```python
In [1]:  #!/usr/bin/python -W ignore::DeprecationWarning

         import sys
         import pickle
         sys.path.append("../tools/")
         from feature_format import featureFormat, targetFeatureSplit
         from tester import dump_classifier_and_data
         import pandas as pd
         import sys
         import pickle
         import csv
         import matplotlib.pyplot as plt


         sys.path.append("../tools/")
         from feature_format import featureFormat, targetFeatureSplit
         #from poi_data import *
         from sklearn.feature_selection import SelectKBest
         from sklearn.pipeline import Pipeline
         from sklearn.preprocessing import StandardScaler
         from sklearn.model_selection import StratifiedShuffleSplit

         from numpy import mean

         from sklearn.model_selection import train_test_split
         from sklearn.model_selection import cross_validate

         from sklearn.metrics import accuracy_score, precision_score, recall_score
```

```python
In [2]:  #% ## Task 1: Select what features you'll use.
         ### features_list is a list of strings, each of which is a feature name.
         ### The first feature must be "poi".
         #features_list = ['poi','salary'] # You will need to use more features

         ############# Task 1: Select what features you'll use.############

         target_label = 'poi'

         email_features_list = [
             'from_messages',
             'from_poi_to_this_person',
             'from_this_person_to_poi',
             'shared_receipt_with_poi',
             'to_messages',
             ]

         financial_features_list = [
             'bonus',
             'deferral_payments',
             'deferred_income',
             'director_fees',
             'exercised_stock_options',
             'expenses',
             'loan_advances',
             'long_term_incentive',
             'other',
             'restricted_stock',
             'restricted_stock_deferred',
             'salary',
             'total_payments',
             'total_stock_value',
         ]
```

```
        features_list = [target_label] + financial_features_list + email_features_list
```

In [3]:
```
### Load the dictionary containing the dataset
with open("final_project_dataset.pkl", "rb") as data_file:
    data_dict = pickle.load(data_file)


### 1.1.0 Explore csv file
def make_csv(data_dict):
    """ generates a csv file from a data set"""
    fieldnames = ['name'] + data_dict.itervalues().next().keys()
    with open('data.csv', 'w') as csvfile:
        writer = csv.DictWriter(csvfile, fieldnames=fieldnames)
        writer.writeheader()
        for record in data_dict:
            person = data_dict[record]
            person['name'] = record
            assert set(person.keys()) == set(fieldnames)
            writer.writerow(person)
```

In [4]:
```
### 1.1.1 Dataset Exploration
print('# Exploratory Data Analysis #')
data_dict.keys()
print('Total number of data points: %d' % len(data_dict.keys()))
num_poi = 0
for name in data_dict.keys():
    if data_dict[name]['poi'] == True:
        num_poi += 1
print('Number of Persons of Interest: %d' % num_poi)
print('Number of people without Person of Interest label: %d' % (len(data_dict.keys()) - n
```

```
# Exploratory Data Analysis #
Total number of data points: 146
Number of Persons of Interest: 18
Number of people without Person of Interest label: 128
```

In [5]:
```
##1.1.2 Feature Exploration
all_features = data_dict['ALLEN PHILLIP K'].keys()
print('Each person has %d features available' %  len(all_features))
### Evaluate dataset for completeness
missing_values = {}
for feature in all_features:
    missing_values[feature] = 0
for person in data_dict.keys():
    records = 0
    for feature in all_features:
        if data_dict[person][feature] == 'NaN':
            missing_values[feature] += 1
        else:
            records += 1

### Print results of completeness analysis
print('Number of Missing Values for Each Feature:')
for feature in all_features:
    print("%s: %d" % (feature, missing_values[feature]))
```

```
Each person has 21 features available
Number of Missing Values for Each Feature:
salary: 51
to_messages: 60
deferral_payments: 107
total_payments: 21
```

```
loan_advances: 142
bonus: 64
email_address: 35
restricted_stock_deferred: 128
deferred_income: 97
total_stock_value: 20
expenses: 51
from_poi_to_this_person: 60
exercised_stock_options: 44
from_messages: 60
other: 53
from_this_person_to_poi: 60
poi: 0
long_term_incentive: 80
shared_receipt_with_poi: 60
restricted_stock: 36
director_fees: 129
```

