adults

December 5, 2018

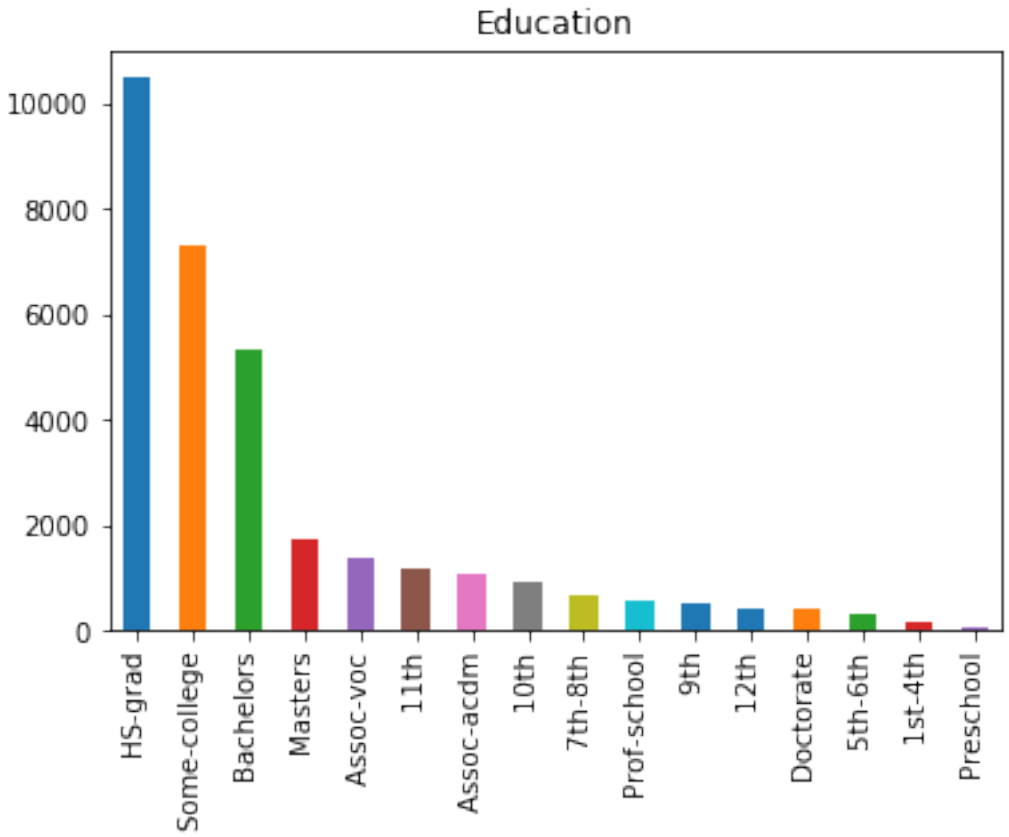
```
In [2]: import numpy as np
        import matplotlib.pyplot as plt
        from sklearn import metrics as m
        from sklearn import preprocessing
        from sklearn.model_selection import GridSearchCV
        import pandas as pd
        import itertools

        header = ["age","workclass","fnlwgt","education","education-num",
                  "marital-status","occupation","relationship","race", "sex",
                 "capital-gain", "capital-loss", "hours-per-week", "native-country", "income"]
        adults_raw = pd.read_csv("./Adult/adult.data", names=header)
```

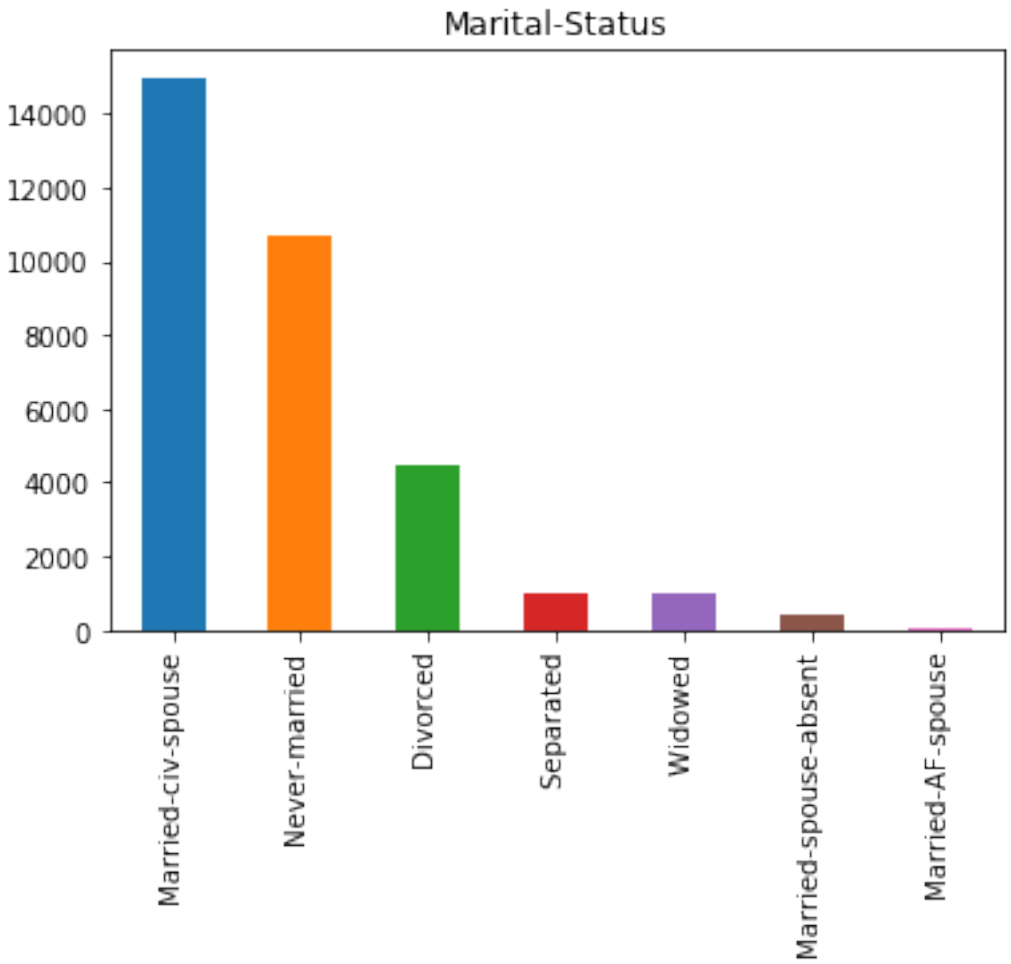
```
In [3]: print(adults_raw.head(n=10))
```

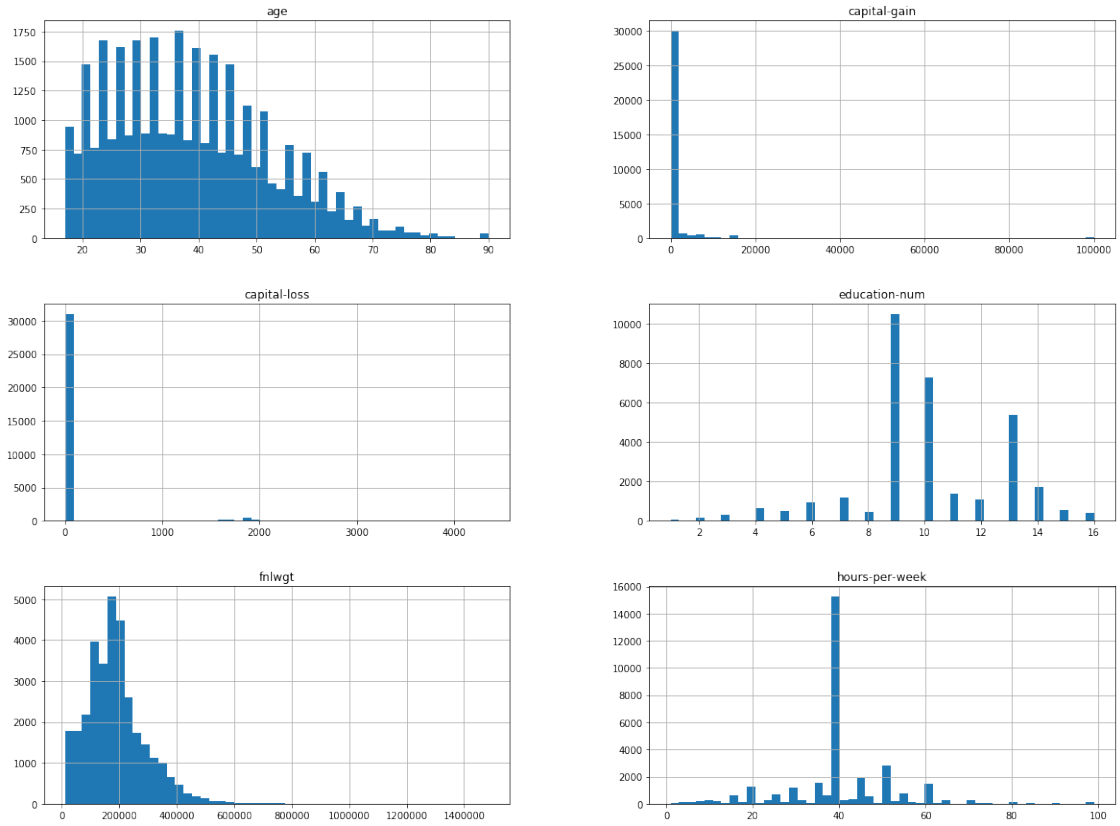
```
   age          workclass  fnlwgt   education  education-num  \
0   39          State-gov   77516   Bachelors             13
1   50   Self-emp-not-inc   83311   Bachelors             13
2   38            Private  215646     HS-grad              9
3   53            Private  234721        11th              7
4   28            Private  338409   Bachelors             13
5   37            Private  284582     Masters             14
6   49            Private  160187         9th              5
7   52   Self-emp-not-inc  209642     HS-grad              9
8   31            Private   45781     Masters             14
9   42            Private  159449   Bachelors             13

           marital-status          occupation    relationship    race  \
0           Never-married        Adm-clerical   Not-in-family   White
1      Married-civ-spouse     Exec-managerial         Husband   White
