Explorando

In [1]:
```
import pickle
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import tester
from sklearn.pipeline import Pipeline
from sklearn import svm
from sklearn.grid_search import GridSearchCV
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.preprocessing import StandardScaler
from sklearn.cross_validation import train_test_split
from sklearn.feature_selection import SelectKBest
from feature_format import featureFormat, targetFeatureSplit
import tester
%matplotlib inline
```

```
C:\Users\Daniel Vieira\Anaconda3\envs\py2\lib\site-packages\sklearn\cross_val
idation.py:41: DeprecationWarning: This module was deprecated in version 0.18
in favor of the model_selection module into which all the refactored classes
and functions are moved. Also note that the interface of the new CV iterators
are different from that of this module. This module will be removed in 0.20.
  "This module will be removed in 0.20.", DeprecationWarning)
C:\Users\Daniel Vieira\Anaconda3\envs\py2\lib\site-packages\sklearn\grid_sear
ch.py:42: DeprecationWarning: This module was deprecated in version 0.18 in f
avor of the model_selection module into which all the refactored classes and
functions are moved. This module will be removed in 0.20.
  DeprecationWarning)
```

In [2]:
```
# Vamos abrir a cerregar dodos os dados para a ánalise
# Usando o With open para melhor uso da memória
with open("final_project_dataset.pkl","rb") as data_file:
    my_dataset = pickle.load(data_file)
```

In [3]:
```
# Convertando para pandas para melhor manipulação
# from_dict é por o cojunto de dados está em formato de dicionário
# Assim ficará normal
df = pd.DataFrame.from_dict(my_dataset, orient='index')
```

In [4]:
```
# Removendo os valores nulos
df = df.replace('NaN',np.nan)
```

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 146 entries, ALLEN PHILLIP K to YEAP SOON
Data columns (total 21 columns):
salary                       95 non-null float64
to_messages                  86 non-null float64
deferral_payments            39 non-null float64
total_payments               125 non-null float64
exercised_stock_options      102 non-null float64
bonus                        82 non-null float64
restricted_stock             110 non-null float64
shared_receipt_with_poi      86 non-null float64
restricted_stock_deferred    18 non-null float64
total_stock_value            126 non-null float64
expenses                     95 non-null float64
loan_advances                4 non-null float64
from_messages                86 non-null float64
other                        93 non-null float64
from_this_person_to_poi      86 non-null float64
poi                          146 non-null bool
director_fees                17 non-null float64
deferred_income              49 non-null float64
long_term_incentive          66 non-null float64
email_address                111 non-null object
from_poi_to_this_person      86 non-null float64
dtypes: bool(1), float64(19), object(1)
memory usage: 24.1+ KB
```

Pode-se observar que que temos 146 individuos e que a grande maioria dos dados são float, apenas a linha "poi" é boolean e os emails são object (Texto), e é possivel observar que após a remoção dos valores nulos, algumas variaveis ficaram com poucas observações, sendo elas observações de ambito financeiro, irei substituir por 0, e as as variaveis de email irei preencher com a média dos valores dos outros