In [6]:
```python
################# Task 2: Remove outliers ####################

def PlotOutlier(data_dict, feature_x, feature_y):
    """ Plot with flag = True in Red """
    data = featureFormat(data_dict, [feature_x, feature_y, 'poi'])
    for point in data:
        x = point[0]
        y = point[1]
        poi = point[2]
        if poi:
            color = 'red'
        else:
            color = 'blue'
        plt.scatter(x, y, color=color)
    plt.xlabel(feature_x)
    plt.ylabel(feature_y)
    plt.show()
```
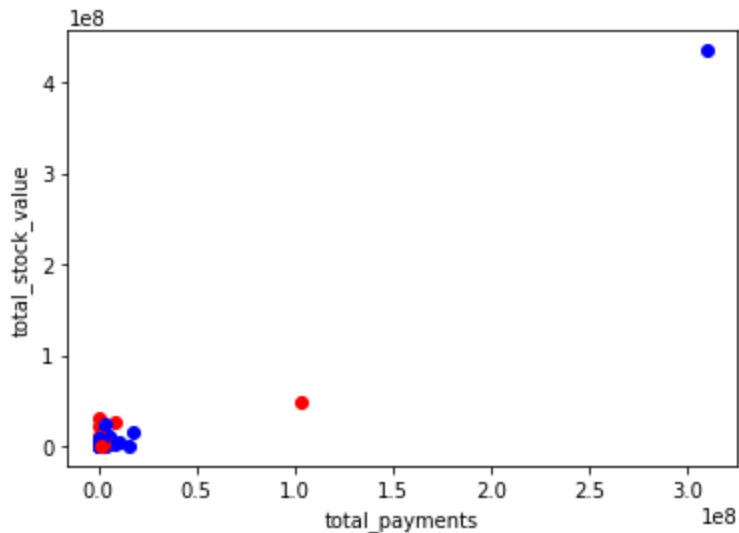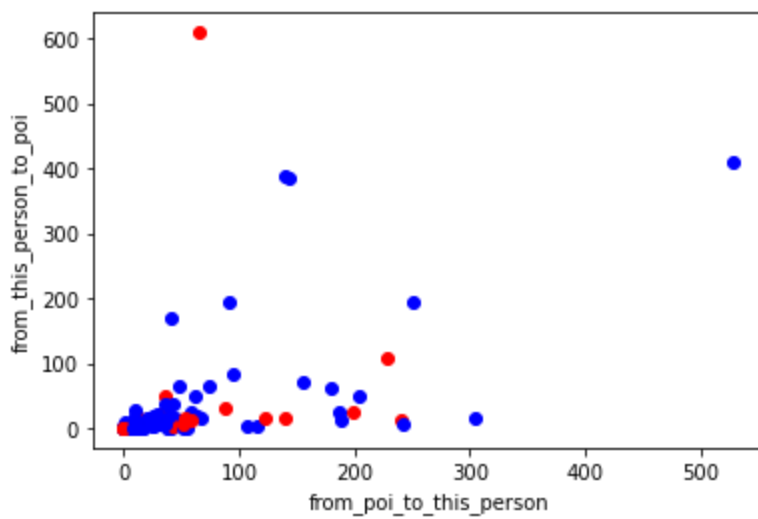
In [7]:
```python
# 2.1 Visualise outliers
print(PlotOutlier(data_dict, 'total_payments', 'total_stock_value'))
print(PlotOutlier(data_dict, 'from_poi_to_this_person', 'from_this_person_to_poi'))
print(PlotOutlier(data_dict, 'salary', 'bonus'))
#Remove outlier TOTAL line in pickle file.
data_dict.pop( 'TOTAL', 0 )
```



```
None
```

None
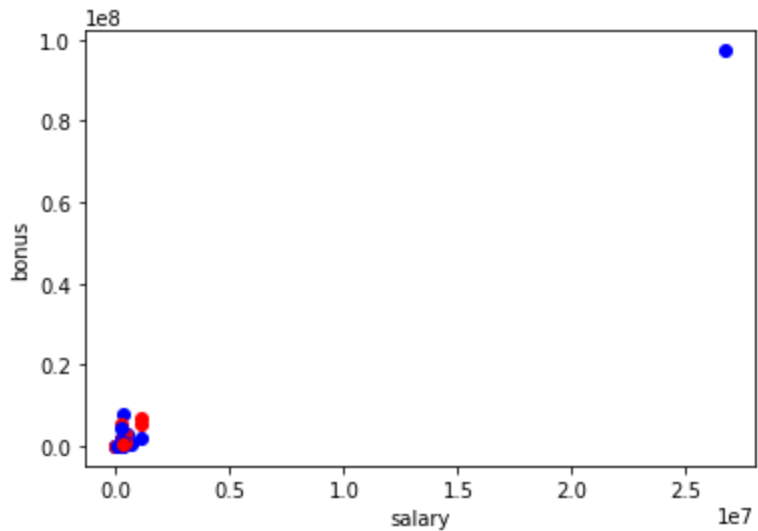
None

Out[7]: {'salary': 26704229,
 'to_messages': 'NaN',
 'deferral_payments': 32083396,
 'total_payments': 309886585,
 'loan_advances': 83925000,
 'bonus': 97343619,
 'email_address': 'NaN',
 'restricted_stock_deferred': -7576788,
 'deferred_income': -27992891,
 'total_stock_value': 434509511,
 'expenses': 5235198,
 'from_poi_to_this_person': 'NaN',
 'exercised_stock_options': 311764000,
 'from_messages': 'NaN',
 'other': 42667589,
 'from_this_person_to_poi': 'NaN',
 'poi': False,
 'long_term_incentive': 48521928,
 'shared_receipt_with_poi': 'NaN',
 'restricted_stock': 130322299,
 'director_fees': 1398517}

In [8]:
```python
# 2.2 Function to remove outliers
def remove_outlier(dict_object, keys):
    """ removes list of outliers keys from dict object """
    for key in keys:
        dict_object.pop(key, 0)

outliers = ['TOTAL', 'THE TRAVEL AGENCY IN THE PARK', 'LOCKHART EUGENE E']
```

```
    remove_outlier(data_dict, outliers)


    #%%
```