2                Divorced   Handlers-cleaners   Not-in-family   White
3      Married-civ-spouse   Handlers-cleaners         Husband   Black
4      Married-civ-spouse      Prof-specialty            Wife   Black
5      Married-civ-spouse     Exec-managerial            Wife   White
6   Married-spouse-absent       Other-service   Not-in-family   Black
7      Married-civ-spouse     Exec-managerial         Husband   White
8           Never-married      Prof-specialty   Not-in-family   White
9      Married-civ-spouse     Exec-managerial         Husband   White
```

	sex	capital-gain	capital-loss	hours-per-week	native-country	income
0	Male	2174	0	40	United-States	<=50K
1	Male	0	0	13	United-States	<=50K
2	Male	0	0	40	United-States	<=50K
3	Male	0	0	40	United-States	<=50K
4	Female	0	0	40	Cuba	<=50K
5	Female	0	0	40	United-States	<=50K
6	Female	0	0	16	Jamaica	<=50K
7	Male	0	0	45	United-States	>50K
8	Female	14084	0	50	United-States	>50K
9	Male	5178	0	40	United-States	>50K

In [4]:
```
adults_raw['education'].value_counts().plot(title = 'Education', kind='bar')
plt.show()
adults_raw['marital-status'].value_counts().plot(title = 'Marital-Status', kind='bar')
plt.show()
adults_raw.hist(bins = 50, figsize = (20,15))
plt.show()
```




Marital-Status
14000
12000
10000
8000
6000
4000
2000
0
Married-civ-spouse
Never-married
Divorced
Separated
Widowed
Married-spouse-absent
Married-AF-spouse




```
In [5]: # make all values to integers
        enc = preprocessing.OrdinalEncoder(categories="auto", dtype=int)
        enc.fit(adults_raw)
        adults = enc.transform(adults_raw)

        # split X and y
        adults_input = adults[:,0:14]