In [6]:
```
# Para agilidade, vou criar um lista separando os grupos das variaveis númeric
as
var_financeiro = ['salary','bonus','long_term_incentive','deferred_income',
                  'deferral_payments','loan_advances','other',
                  'expenses','director_fees','total_payments',
                  'exercised_stock_options','restricted_stock',
                  'restricted_stock_deferred','total_stock_value']

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

features_list = ['poi'] + var_financeiro + var_email
```

In [7]:
```
# verificando novamento o conjunto de dados
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 146 entries, ALLEN PHILLIP K to YEAP SOON
Data columns (total 21 columns):
salary                       95 non-null float64
to_messages                  86 non-null float64
deferral_payments            39 non-null float64
total_payments               125 non-null float64
exercised_stock_options      102 non-null float64
bonus                        82 non-null float64
restricted_stock             110 non-null float64
shared_receipt_with_poi      86 non-null float64
restricted_stock_deferred    18 non-null float64
total_stock_value            126 non-null float64
expenses                     95 non-null float64
loan_advances                4 non-null float64
from_messages                86 non-null float64
other                        93 non-null float64
from_this_person_to_poi      86 non-null float64
poi                          146 non-null bool
director_fees                17 non-null float64
deferred_income              49 non-null float64
long_term_incentive          66 non-null float64
email_address                111 non-null object
from_poi_to_this_person      86 non-null float64
dtypes: bool(1), float64(19), object(1)
memory usage: 24.1+ KB
```

In [8]:
```
df['poi'].value_counts()
```

Out[8]:
```
False    128
True      18
Name: poi, dtype: int64
```

In [9]:
```
df['poi'].value_counts(normalize = True)
```

Out[9]:
```
False    0.876712
True     0.123288
Name: poi, dtype: float64
```

In [10]:
```
not_null = df.count()
it_null = df.isna().sum()
poi = df[df['poi'] == True].count()


table_1 = pd.concat([not_null, it_null], axis=1)
table_1 .columns = ['Vars','NaN']
table_1['P_Var_NaN'] = table_1['NaN']/df.shape[0]
table_1.drop(index = 'poi', inplace = True)
table_1
```

Out[10]:

	Vars	NaN	P_Var_NaN
salary	95	51	0.349315
to_messages	86	60	0.410959
deferral_payments	39	107	0.732877
total_payments	125	21	0.143836
exercised_stock_options	102	44	0.301370
bonus	82	64	0.438356
restricted_stock	110	36	0.246575
shared_receipt_with_poi	86	60	0.410959
restricted_stock_deferred	18	128	0.876712
total_stock_value	126	20	0.136986
expenses	95	51	0.349315
loan_advances	4	142	0.972603
from_messages	86	60	0.410959
other	93	53	0.363014
from_this_person_to_poi	86	60	0.410959
director_fees	17	129	0.883562
deferred_income	49	97	0.664384
long_term_incentive	66	80	0.547945
email_address	111	35	0.239726
from_poi_to_this_person	86	60	0.410959

In [11]:
```
table_1.shape[0]
```

Out[11]: 20

Apenas a variavel "email_address" está faltanto dados, mas como se trata de emails, são dados que realmente não ha possibilidade de preencher