In [36]:
```python
############## Task 3: Create new feature(s) ###################

# 3.1 create new copies of dataset for grading
my_dataset = data_dict

## 3.2 add new features to dataset
def compute_fraction(poi_messages, all_messages):
    """ return fraction of messages from/to that person to/from POI"""
    if poi_messages == 'NaN' or all_messages == 'NaN':
        return 0.
    fraction = poi_messages / all_messages
    return fraction

for name in my_dataset:
    data_point = my_dataset[name]
    from_poi_to_this_person = data_point["from_poi_to_this_person"]
    to_messages = data_point["to_messages"]
    fraction_from_poi = compute_fraction(from_poi_to_this_person, to_messages)
    data_point["fraction_from_poi"] = fraction_from_poi
    from_this_person_to_poi = data_point["from_this_person_to_poi"]
    from_messages = data_point["from_messages"]
    fraction_to_poi = compute_fraction(from_this_person_to_poi, from_messages)
    data_point["fraction_to_poi"] = fraction_to_poi


# 3.3 create new copies of feature list for grading
my_feature_list = features_list +['to_messages', 'from_poi_to_this_person', 'from_messages


# 3.4 get K-best features
num_features = 10

# 3.5 functio using SelectKBest
def get_k_best(data_dict, features_list, k):
    """ runs scikit-learn's SelectKBest feature selection
        returns dict where keys=features, values=scores
    """
    data = featureFormat(data_dict, features_list)
    labels, features = targetFeatureSplit(data)

    k_best = SelectKBest(k=k)
    k_best.fit(features, labels)
    scores = k_best.scores_
    print(scores)
    unsorted_pairs = zip(features_list[1:], scores)
    sorted_pairs = list(reversed(sorted(unsorted_pairs, key=lambda x: x[1])))
    k_best_features = dict(sorted_pairs[:k])
    print ("{0} best features: {1}\n".format(k, k_best_features.keys(), scores))
    return k_best_features


best_features = get_k_best(my_dataset, my_feature_list, num_features)

my_feature_list = [target_label] + list(set(best_features.keys()))

# 3.6 print features
print ("{0} selected features: {1}\n".format(len(my_feature_list) - 1, my_feature_list[1:]

# 3.7 extract the features specified in features_list
```

```
    data = featureFormat(my_dataset, my_feature_list,sort_keys = True)
    # split into labels and features
    labels, features = targetFeatureSplit(data)

    # 3.8 scale features via min-max
    from sklearn import preprocessing
    scaler = preprocessing.MinMaxScaler()
    features = scaler.fit_transform(features)

    #%%
```

```
[20.79225205  0.22461127 11.45847658  2.1263278  24.81507973  6.09417331
  7.18405566  9.92218601  4.18747751  9.21281062  0.06549965 18.28968404
  8.77277773 24.18289868  0.16970095  5.24344971  2.38261211  8.58942073
  1.64634113  1.64634113  5.24344971  0.16970095  2.38261211  8.58942073
 16.40971255]
10 best features: dict_keys(['exercised_stock_options', 'total_stock_value', 'bonus', 'sal
ary', 'fraction_to_poi', 'deferred_income', 'long_term_incentive', 'restricted_stock', 'to
tal_payments', 'shared_receipt_with_poi'])

10 selected features: ['salary', 'bonus', 'long_term_incentive', 'exercised_stock_option
s', 'shared_receipt_with_poi', 'total_payments', 'total_stock_value', 'fraction_to_poi',
'restricted_stock', 'deferred_income']
```

In [10]:

In [11]:

In [12]:

In [13]:

```
[20.79225205  0.22461127 11.45847658  2.1263278  24.81507973  6.09417331
  7.18405566  9.92218601  4.18747751  9.21281062  0.06549965 18.28968404
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ary', 'fraction_to_poi', 'deferred_income', 'long_term_incentive', 'restricted_stock', 'to
tal_payments', 'shared_receipt_with_poi'])
```

In [14]:

```
10 selected features: ['salary', 'bonus', 'long_term_incentive', 'exercised_stock_option
s', 'shared_receipt_with_poi', 'total_payments', 'total_stock_value', 'fraction_to_poi',
'restricted_stock', 'deferred_income']
```

In [15]:

In [16]:

In [17]:
```
### Task 4: Try a varity of classifiers
### Please name your classifier clf for easy export below.
### Note that if you want to do PCA or other multi-stage operations,
```

```python
### you'll need to use Pipelines. For more info:
### http://scikit-learn.org/stable/modules/pipeline.html

# Provided to give you a starting point. Try a variety of classifiers.

#########################Task 4: Using algorithm#######################

###4.1  Gaussian Naive Bayes Classifier
from sklearn.naive_bayes import GaussianNB
g_clf = GaussianNB()

###4.2  Logistic Regression Classifier
from sklearn.linear_model import LogisticRegression

l_clf = Pipeline(steps=[
        ('scaler', StandardScaler()),
        ('classifier', LogisticRegression(C=1e-08, class_weight=None, dual=False, fit_inte
max_iter=100, multi_class='ovr', penalty='l2', random_state=42, solver='liblinear', tol=0.

###4.3  K-means Clustering
from sklearn.cluster import KMeans
k_clf = KMeans(n_clusters=2, tol=0.001)


###4.4 Support Vector Machine Classifier
from sklearn.svm import SVC
s_clf = SVC(kernel='rbf', C=1000,gamma = 0.0001,random_state = 42, class_weight = 'balance

###4.5 Random Forest
from sklearn.ensemble import RandomForestClassifier
rf_clf = RandomForestClassifier(max_depth = 5,max_features = 'sqrt',n_estimators = 10, ran


###4.6 Gradient Boosting Classifier
from sklearn.ensemble  import GradientBoostingClassifier
gb_clf = GradientBoostingClassifier(loss='deviance', learning_rate=0.1, n_estimators=100,

###4.7 evaluate function
def evaluate_clf(clf, features, labels, num_iters=1000, test_size=0.3):
    print (clf)
    accuracy = []
    precision = []
    recall = []
    first = True
    for trial in range(num_iters):
        features_train, features_test, labels_train, labels_test =\
            train_test_split(features, labels, test_size=test_size)
        clf.fit(features_train, labels_train)
        predictions = clf.predict(features_test)
        accuracy.append(accuracy_score(labels_test, predictions))
        precision.append(precision_score(labels_test, predictions))
        recall.append(recall_score(labels_test, predictions))
        if trial % 10 == 0:
            if first:
                sys.stdout.write('\nProcessing')
            sys.stdout.write('.')
            sys.stdout.flush()
            first = False

    print ("done.\n")
    print ("precision: {}".format(mean(precision)))
    print ("recall:    {}".format(mean(recall)))
    return mean(precision), mean(recall)
```

