INF264-ex6

October 18, 2019

```
In [1]: from random import seed
        from random import random
        from random import randrange
        import random
        from sklearn.tree import DecisionTreeClassifier
        from sklearn.linear_model import LogisticRegression
        from sklearn.model_selection import train_test_split,KFold,cross_val_score
        from sklearn.neural_network import MLPClassifier
        from sklearn.dummy import DummyClassifier
        from sklearn.metrics import accuracy_score, f1_score, confusion_matrix, recall_score, p
        from sklearn.utils.testing import ignore_warnings
        from sklearn.exceptions import ConvergenceWarning
        import pandas as pd
        import numpy as np
        import missingno as msno
        import matplotlib.pyplot as plt
        import seaborn as sns
        import warnings
```

```
In [2]: plt.rcParams['figure.figsize'] = [20.0, 7.0]
        plt.rcParams.update({'font.size': 22,})
        sns.set_palette('viridis')
        sns.set_style('white')
        sns.set_context('talk', font_scale=0.8)
        warnings.filterwarnings(action='ignore', category=ConvergenceWarning)
```

1 1. Bootstrap

```
In [3]: #TODO
        # Create a random subsample from the dataset with replacement
        def subsample(X,y, ratio=0.8):

            # pick a random subsample of X and the corresponding y
            num_of_instances = X.shape[0]
            indices = np.random.randint(num_of_instances, size=round(num_of_instances*ratio))
            sample_X, sample_y = X[indices,:], y[indices]
            return sample_X, sample_y
```

In [4]:
```
#TODO
# Bootstrap Aggregation Algorithm
def bagging(X_train, y_train, X_test, n_clfs, Classifier):
    clfs = list()
    for i in range(n_clfs):
        # train the clfs on the train subsamples with random_state = seed and add them
        Classifier.random_state = seed
        features, labels = subsample(X_train,y_train)
        clfs.append(Classifier().fit(features, labels))

    index = 0
    y_ = [None] * X_test.shape[0]
    for row in X_test:
        row = row.reshape(1,-1)
        # predict for each of the classifiers
        predicted_y =  list()
        for i in range(0, len(clfs)):
            predicted_y.append(int(clfs[i].predict(row))) # int classes
        #pick the prediction with the highest number
        temp = np.argmax(np.bincount(predicted_y))
        y_[index] = temp
        index = index + 1

    return(y_)
```

In [5]:
```
def KFold_split(X, y, num_folds, seed):
    KFold_splitter = KFold(n_splits=num_folds, shuffle=True, random_state=seed)
    X_train_folds = []
    X_val_folds = []
    y_train_folds = []
    y_val_folds = []
    for (kth_fold_train_idxs, kth_fold_val_idxs) in KFold_splitter.split(X, y):
        X_train_folds.append(X[kth_fold_train_idxs])
        X_val_folds.append(X[kth_fold_val_idxs])
        y_train_folds.append(y[kth_fold_train_idxs])
        y_val_folds.append(y[kth_fold_val_idxs])
    return X_train_folds, X_val_folds, y_train_folds, y_val_folds
```