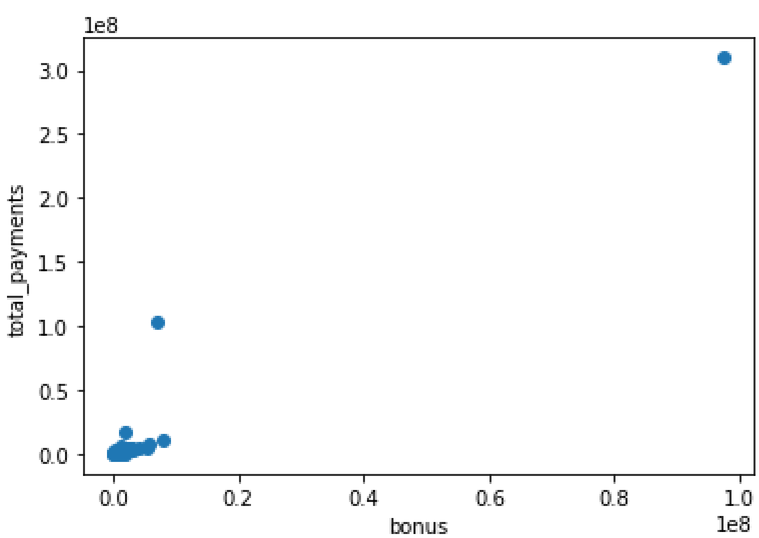
In [12]:
```
# Explorando a vaviravel total_payments
df['total_payments'].describe() , df['salary'].describe()
```

Out[12]:
```
(count    1.250000e+02
 mean     5.081526e+06
 std      2.906172e+07
 min      1.480000e+02
 25%      3.944750e+05
 50%      1.101393e+06
 75%      2.093263e+06
 max      3.098866e+08
 Name: total_payments, dtype: float64, count    9.500000e+01
 mean     5.621943e+05
 std      2.716369e+06
 min      4.770000e+02
 25%      2.118160e+05
 50%      2.599960e+05
 75%      3.121170e+05
 max      2.670423e+07
 Name: salary, dtype: float64)
```

Avalinando a variável "total_payments" ou total pago, é novavél uma grande discrepancia do valor minimo pelo valor maximo,e 75% dos dados, ou seja aprox 110 dos 146 receberam na faixa de 2 dezenas a menos que os 36 restantes, isso pode ser um outline, é preciso verificar

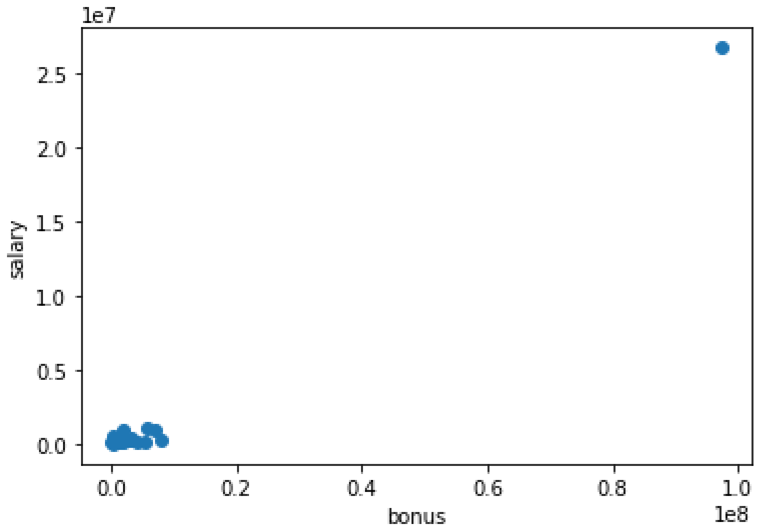
In [13]:
```
plt.scatter(df['bonus'],df['total_payments'])
plt.xlabel('bonus')
plt.ylabel('total_payments')
```

Out[13]:
```
Text(0,0.5,'total_payments')
```



In [14]:
```
plt.scatter(df['bonus'],df['salary'])
plt.xlabel('bonus')
plt.ylabel('salary')
```

Out[14]: Text(0,0.5,'salary')



plotantdo algumas variáveis, é notavel que no cojunto de dados tem algum outline

In [15]:
```
df[df['salary']==df['salary'].max()]
```

Out[15]:

	salary	to_messages	deferral_payments	total_payments	exercised_stock_
TOTAL	26704229.0	NaN	32083396.0	309886585.0	311764000.0

1 rows × 21 columns

aparentemente existe um somatório no total nas observações, como "TOTAL" nao pode ser considerado um POI, vamos retirar o mesmo

In [16]:
```
# Excluindo a observação "TOTAL"
df = df.drop(['TOTAL'],axis = 0)
```

In [17]:
```
# Verificando se o mesmo foi excluido
df[df['salary']==df['salary'].max()]
```

Out[17]:

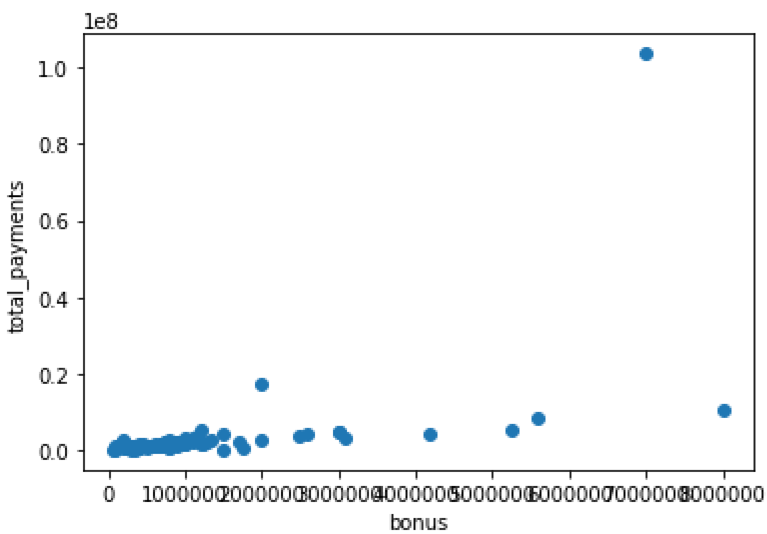
	salary	to_messages	deferral_payments	total_payments	exercised_stock
SKILLING JEFFREY K	1111258.0	3627.0	NaN	8682716.0	19250000.0

1 rows × 21 columns

Agora so temos pessoas no cojunto de dados, vamos checar novamente como está a dospersão dos dados

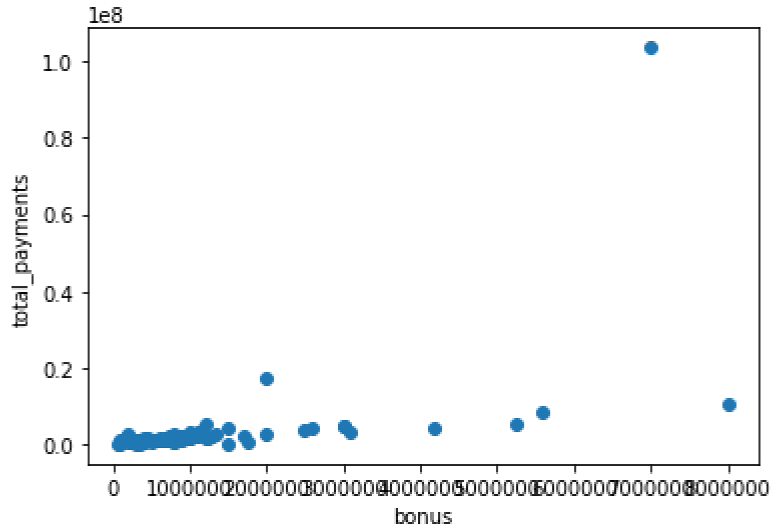
In [18]:
```
plt.scatter(df['bonus'],df['total_payments'])
plt.xlabel('bonus')
plt.ylabel('total_payments')
```

Out[18]: `Text(0,0.5,'total_payments')`



In [19]:
```
plt.scatter(df['bonus'],df['total_payments'],)
plt.xlabel('bonus')
plt.ylabel('total_payments')
```

Out[19]: `Text(0,0.5,'total_payments')`



Ainda temos algums pontos extremos, vamos verificar se essas pessoas são POIS

In [20]:
```
df.nlargest(5,'salary')[df['poi']==False]
```

```
C:\Users\Daniel Vieira\Anaconda3\envs\py2\lib\site-packages\ipykernel_launche
r.py:1: UserWarning: Boolean Series key will be reindexed to match DataFrame
index.
  """Entry point for launching an IPython kernel.
```

Out[20]:

	salary	to_messages	deferral_payments	total_payments	exercised_st
FREVERT MARK A	1060932.0	3275.0	6426990.0	17252530.0	10433518.0
PICKERING MARK R	655037.0	898.0	NaN	1386690.0	28798.0
WHALLEY LAWRENCE G	510364.0	6019.0	NaN	4677574.0	3282960.0

3 rows × 21 columns

In [21]:
```
df.nlargest(5,'total_payments')[df['poi']==False]
```

```
C:\Users\Daniel Vieira\Anaconda3\envs\py2\lib\site-packages\ipykernel_launche
r.py:1: UserWarning: Boolean Series key will be reindexed to match DataFrame
index.
