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=13, p=2,
weights='uniform')

In [195]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Income', 'SelfEmployed',
'Professional']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [196]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.828665568369028, 0.17133443163097195, array([0.82758621, 0.83011583]), array([0.86746988, 0.78181818]), array([0.847
05882, 0.80524345])]
```

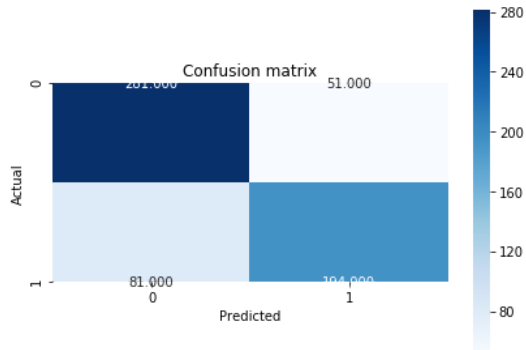
MODEL 3

- Variables Used: Hispanic, Black, White, Percent_Women
- K = 13

```
In [197]: classifier = KNeighborsClassifier(n_neighbors = 13)
classifier.fit(x_train_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Percent_Women']], y_train)

Out[197]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
metric_params=None, n_jobs=None, n_neighbors=13, p=2,
weights='uniform')
```

```
In [198]: y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'Black', 'White', 'Unemployment', 'Percent_Women']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [199]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.7825370675453048, 0.21746293245469517, array([0.77624309, 0.79183673]), array([0.84638554, 0.70545455]), array([0.80979827, 0.74615385])]
```

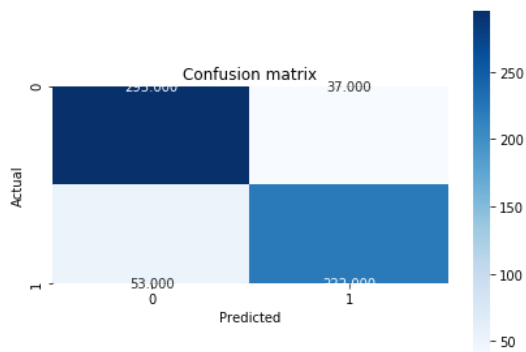
MODEL 4

- Variables Used: White, Hispanic, Black, Unemployment, Income, WorkAtHome
- K = 13

```
In [200]: classifier_childPoverty = KNeighborsClassifier(n_neighbors = 13)
classifier_childPoverty.fit(x_train_scaled_df[['White', 'Hispanic', 'Black', 'Unemployment', 'Income', 'WorkAtHome']], y_train)
```

```
Out[200]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                               metric_params=None, n_jobs=None, n_neighbors=13, p=2,
                               weights='uniform')
```

```
In [201]: y_pred = classifier_childPoverty.predict(x_validation_scaled_df[['White', 'Hispanic', 'Black', 'Unemployment', 'Income', 'WorkAtHome']])
conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```




```
In [202]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - metrics.accuracy_score(y_validation, y_pred)
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8517298187808896, 0.1482701812191104, array([0.84770115, 0.85714286]), array([0.88855422, 0.80727273]), array([0.867
64706, 0.83146067])]
```

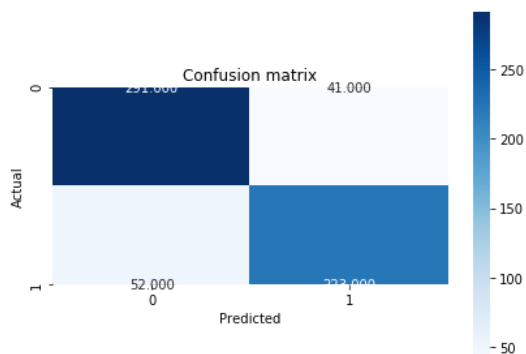
Classification Model Used: Support Vector Machines