In [6]:
```
#TODO
def evaluate_algorithm(X_train_val, y_train_val, num_folds, seed, algorithm, *args):
    # Extract train and validation folds:
    X_train_folds, X_val_folds, y_train_folds, y_val_folds = KFold_split(X_train_val, y
    scores = list()

    for X_train_fold, X_val_fold, y_train_fold, y_val_fold in zip(X_train_folds, X_val_
                                                                   , y_train_folds, y_va
        predictions = algorithm(X_train_fold, y_train_fold, X_val_fold, *args)
        scores.append(accuracy_score(y_val_fold, predictions))#compute the accuracy
    return scores
```

```
In [7]: # Test bagging on the sonar dataset
        seed = 2
        # load and prepare data
        filename = 'sonar.all-data'
        dataset = pd.read_csv(filename,header=None)
        X = dataset.iloc[:,:-1].to_numpy()
        y = (dataset.iloc[:,-1].to_numpy()=='M').astype(int)
        # evaluate algorithm
        num_folds = 5
        sample_size = 0.8
        random.seed(seed)
        # Extract a test set:
        X_train_val, X_test, y_train_val, y_test = train_test_split(X, y, test_size=0.3, shuffl




        # For each hyper-parameter instance, do KFold cross validation:
        for n_trees in [10, 50, 100, 150, 200]:
            scores = evaluate_algorithm(X_train_val, y_train_val, num_folds, seed, bagging, n_t
            print('Trees: %d' % n_trees)
            print('Scores: %s' % scores)
            print('Mean Accuracy: %.3f' % (sum(scores)/float(len(scores))))
```

```
Trees: 10
Scores: [0.7241379310344828, 0.7931034482758621, 0.7241379310344828, 0.6896551724137931, 0.7586
Mean Accuracy: 0.738
Trees: 50
Scores: [0.8620689655172413, 0.7586206896551724, 0.8275862068965517, 0.7931034482758621, 0.7241
Mean Accuracy: 0.793
Trees: 100
Scores: [0.7586206896551724, 0.7931034482758621, 0.7586206896551724, 0.7931034482758621, 0.6896
Mean Accuracy: 0.759
Trees: 150
Scores: [0.7931034482758621, 0.7931034482758621, 0.8275862068965517, 0.8275862068965517, 0.6896
Mean Accuracy: 0.786
Trees: 200
Scores: [0.7586206896551724, 0.7586206896551724, 0.7586206896551724, 0.8275862068965517, 0.6896
Mean Accuracy: 0.759
```

```
In [8]: Best_n = 50
        print('Test set Accuracy: %.3f' %(accuracy_score(bagging(X_train_val,y_train_val,X_tes
                                                                    ,DecisionTreeClassifier),y
```

```
Test set Accuracy: 0.794
```

2 2. Missing numerical values

In [9]:
```
def load_diabetes():
    dataset = pd.read_csv('pima-indians-diabetes.csv', header=None)
    print(dataset.describe())
    return dataset
```

In [10]:
```
# print the first 20 rows of data
dataset = load_diabetes()
print(dataset.head(20))
```

```
                0           1           2           3           4           5  \
count  768.000000  768.000000  768.000000  768.000000  768.000000  768.000000
mean     3.845052  120.894531   69.105469   20.536458   79.799479   31.992578
std      3.369578   31.972618   19.355807   15.952218  115.244002    7.884160
min      0.000000    0.000000    0.000000    0.000000    0.000000    0.000000
25%      1.000000   99.000000   62.000000    0.000000    0.000000   27.300000
50%      3.000000  117.000000   72.000000   23.000000   30.500000   32.000000
75%      6.000000  140.250000   80.000000   32.000000  127.250000   36.600000
max     17.000000  199.000000  122.000000   99.000000  846.000000   67.100000

                6           7           8
count  768.000000  768.000000  768.000000
mean     0.471876   33.240885    0.348958
std      0.331329   11.760232    0.476951
min      0.078000   21.000000    0.000000
25%      0.243750   24.000000    0.000000
50%      0.372500   29.000000    0.000000
75%      0.626250   41.000000    1.000000
max      2.420000   81.000000    1.000000
     0    1   2   3    4     5      6   7  8
0    6  148  72  35    0  33.6  0.627  50  1
1    1   85  66  29    0  26.6  0.351  31  0
2    8  183  64   0    0  23.3  0.672  32  1
3    1   89  66  23   94  28.1  0.167  21  0
4    0  137  40  35  168  43.1  2.288  33  1
5    5  116  74   0    0  25.6  0.201  30  0
6    3   78  50  32   88  31.0  0.248  26  1
7   10  115   0   0    0  35.3  0.134  29  0
8    2  197  70  45  543  30.5  0.158  53  1
9    8  125  96   0    0   0.0  0.232  54  1
10   4  110  92   0    0  37.6  0.191  30  0
11  10  168  74   0    0  38.0  0.537  34  1
12  10  139  80   0    0  27.1  1.441  57  0
13   1  189  60  23  846  30.1  0.398  59  1
14   5  166  72  19  175  25.8  0.587  51  1
15   7  100   0   0    0  30.0  0.484  32  1
16   0  118  84  47  230  45.8  0.551  31  1
```

```
17   7  107  74   0    0  29.6  0.254  31  1
18   1  103  30  38   83  43.3  0.183  33  0
19   1  115  70  30   96  34.6  0.529  32  1
```

```
In [11]: #TODO
         #Count the number of zero values in column indeces [1,2,3,4,5]
         num_of_zeros = [None] * 5
         for i in [1,2,3,4,5]:
             thelist = dataset.values[:,i].tolist()
             frequencies = np.array(np.unique(thelist, return_counts=True)).T
             index = np.where(frequencies[:,0] == 0)
             if index[0].size != 0:
                 num_of_zeros[i-1] = int(frequencies[index[0],1])
         print(num_of_zeros)
```

```
[5, 35, 227, 374, 11]
```

```
In [12]: #TODO
         # mark zero values as missing or NaN
         for i in [1,2,3,4,5]:
             for j in range(dataset.values.shape[0]):
                 if dataset.values[j,i]==0:
                     dataset[i][j] = np.nan
         # count the number of NaN values in each column
         print(dataset.isnull().sum())
```

```
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/i

C:\Users\Amin\AppData\Roaming\Python\Python37\site-packages\pandas\core\indexing.py:205: Setti
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/i
  self._setitem_with_indexer(indexer, value)
```

```
0      0
1      5
2     35
3    227
4    374
5     11
6      0
7      0
8      0
```

```
dtype: int64
```