        adults_input
        adults_target = adults[:,14]
        adults_target
```

```
Out[5]: array([0, 0, 0, ..., 0, 0, 1])
```

```
In [6]: adults_test_raw = pd.read_csv("./Adult/adult.test", names=header)
        adults_test_raw
        enc_test = preprocessing.OrdinalEncoder(categories="auto", dtype=int)
        enc_test.fit(adults_test_raw)
        adults_test = enc_test.transform(adults_test_raw)
        adults_target_test = adults_test[:,14]
        adults_input_test = adults_test[:,0:14]
```

```
In [7]: def plot_confusion_matrix(cm,classes,
                                  title='Confusion matrix',
```

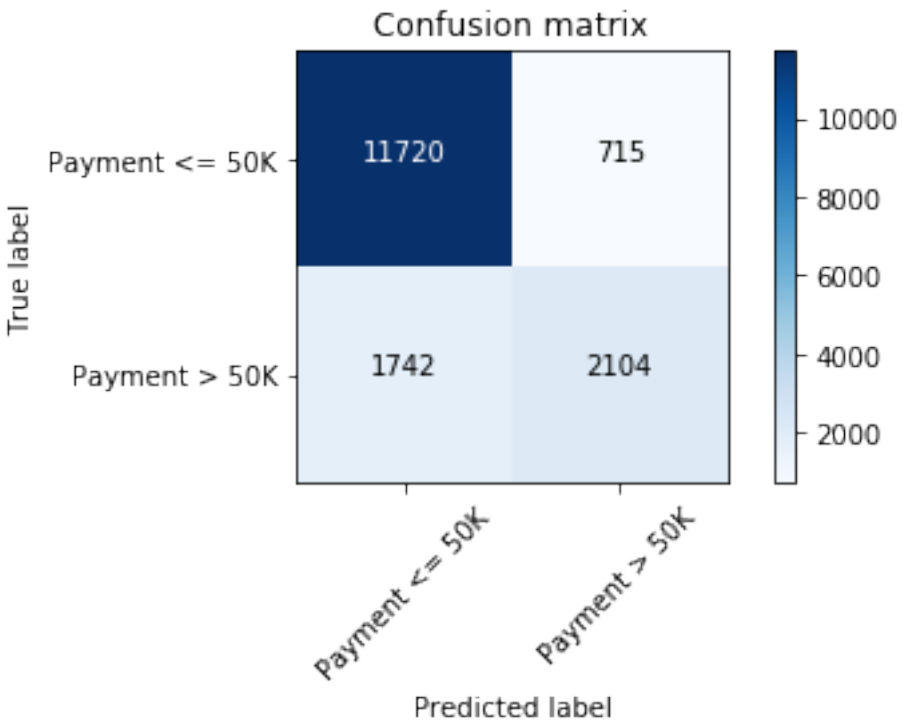
```
                                    cmap=plt.cm.Blues):

            plt.imshow(cm, interpolation='nearest', cmap=cmap)
            plt.title(title)
            plt.colorbar()
            tick_marks = np.arange(len(classes))
            plt.xticks(tick_marks, classes, rotation=45)
            plt.yticks(tick_marks, classes)

            fmt = 'd'
            thresh = cm.max() / 2.
            for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
                plt.text(j, i, format(cm[i, j], fmt),
                         horizontalalignment="center",
                         color="white" if cm[i, j] > thresh else "black")

            plt.ylabel('True label')
            plt.xlabel('Predicted label')
            plt.tight_layout()

In [8]: def plot_results(cnf_matrix, adults_target_test, prediction, title='Confusion matrix')
            class_names = ["Payment <= 50K","Payment > 50K",]
            plt.figure()
            plot_confusion_matrix(cnf_matrix, classes=class_names, title=title)