In [18]:

```python
### 4.8 Evaluate all functions
evaluate_clf(g_clf, features, labels)
evaluate_clf(l_clf, features, labels)
evaluate_clf(k_clf, features, labels)
evaluate_clf(s_clf, features, labels)
evaluate_clf(rf_clf, features, labels)
evaluate_clf(gb_clf, features, labels)

### Select Logistic Regression as final algorithm
clf = l_clf



# dump your classifier, dataset and features_list so
# anyone can run/check your results

pickle.dump(clf, open("../final_project/my_classifier.pkl", "wb"))
pickle.dump(my_dataset, open("../final_project/my_dataset.pkl", "wb"))
pickle.dump(my_feature_list, open("../final_project/my_feature_list.pkl", "wb"))
```

GaussianNB()

Processing..........
C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\metrics_classification.py:1248: Unde
finedMetricWarning: Recall is ill-defined and being set to 0.0 due to no true samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\metrics_classification.py:1248: Unde
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  _warn_prf(average, modifier, msg_start, len(result))
...............................done.

precision: 0.3750325840825841
recall: 0.32848217893217896
Pipeline(steps=[('scaler', StandardScaler()),
                ('classifier',
                 LogisticRegression(C=1e-08, multi_class='ovr', random_state=42,
                                    solver='liblinear', tol=0.001))])

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  _warn_prf(average, modifier, msg_start, len(result))
....
done.

precision: 0.365656398013750-9
recall: 0.4518031746031746
KMeans(n_clusters=2, tol=0.001)

Processing....
C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\metrics_classification.py:1248: Unde
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.done.

precision: 0.3369044537734572
recall:    0.3968604256854257
SVC(C=1000, class_weight='balanced', gamma=0.0001, random_state=42)

Processing..
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.......done.

precision: 0.3796968393201001
recall:    0.3409945526695527
RandomForestClassifier(max_depth=5, max_features='sqrt', n_estimators=10,
                       random_state=42)

Processing.
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..done.

precision: 0.3497876984126984
recall:    0.16737388167388167
GradientBoostingClassifier(random_state=42)

Processing.
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C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
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`zero_division` parameter to control this behavior.
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..done.

precision: 0.34411220168720164
recall:    0.255900974025974
```

In [25]:
```python
### Task 5: Tune your classifier to achieve better than .42 precision and recall
### using our testing script. Check the tester.py script in the final project
### folder for details on the evaluation method, especially the test_classifier
### function. Because of the small size of the dataset, the script uses
### stratified shuffle split cross validation. For more info:
### http://scikit-learn.org/stable/modules/generated/sklearn.cross_validation.StratifiedS

# Example starting point. Try investigating other evaluation techniques!

features_train, features_test, labels_train, labels_test = \
    train_test_split(features, labels, test_size=0.3, random_state=42)

#%%
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
clf2 = SVC(C=5.4, cache_size=200, class_weight='balanced', coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=3.9, kernel='sigmoid',
  max_iter=-1, probability=False, random_state=42, shrinking=True,
  tol=0.001, verbose=False)

clf3 = KNeighborsClassifier(algorithm='ball_tree', leaf_size=1, metric='minkowski',
        metric_params=None, n_jobs=1, n_neighbors=3, p=2,
        weights='distance')

evaluate_clf(clf3, features, labels)
```

```
KNeighborsClassifier(algorithm='ball_tree', leaf_size=1, n_jobs=1,
                     n_neighbors=3, weights='distance')

Processing....
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finedMetricWarning: Recall is ill-defined and being set to 0.0 due to no true samples. Use
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         ..done.