  """Entry point for launching an IPython kernel.
```

Out[21]:

	salary	to_messages	deferral_payments	total_payments	exercised_s
FREVERT MARK A	1060932.0	3275.0	6426990.0	17252530.0	10433518.0
BHATNAGAR SANJAY	NaN	523.0	NaN	15456290.0	2604490.0
LAVORATO JOHN J	339288.0	7259.0	NaN	10425757.0	4158995.0

3 rows × 21 columns

Aparentemnte o FREVERT MARK A, LAVORATO JOHN J, WHALLEY LAWRENCE G aparentam ser um outlines porem eles estão classificados como não POI, pode ser que eles sejam de cargo executivo com alto salário, é interessante em retirar essas pessoas.

BHATNAGAR SANJAY parece que foi inserido errado, não faz sentido alguem com salário zerado está entre os 3 que mais receberam e ainda não ser um POI

In [22]:
```
# removendo as pessoas

df  = df.drop(['FREVERT MARK A','LAVORATO JOHN J',
               'WHALLEY LAWRENCE G','BHATNAGAR SANJAY'],axis =0)
```

In [23]:
```
df['poi'].value_counts()
```

Out[23]:
```
False    123
True      18
Name: poi, dtype: int64
```

In [24]:
```
df['poi'].value_counts(normalize = True)
```

Out[24]:
```
False    0.87234
True     0.12766
Name: poi, dtype: float64
```

Após a limpeza de dados, temos 18 POI correspondendo a 12.8% dos individos

In [25]:
```
df.info()
```

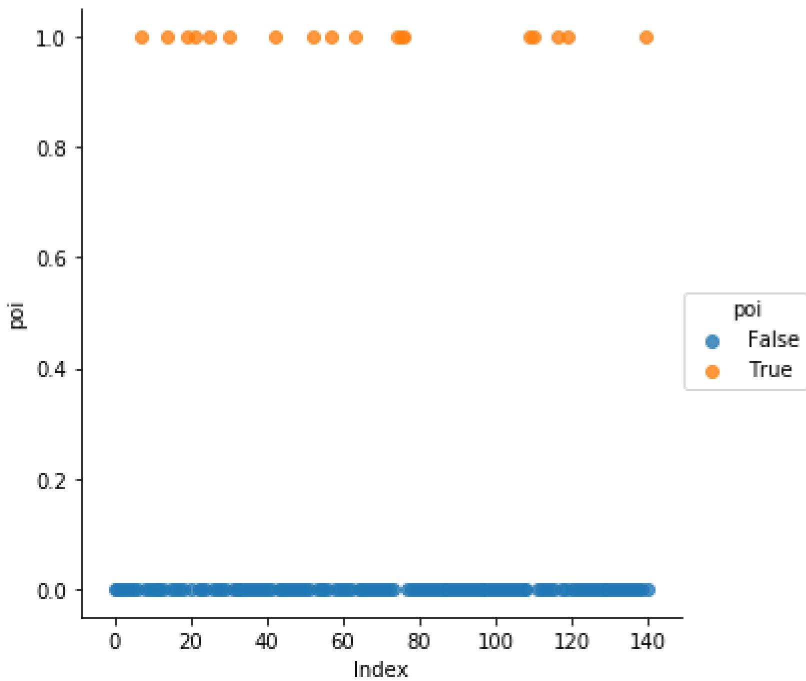
```
<class 'pandas.core.frame.DataFrame'>
Index: 141 entries, ALLEN PHILLIP K to YEAP SOON
Data columns (total 21 columns):
salary                       91 non-null float64
to_messages                  82 non-null float64
deferral_payments            37 non-null float64
total_payments               120 non-null float64
exercised_stock_options      97 non-null float64
bonus                        78 non-null float64
restricted_stock             105 non-null float64