            plt.show()
            print(" Accuracy:\t %.3f" % m.accuracy_score(adults_target_test, prediction))
            print(" Precision:\t %.3f" % m.precision_score(adults_target_test, prediction))
            print(" Sensitivity:\t %.3f" % m.recall_score(adults_target_test, prediction))
            print(" F1:\t\t %.3f" % m.f1_score(adults_target_test, prediction))

In [9]: def get_pd_overview(cv_results):
            pd_results = pd.DataFrame(grid_search.cv_results_)
            params = pd_results.loc[:,"params"]
            mean_test_scores = pd_results.loc[:,"mean_test_score"]
            frames = [mean_test_scores, params]
            overview = pd.concat(frames,  axis=1)
            return overview

In [10]: from sklearn import tree

         ## DECISION TREE

         param_grid = [
           {'max_depth': [1, 5, 10, 50], 'criterion': ["gini"]},
           {'max_depth': [1, 5, 10, 50], 'criterion': ["entropy"]},
          ]

         clf = tree.DecisionTreeClassifier()
```

```
        grid_search = GridSearchCV(clf, param_grid, cv = 5, iid=False, return_train_score=Tru

        grid_search.fit(adults_input, adults_target)
        cv_results = grid_search.cv_results_
        overview = get_pd_overview(cv_results)
```

```
In [11]: print(overview)
         print("\nBest parameters: ", grid_search.best_params_)
```

```
   mean_test_score                                      params
0         0.759190      {'criterion': 'gini', 'max_depth': 1}
1         0.848991      {'criterion': 'gini', 'max_depth': 5}
2         0.852984     {'criterion': 'gini', 'max_depth': 10}
3         0.808268     {'criterion': 'gini', 'max_depth': 50}