         precision: 0.12696868686868687
         recall:    0.06330198412698412

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```

Out[25]:
```
(0.12696868686868687, 0.06330198412698412)
```

In [33]:
```python
# best_features = get_k_best(my_dataset, my_feature_list, num_features)

# my_feature_list = [target_label] + list(set(best_features.keys()))

test=["fraction_to_poi",'shared_receipt_with_poi',"fraction_from_poi"]#,"salary",'exercise

my_feature_list = [target_label] +test

# 3.6 print features
print ("{0} selected features: {1}\n".format(len(my_feature_list) - 1, my_feature_list[1:]

# 3.7 extract the features specified in features_list
data = featureFormat(my_dataset, my_feature_list,sort_keys = True)
# split into labels and features
labels, features = targetFeatureSplit(data)

# 3.8 scale features via min-max
from sklearn import preprocessing
scaler = preprocessing.MinMaxScaler()
features = scaler.fit_transform(features)

from sklearn.model_selection import GridSearchCV
from sklearn.pipeline import make_pipeline
```

```python
from  sklearn.tree import DecisionTreeClassifier
from sklearn.decomposition import PCA
pl = make_pipeline(SelectKBest(), PCA(random_state = 42, svd_solver='randomized'), Decisio
params = dict(
        selectkbest__k = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
        decisiontreeclassifier__criterion = ['gini', 'entropy'],
        decisiontreeclassifier__splitter = ['best', 'random']
)


pca = PCA(n_components='mle')


from time import time

grid = GridSearchCV(pl, param_grid = params, scoring = 'recall')



from sklearn.ensemble import AdaBoostClassifier
clf_AdaBoost = AdaBoostClassifier()

### Task 5: Tune your classifier to achieve better than .3 precision and recall
### using our testing script. Check the tester.py script in the final project
### folder for details on the evaluation method, especially the test_classifier
### function. Because of the small size of the dataset, the script uses
### stratified shuffle split cross validation. For more info:
### http://scikit-learn.org/stable/modules/generated/sklearn.cross_validation.StratifiedSl

# Example starting point. Try investigating other evaluation techniques!
from sklearn.model_selection import train_test_split
features_train, features_test, labels_train, labels_test = \
    train_test_split(features, labels, test_size=0.3, random_state=42)

pca.fit(features_train)
features_train_pca = pca.transform(features_train)
features_test_pca = pca.transform(features_test)

grid.fit(features_train, labels_train)
clf_DT = grid.best_estimator_

t0 = time()
clf_DT.fit(features_train,labels_train)
print ("Decision Tree - training time:", round(time()-t0, 3), "s")
t1 = time()
predictions_DT = clf_DT.predict(features_test)
print ("Decision Tree - prediction time:", round(time()-t1, 3), "s")

t0 = time()
clf_AdaBoost.fit(features_train_pca,labels_train)
print( "AdaBoost - training time:", round(time()-t0, 3), "s")
t1 = time()
predictions_AdaBoost = clf_AdaBoost.predict(features_test_pca)
print ("AdaBoost - prediction time:", round(time()-t1, 3), "s")

### Stochastic Gradient Descent
from sklearn import linear_model
clf_SGD = linear_model.SGDClassifier(class_weight = "balanced")

### Gaussian Naive Bayes
from sklearn.naive_bayes import GaussianNB
clf_NB = GaussianNB()

### Random Forests
from sklearn.ensemble import RandomForestClassifier
clf_RF = RandomForestClassifier()


clf_SGD.fit(features_train_pca,labels_train)
```

```python
predictions_SGD = clf_SGD.predict(features_test_pca)

clf_NB.fit(features_train_pca,labels_train)
predictions_NB = clf_NB.predict(features_test_pca)

clf_RF.fit(features_train_pca,labels_train)
predictions_RF = clf_RF.predict(features_test_pca)


from sklearn.metrics import precision_score, recall_score
print ("precision score for the Gaussian Naive Bayes Classifier : ",precision_score(labels
print ("recall score for the Gaussian Naive Bayes Classifier : ",recall_score(labels_test,

print ("precision score for the Decision tree Classifier : ",precision_score(labels_test,p
print ("recall score for the Decision tree Classifier : ",recall_score(labels_test,predict

print ("precision score for the AdaBoost Classifier : ",precision_score(labels_test,predic
print ("recall score for the AdaBoost Classifier : ",recall_score(labels_test,predictions_

print ("precision score for the Random Forest Classifier : ",precision_score(labels_test,p
print ("recall score for the Random Forest Classifier : ",recall_score(labels_test,predict

print ("precision score for the Stochastic Gradient Descent Classifier : ",precision_score
print ("recall score for the Stochastic Gradient Descent Classifier : ",recall_score(label
```

```
3 selected features: ['fraction_to_poi', 'shared_receipt_with_poi', 'fraction_from_poi']


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ValueError: k should be >=0, <= n_features = 3; got 5. Use k='all' to return all features.

  warnings.warn("Estimator fit failed. The score on this train-test"
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  File "C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\feature_selection\_univariate
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    raise ValueError("k should be >=0, <= n_features = %d; got %r. "
ValueError: k should be >=0, <= n_features = 3; got 9. Use k='all' to return all features.

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: F
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rameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\model_selection\_validation.p
y", line 598, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\pipeline.py", line 341, in fi
t
    Xt = self._fit(X, y, **fit_params_steps)
  File "C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\pipeline.py", line 303, in _f
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    X, fitted_transformer = fit_transform_one_cached(
  File "C:\Users\Varesse\anaconda3\lib\site-packages\joblib\memory.py", line 349, in __cal
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    return self.func(*args, **kwargs)
  File "C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\pipeline.py", line 754, in _f
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```

```
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    raise ValueError("k should be >=0, <= n_features = %d; got %r. "
ValueError: k should be >=0, <= n_features = 3; got 10. Use k='all' to return all feature
s.