MODEL 1

-Variables Used: All

```
In [203]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df, y_train)
y_pred = classifier.predict(x_validation_scaled_df)

In [204]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [205]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

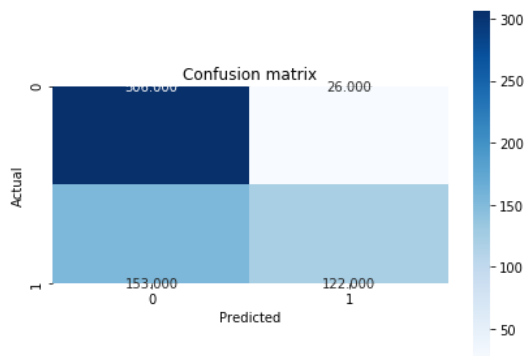
[0.8467874794069192, 0.15321252059308077, array([0.8483965, 0.84469697]), array([0.87650602, 0.81090909]), array([0.86
222222, 0.82745826])]
```

MODEL 2

-Variables Used: Hispanic, White, Black

```
In [206]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Hispanic', 'White', 'Black']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'White', 'Black']])
```

```
In [207]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [208]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

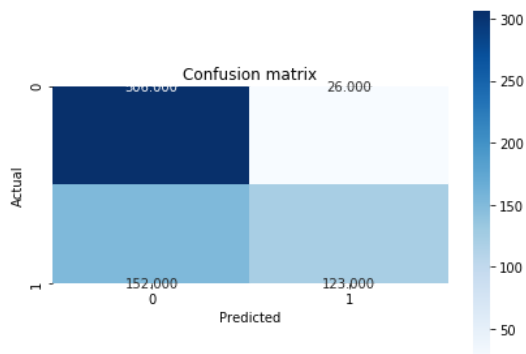
[0.7051070840197694, 0.2948929159802306, array([0.66666667, 0.82432432]), array([0.92168675, 0.44363636]), array([0.77370417, 0.57683215])]
```

MODEL 3

-Variables Used: Hispanic, White, Black, Percent_Women

```
In [209]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Hispanic', 'White', 'Black', 'Percent_Women']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Hispanic', 'White', 'Black', 'Percent_Women']])
```

```
In [210]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [211]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

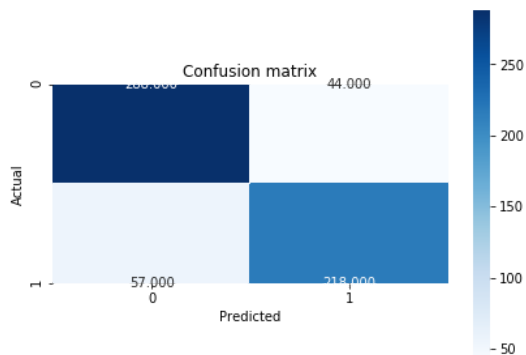
[0.7067545304777595, 0.2932454695222405, array([0.66812227, 0.82550336]), array([0.92168675, 0.44727273]), array([0.77468354, 0.58018868])]
```

MODEL 4

- Variables Used: Unemployment, Income, SelfEmployed

```
In [212]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Unemployment', 'Income', 'SelfEmployed']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Unemployment', 'Income', 'SelfEmployed']])
```

```
In [213]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [214]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

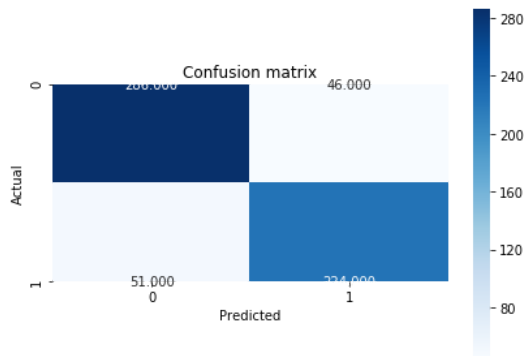
[0.8336079077429983, 0.1663920922570017, array([0.83478261, 0.83206107]), array([0.86746988, 0.79272727]), array([0.85081241, 0.81191806])]
```