4         0.759190   {'criterion': 'entropy', 'max_depth': 1}
5         0.846442   {'criterion': 'entropy', 'max_depth': 5}
6         0.852093  {'criterion': 'entropy', 'max_depth': 10}
7         0.813734  {'criterion': 'entropy', 'max_depth': 50}

Best parameters:  {'criterion': 'gini', 'max_depth': 10}
```

```
In [12]: # use best parameters for model
         clf = grid_search.best_estimator_

         prediction = clf.predict(adults_input_test)
         cnf_matrix = m.confusion_matrix(adults_target_test, prediction)

         plot_results(cnf_matrix, adults_target_test, prediction)
```



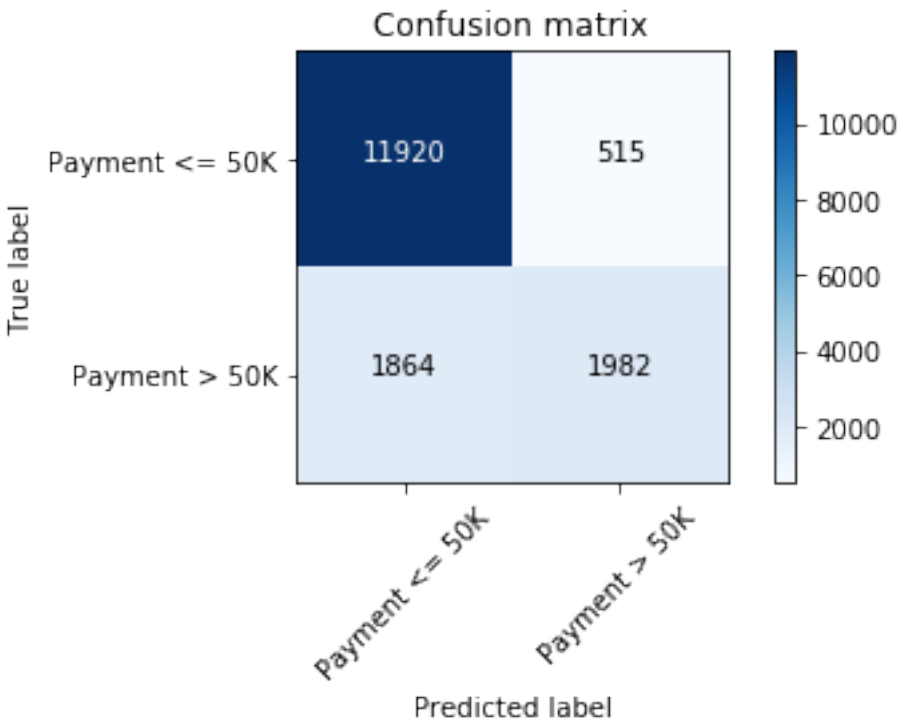

```
Accuracy:          0.849
Precision:          0.746
Sensitivity:          0.547
F1:                 0.631
```

```
In [13]: from sklearn.ensemble import RandomForestClassifier

         ##RANDOM FOREST
         rand_forest = RandomForestClassifier()
         param_grid = [
           {'n_estimators':[20,100,200],'max_depth': [1, 5, 10, 50], 'criterion': ["gini"]},
           {'n_estimators':[20,100,200],'max_depth': [1, 5, 10, 50], 'criterion': ["entropy"]}
          ]

         grid_search = GridSearchCV(rand_forest, param_grid, cv = 5, iid=False, return_train_s

         grid_search.fit(adults_input, adults_target)
         cv_results = grid_search.cv_results_
         overview = get_pd_overview(cv_results)
```

```
In [14]: print(overview)
         print("\nBest parameters: ", grid_search.best_params_)
```

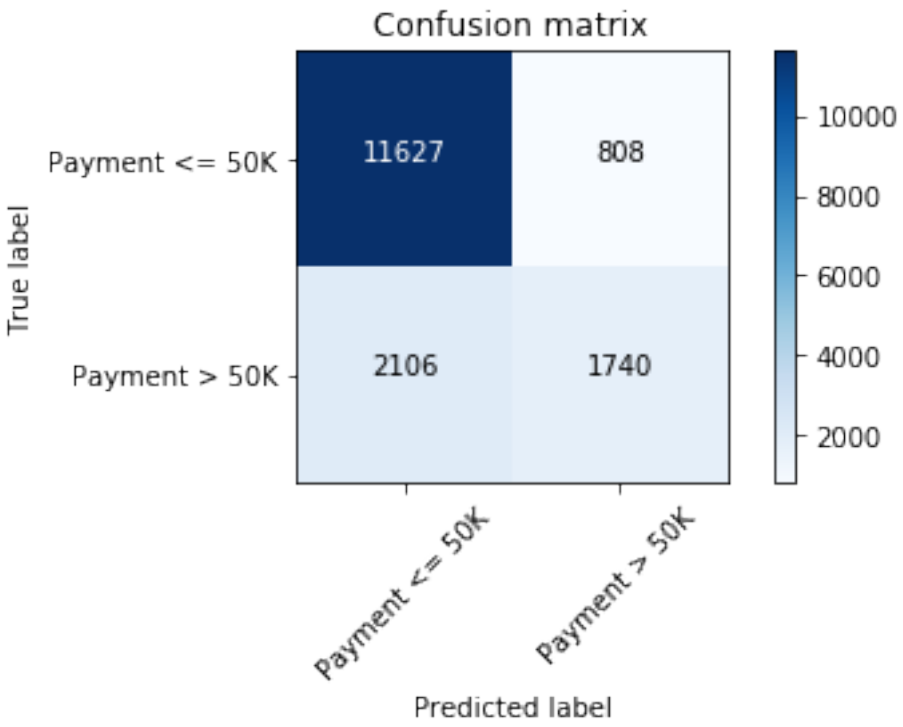
```
    mean_test_score                                              params
0          0.764074  {'criterion': 'gini', 'max_depth': 1, 'n_estim...