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\model_selection\_search.py:922: UserW
arning: One or more of the test scores are non-finite: [0.33333333 0.23333333 0.33333333
       nan        nan        nan
       nan        nan        nan        nan 0.33333333 0.16666667
 0.36666667        nan        nan        nan        nan        nan
       nan        nan 0.33333333 0.33333333 0.4               nan
       nan        nan        nan        nan        nan        nan
 0.33333333 0.16666667 0.26666667        nan        nan        nan
       nan        nan        nan        nan]
  warnings.warn(
Decision Tree - training time: 0.0 s
Decision Tree - prediction time: 0.0 s
AdaBoost - training time: 0.131 s
AdaBoost - prediction time: 0.016 s
precision score for the Gaussian Naive Bayes Classifier :  0.0
recall score for the Gaussian Naive Bayes Classifier :  0.0
precision score for the Decision tree Classifier :  0.0
recall score for the Decision tree Classifier :  0.0
precision score for the AdaBoost Classifier :  0.0
recall score for the AdaBoost Classifier :  0.0
precision score for the Random Forest Classifier :  0.0
recall score for the Random Forest Classifier :  0.0
precision score for the Stochastic Gradient Descent Classifier :  0.07692307692307693
recall score for the Stochastic Gradient Descent Classifier :  1.0

C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted samp
les. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [37]:
```python
clf = SVC(gamma=3, C=2)
clf.fit(features_train,labels_train)
pred = clf.predict(features_test)
from sklearn.metrics import accuracy_score
```

```
accuracy = accuracy_score(labels_test,pred)
print("SVM Classifier: ")
print ("Accuracy: " + str(accuracy))
print ("Precision Score: " + str(precision_score(labels_test,pred)))
print ("Recall Score: " + str(recall_score(labels_test,pred)))
```

```
SVM Classifier:
Accuracy: 0.9230769230769231
Precision Score: 0.0
Recall Score: 0.0
```

C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\metrics_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted samp
les. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))

In [38]:
```python
cv = StratifiedShuffleSplit(labels)#, n_iter=10)


def scoring(estimator, features_test, labels_test):
    labels_pred = estimator.predict(features_test)
    p = precision_score(labels_test, labels_pred, average='micro')
    r = recall_score(labels_test, labels_pred, average='micro')
    if p > 0.3 and r > 0.3:
        return f1_score(labels_test, labels_pred, average='macro')
    return 0
import matplotlib.pyplot as plt
from sklearn.svm import SVC
from sklearn.model_selection import StratifiedKFold
from sklearn.feature_selection import RFECV
clf = DecisionTreeClassifier(max_depth = 5)
rfecv = RFECV(estimator=clf, step=1, cv=StratifiedKFold(labels, 50),
            scoring='precision')
rfecv.fit(features, labels)
print("Optimal number of features : %d" % rfecv.n_features_)
print (rfecv.support_)
features=features[:,rfecv.support_]
# Plot number of features VS. cross-validation scores
plt.figure()
plt.xlabel("Number of features selected")
plt.ylabel("Cross validation score (nb of correct classifications)")
plt.plot(range(1, len(rfecv.grid_scores_) + 1), rfecv.grid_scores_)
plt.show()
```

C:\Users\Varesse\anaconda3\lib\site-packages\sklearn\utils\validation.py:70: FutureWarnin
g: Pass shuffle=50 as keyword args. From version 1.0 (renaming of 0.25) passing these as p
ositional arguments will result in an error
  warnings.warn(f"Pass {args_msg} as keyword args. From version "

ValueError   Traceback (most recent call last)
~\AppData\Local\Temp/ipykernel_11948/993052230.py in <module>
     14 from sklearn.feature_selection import RFECV
     15 clf = DecisionTreeClassifier(max_depth = 5)
---> 16 rfecv = RFECV(estimator=clf, step=1, cv=StratifiedKFold(labels, 50),
     17   scoring='precision')
     18 rfecv.fit(features, labels)

~\anaconda3\lib\site-packages\sklearn\utils\validation.py in inner_f(*args, **kwargs)
     72   "will result in an error", FutureWarning)
     73   kwargs.update(zip(sig.parameters, args))
---> 74   return f(**kwargs)
     75   return inner_f
     76

~\anaconda3\lib\site-packages\sklearn\model_selection_split.py in __init__(self, n_split
```

```
                 s, shuffle, random_state)
         634              @_deprecate_positional_args
         635              def __init__(self, n_splits=5, *, shuffle=False, random_state=None):
    --> 636                  super().__init__(n_splits=n_splits, shuffle=shuffle,
         637                                   random_state=random_state)
         638

    ~\anaconda3\lib\site-packages\sklearn\utils\validation.py in inner_f(*args, **kwargs)
          61                  extra_args = len(args) - len(all_args)
          62                  if extra_args <= 0:
    ---> 63                      return f(*args, **kwargs)
          64
          65                  # extra_args > 0

    ~\anaconda3\lib\site-packages\sklearn\model_selection\_split.py in __init__(self, n_split
    s, shuffle, random_state)
         272          def __init__(self, n_splits, *, shuffle, random_state):
         273              if not isinstance(n_splits, numbers.Integral):
    --> 274                  raise ValueError('The number of folds must be of Integral type. '
         275                                   '%s of type %s was passed.'
         276                                   % (n_splits, type(n_splits)))

    ValueError: The number of folds must be of Integral type. [0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
     0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 1.0, 0.0,
     0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
     0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 1.0,
     0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 1.0,
     0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
     0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 1.0, 0.0,
     0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
     0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0] of type <class 'list'> was passed.
```

In [20]:
```
### Task 6: Dump your classifier, dataset, and features_list so anyone can
### check your results. You do not need to change anything below, but make sure
### that the version of poi_id.py that you submit can be run on its own and
### generates the necessary .pkl files for validating your results.