shared_receipt_with_poi      82 non-null float64
restricted_stock_deferred    16 non-null float64
total_stock_value            122 non-null float64
expenses                     91 non-null float64
loan_advances                2 non-null float64
from_messages                82 non-null float64
other                        88 non-null float64
from_this_person_to_poi      82 non-null float64
poi                          141 non-null bool
director_fees                15 non-null float64
deferred_income              47 non-null float64
long_term_incentive          62 non-null float64
email_address                107 non-null object
from_poi_to_this_person      82 non-null float64
dtypes: bool(1), float64(19), object(1)
memory usage: 23.3+ KB
```

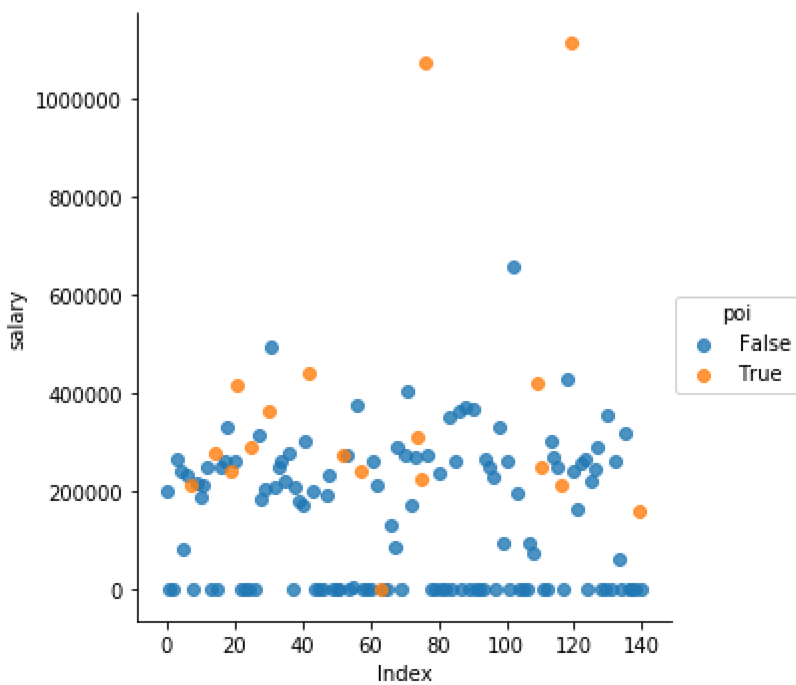
In [26]:
```
new_features =[]
df['p_bonus'] = df['bonus']/df['total_payments']
df['p_salary'] = df['salary']/df['total_payments']