1          0.766224  {'criterion': 'gini', 'max_depth': 1, 'n_estim...
2          0.761432  {'criterion': 'gini', 'max_depth': 1, 'n_estim...
3          0.848408  {'criterion': 'gini', 'max_depth': 5, 'n_estim...
4          0.849698  {'criterion': 'gini', 'max_depth': 5, 'n_estim...
5          0.850435  {'criterion': 'gini', 'max_depth': 5, 'n_estim...
6          0.858113  {'criterion': 'gini', 'max_depth': 10, 'n_esti...
7          0.858604  {'criterion': 'gini', 'max_depth': 10, 'n_esti...
8          0.858358  {'criterion': 'gini', 'max_depth': 10, 'n_esti...
9          0.851172  {'criterion': 'gini', 'max_depth': 50, 'n_esti...
10         0.857068  {'criterion': 'gini', 'max_depth': 50, 'n_esti...
11         0.856976  {'criterion': 'gini', 'max_depth': 50, 'n_esti...
12         0.766807  {'criterion': 'entropy', 'max_depth': 1, 'n_es...
13         0.761432  {'criterion': 'entropy', 'max_depth': 1, 'n_es...
14         0.759190  {'criterion': 'entropy', 'max_depth': 1, 'n_es...
15         0.846626  {'criterion': 'entropy', 'max_depth': 5, 'n_es...
16         0.848653  {'criterion': 'entropy', 'max_depth': 5, 'n_es...
17         0.849421  {'criterion': 'entropy', 'max_depth': 5, 'n_es...
18         0.858266  {'criterion': 'entropy', 'max_depth': 10, 'n_e...
19         0.857591  {'criterion': 'entropy', 'max_depth': 10, 'n_e...
20         0.857191  {'criterion': 'entropy', 'max_depth': 10, 'n_e...
21         0.854611  {'criterion': 'entropy', 'max_depth': 50, 'n_e...
22         0.857990  {'criterion': 'entropy', 'max_depth': 50, 'n_e...
23         0.856239  {'criterion': 'entropy', 'max_depth': 50, 'n_e...