dump_classifier_and_data(clf, my_dataset, features_list)
```

In [39]:
```
!pip install nbconvert[webpdf]
```

```
Requirement already satisfied: nbconvert[webpdf] in c:\users\varesse\anaconda3\lib\site-pa
ckages (6.1.0)
Requirement already satisfied: jupyterlab-pygments in c:\users\varesse\anaconda3\lib\site-
packages (from nbconvert[webpdf]) (0.1.2)
Requirement already satisfied: defusedxml in c:\users\varesse\anaconda3\lib\site-packages
(from nbconvert[webpdf]) (0.7.1)
Requirement already satisfied: jupyter-core in c:\users\varesse\anaconda3\lib\site-package
s (from nbconvert[webpdf]) (4.8.1)
Requirement already satisfied: nbclient<0.6.0,>=0.5.0 in c:\users\varesse\anaconda3\lib\si
te-packages (from nbconvert[webpdf]) (0.5.3)
Requirement already satisfied: jinja2>=2.4 in c:\users\varesse\anaconda3\lib\site-packages
(from nbconvert[webpdf]) (2.11.3)
Requirement already satisfied: traitlets>=5.0 in c:\users\varesse\anaconda3\lib\site-packa
ges (from nbconvert[webpdf]) (5.1.0)
Requirement already satisfied: mistune<2,>=0.8.1 in c:\users\varesse\anaconda3\lib\site-pa
ckages (from nbconvert[webpdf]) (0.8.4)
Requirement already satisfied: nbformat>=4.4 in c:\users\varesse\anaconda3\lib\site-packag
es (from nbconvert[webpdf]) (5.1.3)
Requirement already satisfied: pandocfilters>=1.4.1 in c:\users\varesse\anaconda3\lib\site
-packages (from nbconvert[webpdf]) (1.4.3)
Requirement already satisfied: pygments>=2.4.1 in c:\users\varesse\anaconda3\lib\site-pack
ages (from nbconvert[webpdf]) (2.10.0)
```

```
Requirement already satisfied: testpath in c:\users\varesse\anaconda3\lib\site-packages (f
rom nbconvert[webpdf]) (0.5.0)
Requirement already satisfied: bleach in c:\users\varesse\anaconda3\lib\site-packages (fro
m nbconvert[webpdf]) (4.0.0)
Requirement already satisfied: entrypoints>=0.2.2 in c:\users\varesse\anaconda3\lib\site-p
ackages (from nbconvert[webpdf]) (0.3)
Collecting pyppeteer==0.2.2
  Downloading pyppeteer-0.2.2-py3-none-any.whl (145 kB)
Collecting pyee<8.0.0,>=7.0.1
  Downloading pyee-7.0.4-py2.py3-none-any.whl (12 kB)
Requirement already satisfied: tqdm<5.0.0,>=4.42.1 in c:\users\varesse\anaconda3\lib\site-
packages (from pyppeteer==0.2.2->nbconvert[webpdf]) (4.62.3)
Requirement already satisfied: urllib3<2.0.0,>=1.25.8 in c:\users\varesse\anaconda3\lib\si
te-packages (from pyppeteer==0.2.2->nbconvert[webpdf]) (1.26.7)
Collecting websockets<9.0,>=8.1
  Downloading websockets-8.1.tar.gz (58 kB)
Requirement already satisfied: appdirs<2.0.0,>=1.4.3 in c:\users\varesse\anaconda3\lib\sit
e-packages (from pyppeteer==0.2.2->nbconvert[webpdf]) (1.4.4)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\varesse\anaconda3\lib\site-pac
kages (from jinja2>=2.4->nbconvert[webpdf]) (1.1.1)
Requirement already satisfied: jupyter-client>=6.1.5 in c:\users\varesse\anaconda3\lib\sit
e-packages (from nbclient<0.6.0,>=0.5.0->nbconvert[webpdf]) (6.1.12)
Requirement already satisfied: async-generator in c:\users\varesse\anaconda3\lib\site-pack
ages (from nbclient<0.6.0,>=0.5.0->nbconvert[webpdf]) (1.10)
Requirement already satisfied: nest-asyncio in c:\users\varesse\anaconda3\lib\site-package
s (from nbclient<0.6.0,>=0.5.0->nbconvert[webpdf]) (1.5.1)
Requirement already satisfied: tornado>=4.1 in c:\users\varesse\anaconda3\lib\site-package
s (from jupyter-client>=6.1.5->nbclient<0.6.0,>=0.5.0->nbconvert[webpdf]) (6.1)
Requirement already satisfied: pyzmq>=13 in c:\users\varesse\anaconda3\lib\site-packages
(from jupyter-client>=6.1.5->nbclient<0.6.0,>=0.5.0->nbconvert[webpdf]) (22.2.1)
Requirement already satisfied: python-dateutil>=2.1 in c:\users\varesse\anaconda3\lib\site
-packages (from jupyter-client>=6.1.5->nbclient<0.6.0,>=0.5.0->nbconvert[webpdf]) (2.8.2)
Requirement already satisfied: pywin32>=1.0 in c:\users\varesse\anaconda3\lib\site-package
s (from jupyter-core->nbconvert[webpdf]) (228)
Requirement already satisfied: jsonschema!=2.5.0,>=2.4 in c:\users\varesse\anaconda3\lib\s
ite-packages (from nbformat>=4.4->nbconvert[webpdf]) (3.2.0)
Requirement already satisfied: ipython-genutils in c:\users\varesse\anaconda3\lib\site-pac
kages (from nbformat>=4.4->nbconvert[webpdf]) (0.2.0)
Requirement already satisfied: six>=1.11.0 in c:\users\varesse\anaconda3\lib\site-packages
(from jsonschema!=2.5.0,>=2.4->nbformat>=4.4->nbconvert[webpdf]) (1.16.0)
Requirement already satisfied: attrs>=17.4.0 in c:\users\varesse\anaconda3\lib\site-packag
es (from jsonschema!=2.5.0,>=2.4->nbformat>=4.4->nbconvert[webpdf]) (21.2.0)
Requirement already satisfied: pyrsistent>=0.14.0 in c:\users\varesse\anaconda3\lib\site-p
ackages (from jsonschema!=2.5.0,>=2.4->nbformat>=4.4->nbconvert[webpdf]) (0.18.0)
Requirement already satisfied: setuptools in c:\users\varesse\anaconda3\lib\site-packages
(from jsonschema!=2.5.0,>=2.4->nbformat>=4.4->nbconvert[webpdf]) (58.0.4)
Requirement already satisfied: colorama in c:\users\varesse\anaconda3\lib\site-packages (f
rom tqdm<5.0.0,>=4.42.1->pyppeteer==0.2.2->nbconvert[webpdf]) (0.4.4)
Requirement already satisfied: webencodings in c:\users\varesse\anaconda3\lib\site-package
s (from bleach->nbconvert[webpdf]) (0.5.1)
Requirement already satisfied: packaging in c:\users\varesse\anaconda3\lib\site-packages
(from bleach->nbconvert[webpdf]) (21.0)
Requirement already satisfied: pyparsing>=2.0.2 in c:\users\varesse\anaconda3\lib\site-pac
kages (from packaging->bleach->nbconvert[webpdf]) (3.0.4)
Building wheels for collected packages: websockets
  Building wheel for websockets (setup.py): started
  Building wheel for websockets (setup.py): finished with status 'done'
  Created wheel for websockets: filename=websockets-8.1-cp39-cp39-win_amd64.whl size=62758
sha256=a70d5b2d3a05cd3248bdebad3f722e784e725f2868a10e7ce29b6c8e91091175
  Stored in directory: c:\users\varesse\appdata\local\pip\cache\wheels\d8\b9\a0\b97b211aed
a2ebd6ac2e43fc300d308dbf1f9df520ed390cae
Successfully built websockets
Installing collected packages: websockets, pyee, pyppeteer
Successfully installed pyee-7.0.4 pyppeteer-0.2.2 websockets-8.1
```