MODEL 5

Variables Used: Unemployment, Income, White, Black, Hispanic

```
In [215]: classifier = SVC(kernel = 'rbf')
classifier.fit(x_train_scaled_df[['Unemployment', 'Income', 'White', 'Black', 'Hispanic']], y_train)
y_pred = classifier.predict(x_validation_scaled_df[['Unemployment', 'Income', 'White', 'Black', 'Hispanic']])
```

```
In [216]: conf_matrix = metrics.confusion_matrix(y_validation, y_pred)
sns.heatmap(conf_matrix, annot = True, fmt = ".3f", square = True, cmap = plt.cm.Blues)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title('Confusion matrix')
plt.tight_layout()
```



```
In [217]: accuracy = metrics.accuracy_score(y_validation, y_pred)
error = 1 - accuracy
precision = metrics.precision_score(y_validation, y_pred, average = None)
recall = metrics.recall_score(y_validation, y_pred, average = None)
F1_score = metrics.f1_score(y_validation, y_pred, average = None)
print([accuracy, error, precision, recall, F1_score])

[0.8401976935749588, 0.15980230642504123, array([0.84866469, 0.82962963]), array([0.86144578, 0.81454545]), array([0.85500747, 0.82201835])]
```

BEST MODELS FOR Child Poverty Variable

- The best model for Decision Tree classifier is MODEL 5 with accuracy of 0.80. The variables used in this model are Hispanic, Black, White, Unemployment, Income, SelfEmployment.
- The best model for K-Nearest Neighbors classifier is MODEL 4 with accuracy of 0.85. The variables used in this model are White, Hispanic, Black, Unemployment, Income, WorkAtHome
- The best model for Support Vector Machines is MODEL 1 with accuracy of 0.85. All variables are used in this model.

We could observe that the shared variables for each of the models are Income, Unemployment, Hispanic, Black, and White.

```
In [218]: # Load Census test dataset
test_census = pd.read_csv('test_dp_output.csv')
test_census.head()
```

Out[218]:

	Unnamed: 0	CountyId	State	County	TotalPop	Percent_Women	Hispanic	White	Black	Income	...	Professional	Service	Production	Carpool	WorkAtH
0	0	1005	Alabama	Barbour County	26201.0	46.658524	4.2	45.7	47.8	33368	...	25.0	16.8	24.1	11.1	
1	1	1025	Alabama	Clarke County	24625.0	52.694416	0.2	53.0	45.7	33827	...	21.6	14.3	25.6	11.9	
2	2	1037	Alabama	Coosa County	10955.0	50.031949	0.1	65.3	33.2	34792	...	17.6	23.2	20.9	9.7	
3	3	1047	Alabama	Dallas County	40755.0	53.848608	1.0	27.7	70.2	30065	...	26.7	18.2	25.3	8.9	
4	4	1053	Alabama	Escambia County	37621.0	48.629755	2.2	60.2	32.2	35026	...	24.6	21.2	18.3	7.0	

5 rows x 21 columns

```
In [219]: #Remove unnamed first column
test_census = test_census.loc[:, ~test_census.columns.str.contains('^Unnamed')]
test_census.head()
```

Out[219]:

	CountyId	State	County	TotalPop	Percent_Women	Hispanic	White	Black	Income	IncomePerCap	Professional	Service	Production	Carpool	WorkAtt
0	1005	Alabama	Barbour County	26201.0	46.658524	4.2	45.7	47.8	33368	17561	25.0	16.8	24.1	11.1	
1	1025	Alabama	Clarke County	24625.0	52.694416	0.2	53.0	45.7	33827	20765	21.6	14.3	25.6	11.9	
2	1037	Alabama	Coosa County	10955.0	50.031949	0.1	65.3	33.2	34792	20342	17.6	23.2	20.9	9.7	
3	1047	Alabama	Dallas County	40755.0	53.848608	1.0	27.7	70.2	30065	18248	26.7	18.2	25.3	8.9	
4	1053	Alabama	Escambia County	37621.0	48.629755	2.2	60.2	32.2	35026	18164	24.6	21.2	18.3	7.0	

```
In [220]: test_census = test_census[['CountyId', 'State', 'County', 'TotalPop', 'Percent_Women', 'Hispanic', 'White', 'Black', 'Income', 'IncomePerCap', 'Professional', 'Service', 'Production', 'Carpool', 'WorkAtHome', 'PrivateWork', 'PublicWork', 'SelfEmployed', 'Unemployment']]
test_census.head()
```