In [13]:
```python
dataset.head(20)
```

Out[13]:

	0	1	2	3	4	5	6	7	8
0	6	148.0	72.0	35.0	NaN	33.6	0.627	50	1
1	1	85.0	66.0	29.0	NaN	26.6	0.351	31	0
2	8	183.0	64.0	NaN	NaN	23.3	0.672	32	1
3	1	89.0	66.0	23.0	94.0	28.1	0.167	21	0
4	0	137.0	40.0	35.0	168.0	43.1	2.288	33	1
5	5	116.0	74.0	NaN	NaN	25.6	0.201	30	0
6	3	78.0	50.0	32.0	88.0	31.0	0.248	26	1
7	10	115.0	NaN	NaN	NaN	35.3	0.134	29	0
8	2	197.0	70.0	45.0	543.0	30.5	0.158	53	1
9	8	125.0	96.0	NaN	NaN	NaN	0.232	54	1
10	4	110.0	92.0	NaN	NaN	37.6	0.191	30	0
11	10	168.0	74.0	NaN	NaN	38.0	0.537	34	1
12	10	139.0	80.0	NaN	NaN	27.1	1.441	57	0
13	1	189.0	60.0	23.0	846.0	30.1	0.398	59	1
14	5	166.0	72.0	19.0	175.0	25.8	0.587	51	1
15	7	100.0	NaN	NaN	NaN	30.0	0.484	32	1
16	0	118.0	84.0	47.0	230.0	45.8	0.551	31	1
17	7	107.0	74.0	NaN	NaN	29.6	0.254	31	1
18	1	103.0	30.0	38.0	83.0	43.3	0.183	33	0
19	1	115.0	70.0	30.0	96.0	34.6	0.529	32	1

In [14]:
```python
#TODO
#delete rows contating NAN values from the dataset using .dropna(inplace = True) buil
# print (dataset.shape)
dataset.dropna(inplace=True)
print (dataset.shape)
```

```
(392, 9)
```

In [15]:
```python
values = dataset.values
X = values[:,0:8]
y = values[:,8]
X_train, X_valid, y_train, y_valid = train_test_split(X, y, test_size=0.25, shuffle=T
```