```
In [40]:  !pip install Pyppeteer
```

Requirement already satisfied: Pyppeteer in c:\users\varesse\anaconda3\lib\site-packages
(0.2.2)
Requirement already satisfied: urllib3<2.0.0,>=1.25.8 in c:\users\varesse\anaconda3\lib\si
te-packages (from Pyppeteer) (1.26.7)
Requirement already satisfied: pyee<8.0.0,>=7.0.1 in c:\users\varesse\anaconda3\lib\site-p
ackages (from Pyppeteer) (7.0.4)
Requirement already satisfied: appdirs<2.0.0,>=1.4.3 in c:\users\varesse\anaconda3\lib\sit
e-packages (from Pyppeteer) (1.4.4)
Requirement already satisfied: tqdm<5.0.0,>=4.42.1 in c:\users\varesse\anaconda3\lib\site-
packages (from Pyppeteer) (4.62.3)
Requirement already satisfied: websockets<9.0,>=8.1 in c:\users\varesse\anaconda3\lib\site
-packages (from Pyppeteer) (8.1)
Requirement already satisfied: colorama in c:\users\varesse\anaconda3\lib\site-packages (f
rom tqdm<5.0.0,>=4.42.1->Pyppeteer) (0.4.4)

```
In [ ]:  !pip install chromium
```

```
In [ ]:
```

Requirement already satisfied: Pyppeteer in c:\users\varesse\anaconda3\lib\site-packages
(0.2.2)
Requirement already satisfied: urllib3<2.0.0,>=1.25.8 in c:\users\varesse\anaconda3\lib\si
te-packages (from Pyppeteer) (1.26.7)
Requirement already satisfied: pyee<8.0.0,>=7.0.1 in c:\users\varesse\anaconda3\lib\site-p
ackages (from Pyppeteer) (7.0.4)
Requirement already satisfied: appdirs<2.0.0,>=1.4.3 in c:\users\varesse\anaconda3\lib\sit
e-packages (from Pyppeteer) (1.4.4)
Requirement already satisfied: tqdm<5.0.0,>=4.42.1 in c:\users\varesse\anaconda3\lib\site-
packages (from Pyppeteer) (4.62.3)
Requirement already satisfied: websockets<9.0,>=8.1 in c:\users\varesse\anaconda3\lib\site
-packages (from Pyppeteer) (8.1)
Requirement already satisfied: colorama in c:\users\varesse\anaconda3\lib\site-packages (f
rom tqdm<5.0.0,>=4.42.1->Pyppeteer) (0.4.4)