Best parameters:  {'criterion': 'gini', 'max_depth': 10, 'n_estimators': 100}
```

```
In [15]: # use best parameters for model
         rand_forest = grid_search.best_estimator_

         prediction = rand_forest.predict(adults_input_test)
         cnf_matrix = m.confusion_matrix(adults_target_test, prediction)

         plot_results(cnf_matrix, adults_target_test, prediction)
```



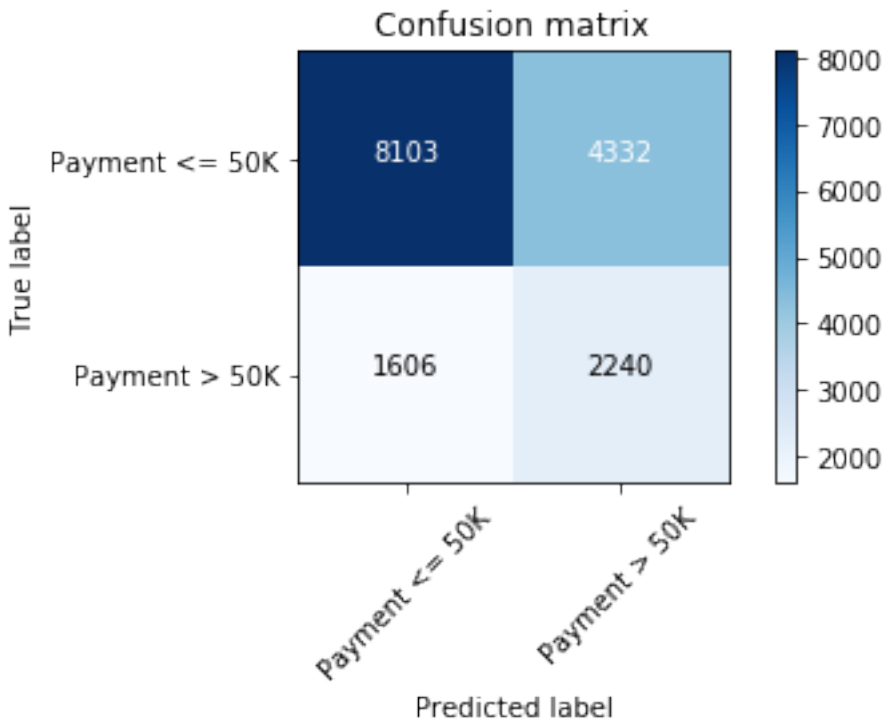

```
Accuracy:          0.854
Precision:          0.794
Sensitivity:          0.515
F1:                  0.625
```

```
In [16]: from sklearn.naive_bayes import GaussianNB

         ##GAUSSIAN NAIVE BAYES

         gnb = GaussianNB()
         gnb.fit(adults_input,adults_target)

         prediction = gnb.predict(adults_input_test)
         cnf_matrix = m.confusion_matrix(adults_target_test, prediction)

         plot_results(cnf_matrix, adults_target_test, prediction)
```




```
Accuracy:          0.821
Precision:          0.683
Sensitivity:          0.452
F1:                  0.544
```

```
In [17]: from sklearn.naive_bayes import MultinomialNB

         ## MULTINOMAIL NAIVE BAYES

         gnb = MultinomialNB()
         gnb.fit(adults_input,adults_target)

         prediction = gnb.predict(adults_input_test)
         cnf_matrix = m.confusion_matrix(adults_target_test, prediction)

         plot_results(cnf_matrix, adults_target_test, prediction)
```




```
Accuracy:          0.635
Precision:          0.341
Sensitivity:          0.582
F1:                 0.430
```

```
In [ ]: from sklearn.svm import SVC

        ## SUPPORT VECTOR MACHINE

        svcl = SVC();
        param_grid = [
          {'gamma': [0.1, 1.0],'C': [0.1, 1, 10, 100], 'kernel': ["rbf"]}
         ]

        grid_search = GridSearchCV(svcl, param_grid, cv = 5, iid=False, return_train_score=Tru

        grid_search.fit(adults_input, adults_target)
        cv_results = grid_search.cv_results_
        overview = get_pd_overview(cv_results)
```

```
In [ ]: print(overview)
        print("\nBest parameters: ", grid_search.best_params_)
```

In [ ]:
```
# use best parameters for model
svcl = grid_search.best_estimator_

prediction = svcl.predict(adults_input_test)
cnf_matrix = m.confusion_matrix(adults_target_test, prediction)

plot_results(cnf_matrix, adults_target_test, prediction)
```