In [16]:
```python
#TODO
#complete the function to
#evaluate the MLP model on the test set
def evaluate_MLP(X_train, y_train,X_valid,y_valid,seed=7):
    model = MLPClassifier()
    model.fit(X_train, y_train)
    result = model.predict(X_valid)
    print(accuracy_score(result,y_valid))
```

```
In [17]: evaluate_MLP(X_train, y_train,X_valid,y_valid,7)
```

```
0.42857142857142855
```

```
In [18]: dataset = load_diabetes()
         #TODO
         # Mark zero values of column indices [1,2,3,4,5] as missing or NaN
         for i in [1,2,3,4,5]:
             for j in range(dataset.values.shape[0]):
                 if dataset.values[j,i]==0:
                     dataset[i][j] = np.nan
         # This time fill missing values with mean column values using .fillna(dataset.mean(),
         dataset.fillna(dataset.mean(),inplace=True)
         # count the number of NaN values in each column
         print(dataset.isnull().sum())
```

```
                0           1           2           3           4           5  \
count  768.000000  768.000000  768.000000  768.000000  768.000000  768.000000
mean     3.845052  120.894531   69.105469   20.536458   79.799479   31.992578
std      3.369578   31.972618   19.355807   15.952218  115.244002    7.884160
min      0.000000    0.000000    0.000000    0.000000    0.000000    0.000000
25%      1.000000   99.000000   62.000000    0.000000    0.000000   27.300000
50%      3.000000  117.000000   72.000000   23.000000   30.500000   32.000000
75%      6.000000  140.250000   80.000000   32.000000  127.250000   36.600000
max     17.000000  199.000000  122.000000   99.000000  846.000000   67.100000

                6           7           8
count  768.000000  768.000000  768.000000
mean     0.471876   33.240885    0.348958
std      0.331329   11.760232    0.476951
min      0.078000   21.000000    0.000000
25%      0.243750   24.000000    0.000000
50%      0.372500   29.000000    0.000000
75%      0.626250   41.000000    1.000000
max      2.420000   81.000000    1.000000
```

```
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/i
  import sys
C:\Users\Amin\AppData\Roaming\Python\Python37\site-packages\pandas\core\indexing.py:205: Setti
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/i
  self._setitem_with_indexer(indexer, value)
```

```
0    0
1    0
2    0
3    0
4    0
5    0
6    0
7    0
8    0
dtype: int64
```

In [19]:
```
dataset.head(20)
```

Out[19]:

	0	1	2	3	4	5	6	7	8
0	6	148.0	72.000000	35.00000	155.548223	33.600000	0.627	50	1
1	1	85.0	66.000000	29.00000	155.548223	26.600000	0.351	31	0
2	8	183.0	64.000000	29.15342	155.548223	23.300000	0.672	32	1
3	1	89.0	66.000000	23.00000	94.000000	28.100000	0.167	21	0
4	0	137.0	40.000000	35.00000	168.000000	43.100000	2.288	33	1
5	5	116.0	74.000000	29.15342	155.548223	25.600000	0.201	30	0
6	3	78.0	50.000000	32.00000	88.000000	31.000000	0.248	26	1
7	10	115.0	72.405184	29.15342	155.548223	35.300000	0.134	29	0
8	2	197.0	70.000000	45.00000	543.000000	30.500000	0.158	53	1
9	8	125.0	96.000000	29.15342	155.548223	32.457464	0.232	54	1
10	4	110.0	92.000000	29.15342	155.548223	37.600000	0.191	30	0
11	10	168.0	74.000000	29.15342	155.548223	38.000000	0.537	34	1
12	10	139.0	80.000000	29.15342	155.548223	27.100000	1.441	57	0
13	1	189.0	60.000000	23.00000	846.000000	30.100000	0.398	59	1
14	5	166.0	72.000000	19.00000	175.000000	25.800000	0.587	51	1
15	7	100.0	72.405184	29.15342	155.548223	30.000000	0.484	32	1
16	0	118.0	84.000000	47.00000	230.000000	45.800000	0.551	31	1
17	7	107.0	74.000000	29.15342	155.548223	29.600000	0.254	31	1
18	1	103.0	30.000000	38.00000	83.000000	43.300000	0.183	33	0
19	1	115.0	70.000000	30.00000	96.000000	34.600000	0.529	32	1

In [20]:
```
values = dataset.values
X = values[:,0:8]
y = values[:,8]
X_train, _, y_train, _ = train_test_split(X, y, test_size=0.25, shuffle=True, random_s
```