Out[220]:

	CountyId	State	County	TotalPop	Percent_Women	Hispanic	White	Black	Income	IncomePerCap	Professional	Service	Production	Carpool	WorkAtt
0	1005	Alabama	Barbour County	26201.0	46.658524	4.2	45.7	47.8	33368	17561	25.0	16.8	24.1	11.1	
1	1025	Alabama	Clarke County	24625.0	52.694416	0.2	53.0	45.7	33827	20765	21.6	14.3	25.6	11.9	
2	1037	Alabama	Coosa County	10955.0	50.031949	0.1	65.3	33.2	34792	20342	17.6	23.2	20.9	9.7	
3	1047	Alabama	Dallas County	40755.0	53.848608	1.0	27.7	70.2	30065	18248	26.7	18.2	25.3	8.9	
4	1053	Alabama	Escambia County	37621.0	48.629755	2.2	60.2	32.2	35026	18164	24.6	21.2	18.3	7.0	

```
In [221]: x_test = test_census.select_dtypes(include=[np.int64,np.float64])
x_test = x_test.iloc[:,1:17]
x_test_scaled = scaler.transform(x_test)
x_test_scaled_df = pd.DataFrame(x_test_scaled,index = x_test.index,columns=x_test.columns)
```

```
In [222]: y_predicted_povertyCat = classifier_poverty.predict(x_test_scaled_df[['Unemployment', 'Income', 'SelfEmployed', 'Black', 'White', 'Hispanic', 'Percent_Women', 'Professional']])
test_census['Poverty Category'] = y_predicted_povertyCat
test_census.head()
```

Out[222]:

	CountyId	State	County	TotalPop	Percent_Women	Hispanic	White	Black	Income	IncomePerCap	Professional	Service	Production	Carpool	WorkAtt
0	1005	Alabama	Barbour County	26201.0	46.658524	4.2	45.7	47.8	33368	17561	25.0	16.8	24.1	11.1	
1	1025	Alabama	Clarke County	24625.0	52.694416	0.2	53.0	45.7	33827	20765	21.6	14.3	25.6	11.9	
2	1037	Alabama	Coosa County	10955.0	50.031949	0.1	65.3	33.2	34792	20342	17.6	23.2	20.9	9.7	
3	1047	Alabama	Dallas County	40755.0	53.848608	1.0	27.7	70.2	30065	18248	26.7	18.2	25.3	8.9	
4	1053	Alabama	Escambia County	37621.0	48.629755	2.2	60.2	32.2	35026	18164	24.6	21.2	18.3	7.0	

```
In [223]: y_predicted_childPovertyCat = classifier_.predict(x_test_scaled_df[['White', 'Hispanic', 'Black', 'Unemployment', 'Income', 'WorkAtHome']])
test_census['Child_Poverty Category'] = y_predicted_childPovertyCat
test_census.head()
```

```
-----
NameError                                Traceback (most recent call last)
<ipython-input-223-b17899c904fd> in <module>
----> 1 y_predicted_childPovertyCat = classifier_.predict(x_test_scaled_df[['White', 'Hispanic', 'Black', 'Unemployment', 'Income', 'WorkAtHome']])
      2 test_census['Child_Poverty Category'] = y_predicted_childPovertyCat
      3 test_census.head()
```

NameError: name 'classifier_' is not defined

```
In [ ]: # Load sample output dataset
sample_output = pd.read_excel('sample_output.xlsx')
sample_output.head()
```

```
In [ ]: #Remove unnamed first column
sample_output = sample_output.loc[:, ~sample_output.columns.str.contains('^Unnamed')]
sample_output.head()
```

```
In [ ]: sample_output['Poverty Category'] = test_census['Poverty Category']
sample_output['Child_Poverty Category'] = test_census['Child_Poverty Category']
sample_output.head()
```

```
In [ ]: sample_output.to_excel("sample_output.xlsx")
```

```
In [ ]:
```