new_features.append('p_bonus')
new_features.append('p_salary')
```

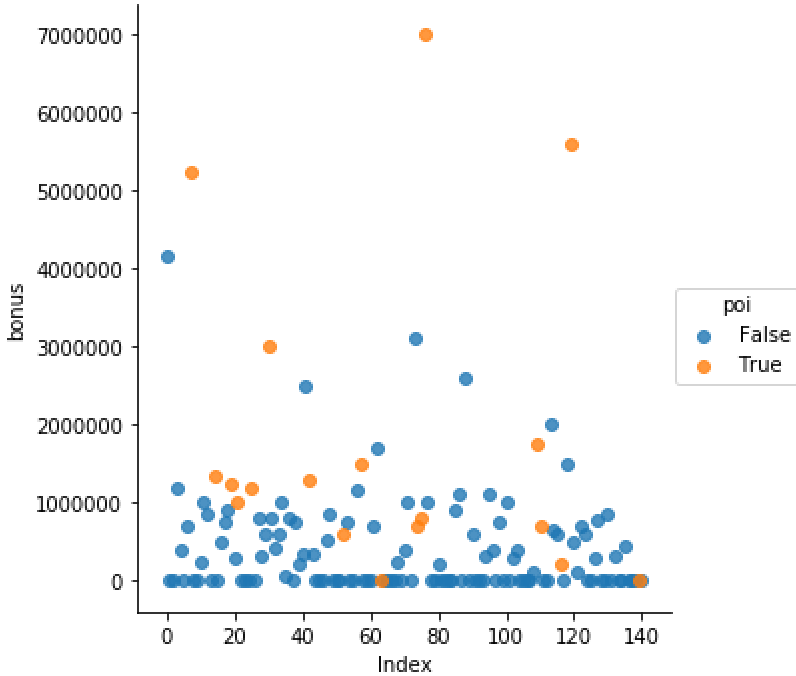
In [27]:
```
df['p_to_poi'] = df['from_poi_to_this_person'] / df['to_messages']
df['p_shared_poi'] = df['shared_receipt_with_poi'] / df['to_messages']
new_features.append('p_to_poi')
new_features.append('p_shared_poi')
```

In [28]:
```
df = df.replace('NaN',np.nan)
df = df.fillna(0.0)
```

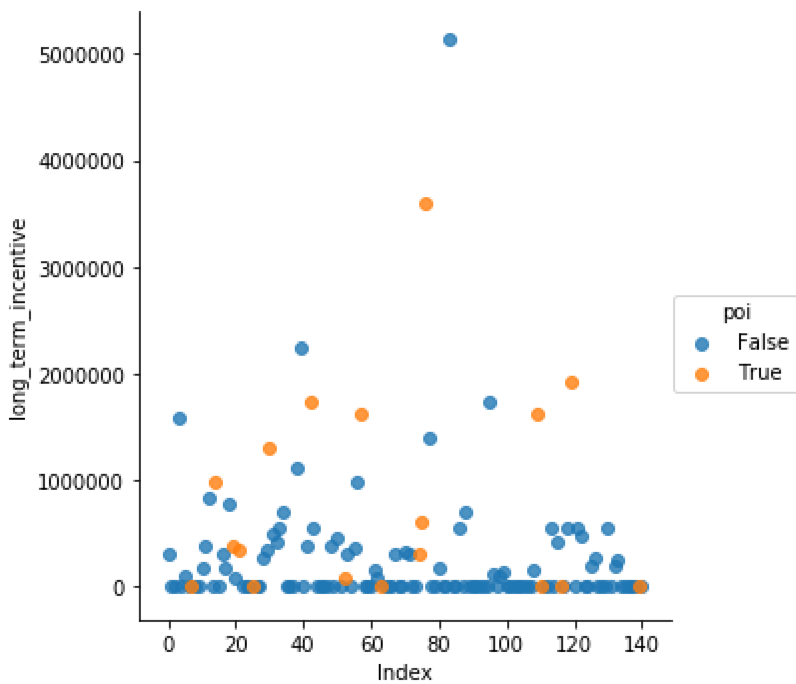
In [29]:
```
df['name'] = df.index
df = df.reset_index()
df['index'] = df.index
for feature in features_list:
    sns.lmplot('index', feature,
           data=df,
           fit_reg=False,
           hue="poi",
           size =5 )
    plt.xlabel('Index');
    plt.ylabel(feature);
```


1.0
0.8
0.6
0.4
0.2
0.0
poi
0
20
40
60
80
100
120
140
Index
poi
False
True

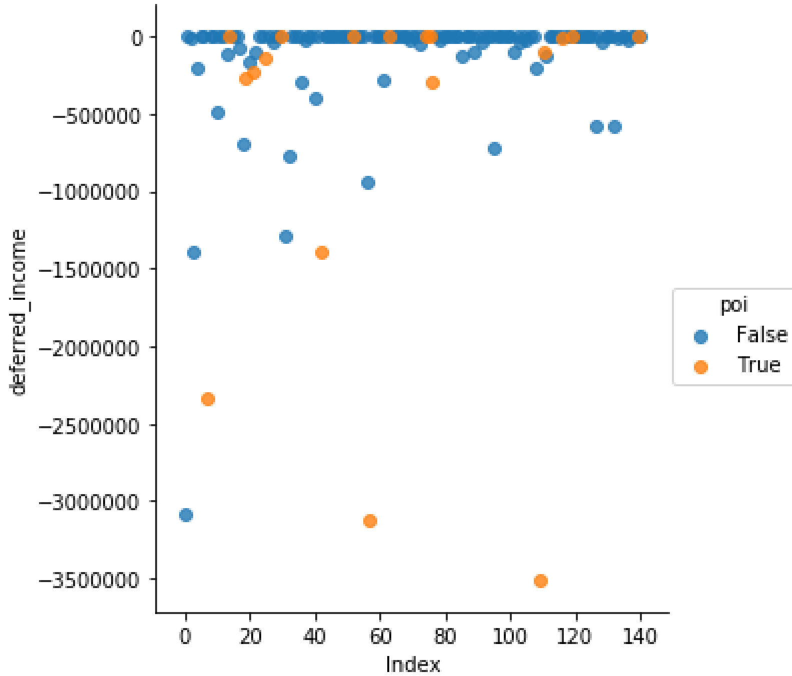

1000000