In [21]:
```
X_train.shape
```

Out[21]:
```
(576, 8)
```

In [22]:
```
evaluate_MLP(X_train, y_train,X_valid,y_valid,7)
```

```
0.6938775510204082
```

3 3. Imbalanced Data

```
In [23]: df = pd.read_csv('creditcard.csv')
         print(df.shape)
         df.head()
```

```
(284807, 31)
```

```
Out[23]:    Time        V1        V2        V3        V4        V5        V6        V7  \
         0   0.0 -1.359807 -0.072781  2.536347  1.378155 -0.338321  0.462388  0.239599
         1   0.0  1.191857  0.266151  0.166480  0.448154  0.060018 -0.082361 -0.078803
         2   1.0 -1.358354 -1.340163  1.773209  0.379780 -0.503198  1.800499  0.791461
         3   1.0 -0.966272 -0.185226  1.792993 -0.863291 -0.010309  1.247203  0.237609
         4   2.0 -1.158233  0.877737  1.548718  0.403034 -0.407193  0.095921  0.592941

                  V8        V9  ...       V21       V22       V23       V24       V25  \
         0  0.098698  0.363787  ... -0.018307  0.277838 -0.110474  0.066928  0.128539
         1  0.085102 -0.255425  ... -0.225775 -0.638672  0.101288 -0.339846  0.167170
         2  0.247676 -1.514654  ...  0.247998  0.771679  0.909412 -0.689281 -0.327642
         3  0.377436 -1.387024  ... -0.108300  0.005274 -0.190321 -1.175575  0.647376
         4 -0.270533  0.817739  ... -0.009431  0.798278 -0.137458  0.141267 -0.206010

                 V26       V27       V28  Amount  Class
         0 -0.189115  0.133558 -0.021053  149.62      0
         1  0.125895 -0.008983  0.014724    2.69      0
         2 -0.139097 -0.055353 -0.059752  378.66      0
         3 -0.221929  0.062723  0.061458  123.50      0
         4  0.502292  0.219422  0.215153   69.99      0

         [5 rows x 31 columns]
```

```
In [24]: print(df.Class.value_counts())
```

```
0    284315
1       492
Name: Class, dtype: int64
```

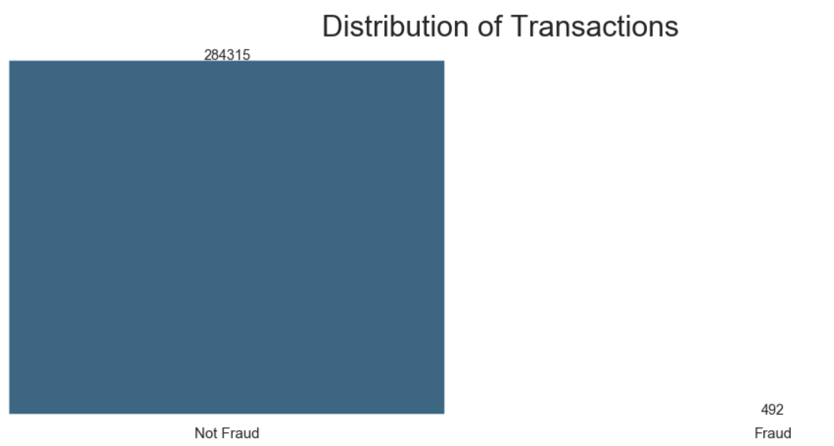
```
In [25]: # using seaborns countplot to show distribution of questions in dataset
         fig, ax = plt.subplots()
         g = sns.countplot(df.Class, palette='viridis')
         g.set_xticklabels(['Not Fraud', 'Fraud'])
         g.set_yticklabels([])

         # function to show values on bars
         def show_values_on_bars(axs):
             def _show_on_single_plot(ax):
                 for p in ax.patches:
```

```
                _x = p.get_x() + p.get_width() / 2
                _y = p.get_y() + p.get_height()
                value = '{:.0f}'.format(p.get_height())
                ax.text(_x, _y, value, ha="center")

        if isinstance(axs, np.ndarray):
            for idx, ax in np.ndenumerate(axs):
                _show_on_single_plot(ax)
        else:
            _show_on_single_plot(axs)
    show_values_on_bars(ax)

    sns.despine(left=True, bottom=True)
    plt.xlabel('')
    plt.ylabel('')
    plt.title('Distribution of Transactions', fontsize=30)
    plt.tick_params(axis='x', which='major', labelsize=15)
    plt.show()
```



In [26]:
```
# TODO
# print percentage of samples where target == 1
df.Class.value_counts()[1]/df.Class.value_counts()[0]
```

Out[26]:
```
0.0017304750013189597
```

In [27]:
```
# Prepare data for modeling
# Separate input features and target
y = df.Class
X = df.drop('Class', axis=1)

# setting up validation and training sets
X_train, X_valid, y_train, y_valid = train_test_split(X, y, test_size=0.25, random_sta
```

In [28]:
```
#TODO
# Train a DummyClassifier to predict with 'most_frequent' strategy
dummy = DummyClassifier()
dummy.fit(X_train,y_train)
dummy_pred = dummy.predict(X_valid)

# checking unique labels
print('Unique predicted labels: ', (np.unique(dummy_pred)))

# checking accuracy
print('Validation score: ', accuracy_score(y_valid, dummy_pred))
```

```
Unique predicted labels:  [0 1]
Validation score:  0.9965590854189489


C:\ProgramData\Anaconda3\lib\site-packages\sklearn\dummy.py:227: FutureWarning: arrays to stac
  k in range(self.n_outputs_)).T
```

In [29]:
```
def evaluate_imbalanced(y_valid, lr_pred):
    # Checking accuracy
    print('Accuracy: ', accuracy_score(y_valid, lr_pred))
    #recall score
    print('Recall: ',recall_score(y_valid, lr_pred))
    #precision score
    print('Precision: ', precision_score(y_valid, lr_pred))
    # f1 score
    print('F1 score: ',f1_score(y_valid, lr_pred))
    # confusion matrix
    print('ConfMat')
    print(pd.DataFrame(confusion_matrix(y_valid, lr_pred)))
```

In [30]:
```
#TODO
# Train a LogisticRegressio model with solver as 'liblinear' on the training data
lr = LogisticRegression()
lr.fit(X_train, y_train)

# Predict on validation set
lr_pred = lr.predict(X_valid)
```

In [31]:
```
evaluate_imbalanced(y_valid, lr_pred)
```

```
Accuracy:  0.9992135052386169
Recall:  0.6439393939393939
Precision:  0.9042553191489362
F1 score:  0.7522123893805309
ConfMat
       0   1
```

```
0  71061   9
1     47  85
```

```
In [32]: from sklearn.utils import resample
```

```
In [33]: y = df.Class
         X = df.drop('Class', axis=1)

         # setting up validation and training sets
         X_train, X_valid, y_train, y_valid = train_test_split(X, y, test_size=0.25, random_sta
```

```
In [34]: # concatenate our training data back together
         X = pd.concat([X_train, y_train], axis=1)
         X.head()
```

```
Out[34]:             Time        V1        V2        V3        V4        V5        V6  \
         264873  161634.0 -0.395578  1.489129 -0.833442 -0.224271  0.369444 -1.453886
         163821  116237.0  1.950487  0.002312 -1.761814  1.232470  0.523175 -0.650657
         72083    54557.0  1.105167 -0.166253  0.569520  0.681043 -0.259189  0.642792
         196949  131771.0  1.805238  0.961264 -1.717212  4.094625  0.938666 -0.227785
         126213   77959.0  0.835421 -1.191847  0.578455  0.586101 -1.236663  0.194617

                       V7        V8        V9  ...       V21       V22       V23  \
         264873  0.796593 -0.060403  0.338270  ...  0.231624  0.955194 -0.172092
         163821  0.504231 -0.200857  0.116805  ...  0.086306  0.326297 -0.068839
         72083  -0.437034  0.356746  0.441417  ...  0.009073  0.293023 -0.028688
         196949  0.152911  0.066753 -1.073784  ... -0.137875 -0.450959  0.098530
         126213 -0.532404  0.061561 -0.734344  ... -0.072349 -0.109154 -0.308356

                      V24       V25       V26       V27       V28  Amount  Class
         264873 -0.041050 -0.313444 -0.174301  0.064657 -0.036960    2.74      0
         163821 -0.416589  0.426044 -0.486299 -0.031266 -0.072543   38.44      0
         72083  -0.242206  0.389813  0.482852  0.010705 -0.008399    1.00      0
         196949 -0.662272 -0.150154 -0.098852 -0.000030  0.017622   37.89      0
         126213  0.011968  0.461350 -0.244810  0.031845  0.060910  237.00      0

         [5 rows x 31 columns]
```

```
In [35]: # TODO
         # separate minority and majority classes
         not_fraud =  pd.DataFrame(df, index=np.where(df.values[:,-1] == 0)[0])
         fraud = pd.DataFrame(df, index=np.where(df.values[:,-1] == 1)[0])

         # upsample minority using resample and n_samples equal to the size of majority
         fraud_upsampled = resample(fraud,
                                    replace=True, # sample with replacement
                                    n_samples=not_fraud.shape[0], # match number in majority cl
                                    random_state=27) # reproducible result
```

```
# combine majority and upsampled minority
upsampled = pd.concat([not_fraud, fraud_upsampled])

# check new class counts
upsampled.Class.value_counts()
```

Out[35]:

```
1    284315
0    284315
Name: Class, dtype: int64
```

In [36]:

```
#TODO
# trying logistic regression again with the balanced dataset
y = upsampled.Class
X = upsampled.drop('Class', axis=1)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_state
# y_train = ...
# X_train = ...

# Train a logistic regression with solver 'liblinear' on the train data
upsampled = LogisticRegression(solver='liblinear')
upsampled.fit(X_train, y_train)
# predict on the test data
upsampled_pred = upsampled.predict(X_test)
```

In [37]:

```
evaluate_imbalanced(y_test, upsampled_pred)
```

```
Accuracy:  0.9379563584180982
Recall:  0.9023495685899778
Precision:  0.9716875491798317
F1 score:  0.9357358320096761
ConfMat
       0      1
0  69125   1871
1   6949  64213
```

In [38]:

```
# still using our separated classes fraud and not_fraud from above
# TODO
# downsample majority
not_fraud_downsampled = resample(not_fraud,
                                replace = False, # sample without replacement
                                n_samples = fraud.shape[0], # match minority n
                                random_state = 27) # reproducible results

# combine minority and downsampled majority
downsampled = pd.concat([not_fraud_downsampled, fraud])
```

```
# checking counts
downsampled.Class.value_counts()
```

Out[38]:

```
1    492
0    492
Name: Class, dtype: int64
```

In [39]:

```
# TODO
# trying logistic regression again with the undersampled dataset
y = downsampled.Class
X = downsampled.drop('Class', axis=1)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_stat
# X_train = ...
# y_train = ...

# Train a logistic regression with solver 'liblinear' on the train data
undersampled = LogisticRegression(solver='liblinear')
undersampled.fit(X_train, y_train)
undersampled_pred = undersampled.predict(X_test)
```

In [40]:

```
evaluate_imbalanced(y_test, undersampled_pred)
```

```
Accuracy:  0.9512195121951219
Recall:  0.8983050847457628
Precision:  1.0
F1 score:  0.9464285714285715
ConfMat
     0    1
0  128    0
1   12  106
```

In [41]:

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

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\ensemble\weight_boosting.py:29: Deprecation
  from numpy.core.umath_tests import inner1d
```

In [42]:

```
df = pd.read_csv('creditcard.csv')
y = df.Class
X = df.drop('Class', axis=1)

# setting up testing and training sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_stat
```

In [43]:

```
# train a random forest model
rfc = RandomForestClassifier()
rfc.fit(X_train, y_train)
# predict on test set
rfc_pred = rfc.predict(X_test)
```

In [44]: evaluate_imbalanced(y_test,rfc_pred)

```
Accuracy:  0.9995786635206876
Recall:  0.803030303030303
Precision:  0.9636363636363636
F1 score:  0.8760330578512396
ConfMat
       0    1
0  71066    4
1     26  106
```