800000
600000
400000
200000
0
salary
0
20
40
60
80
100
120
140
Index
poi
False
True

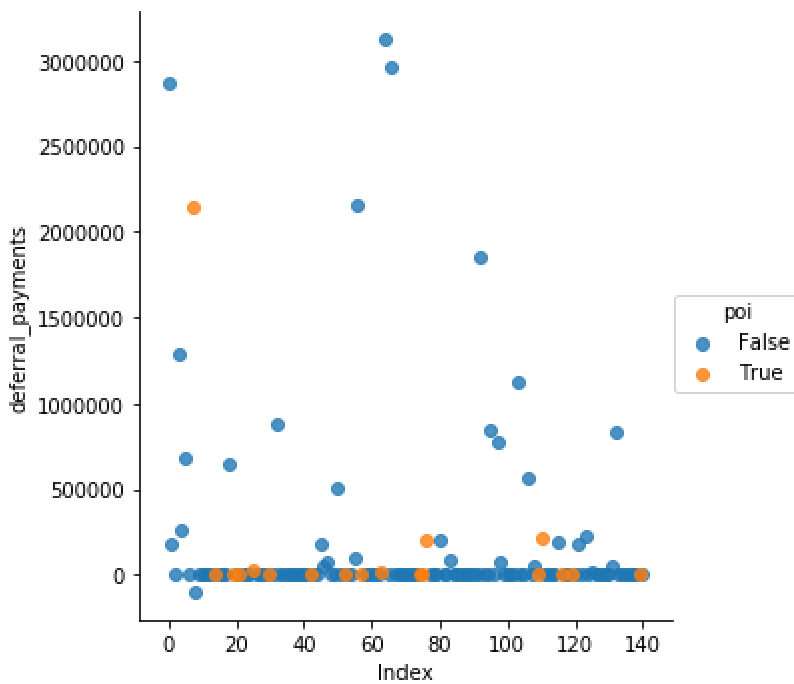


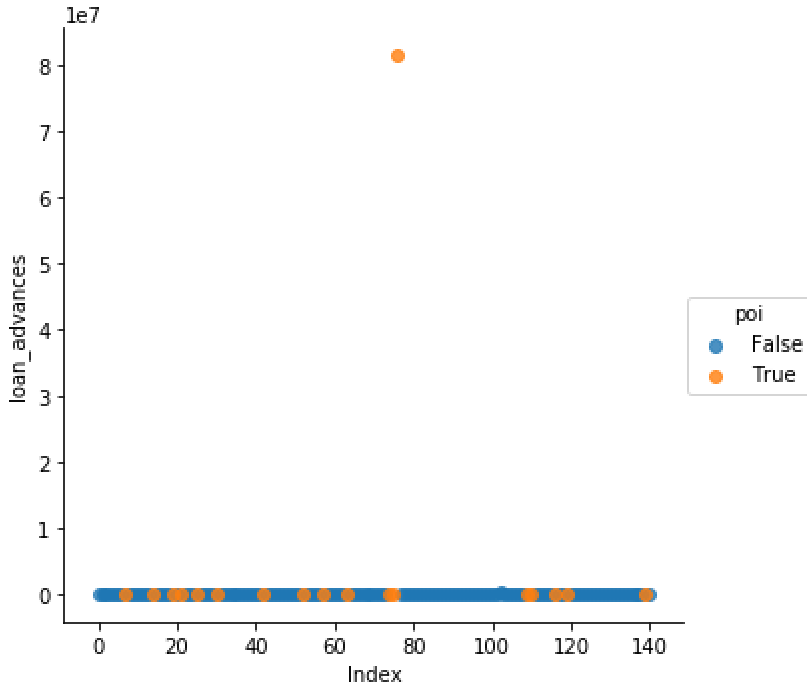
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
bonus
0
20
40
60
80
100
120
140
Index
poi
False
True

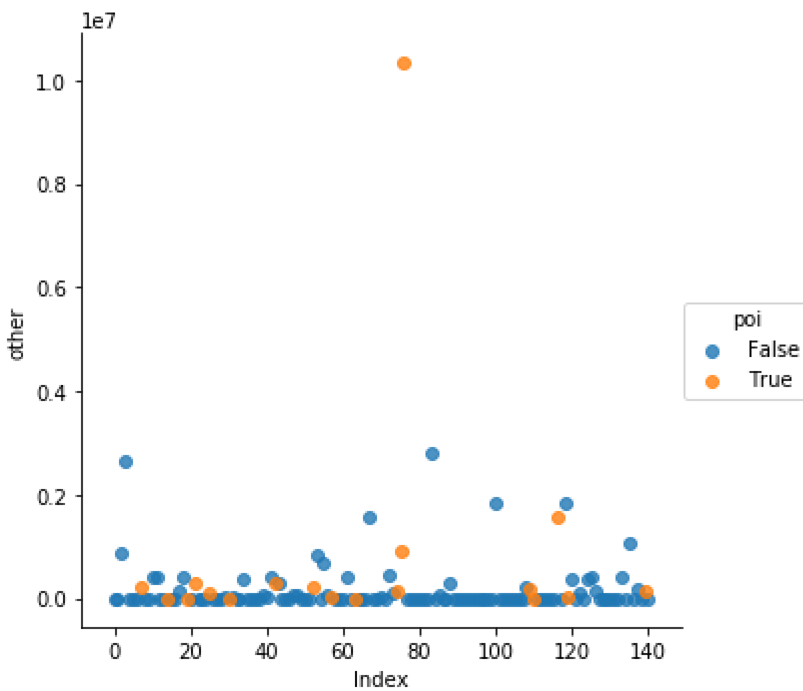


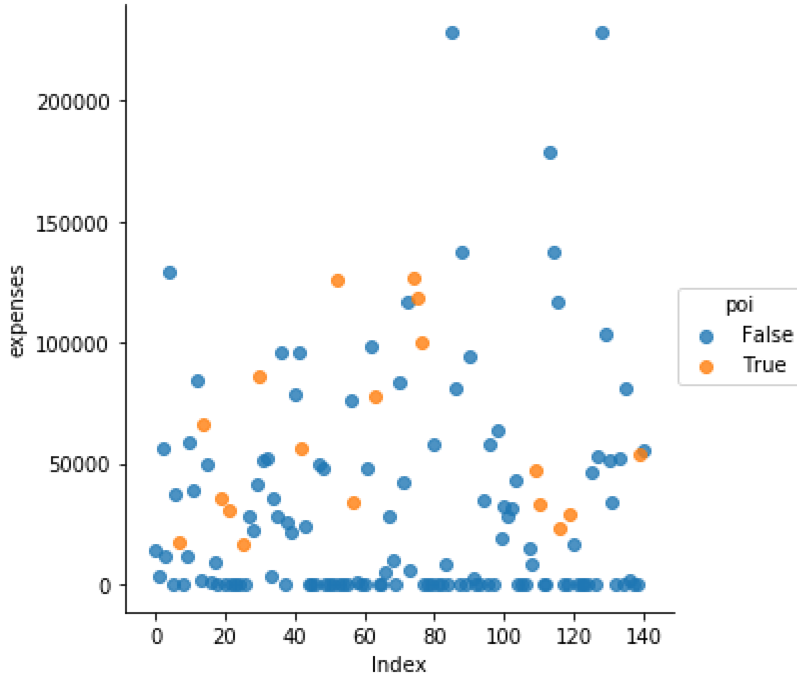
5000000
4000000
3000000
2000000
1000000
0
long_term_incentive
0
20
40
60
80
100
120
140
Index
poi
False
True

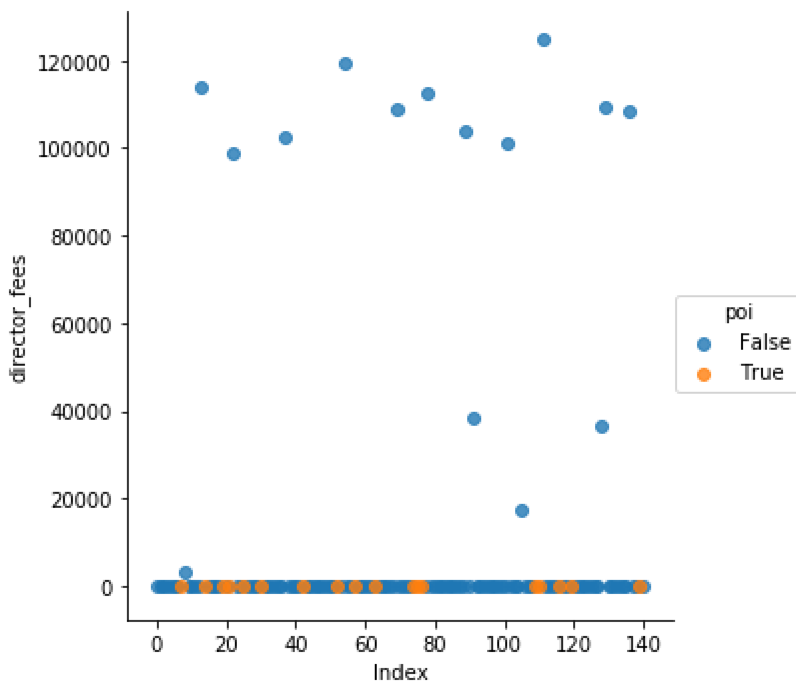

deferred_income
0
−500000
−1000000
−1500000
−2000000
−2500000
−3000000
−3500000
0 20 40 60 80 100 120 140
Index
poi
False
True

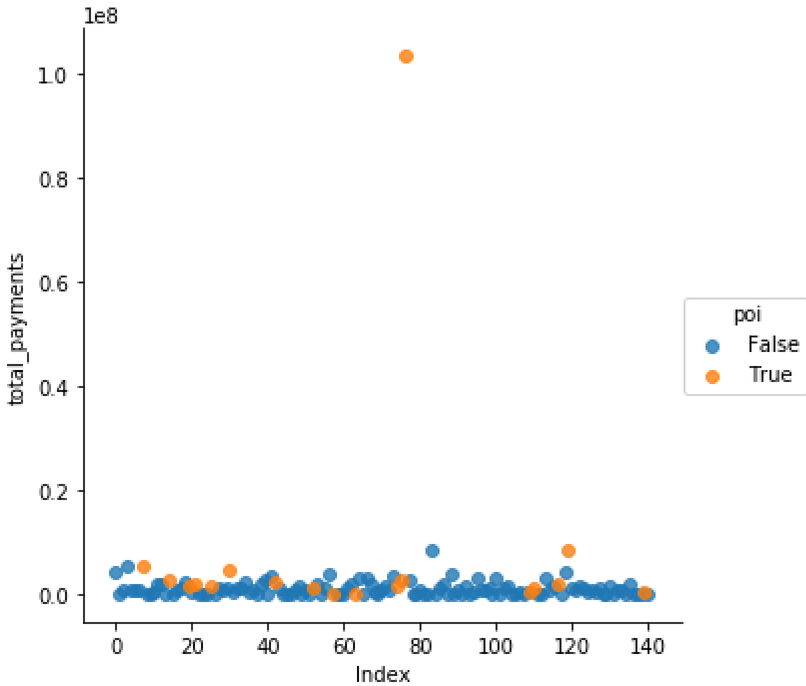

deferral_payments
3000000
2500000
2000000
1500000
1000000
500000
0
0 20 40 60 80 100 120 140
Index
poi
False
True

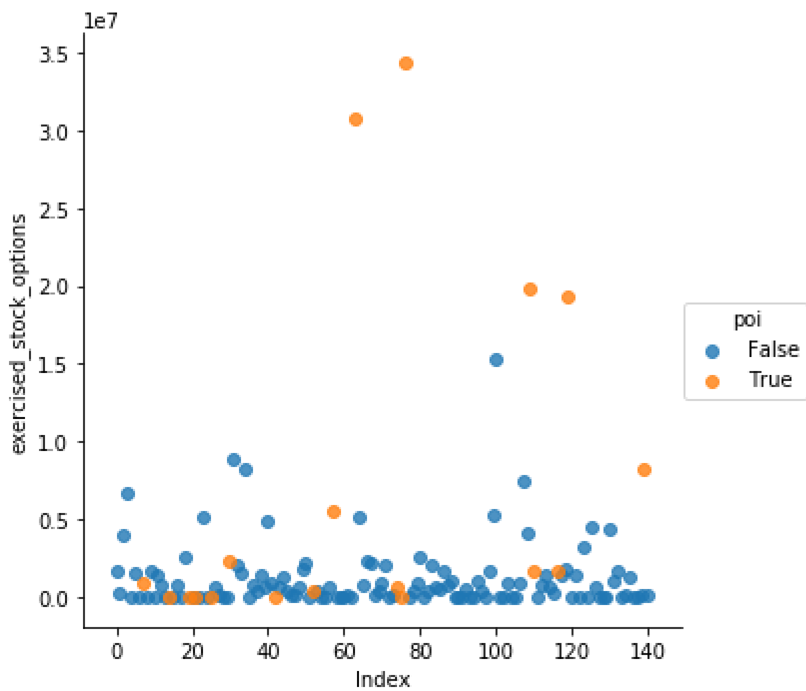

1e7
loan_advances
Index
poi
False
True

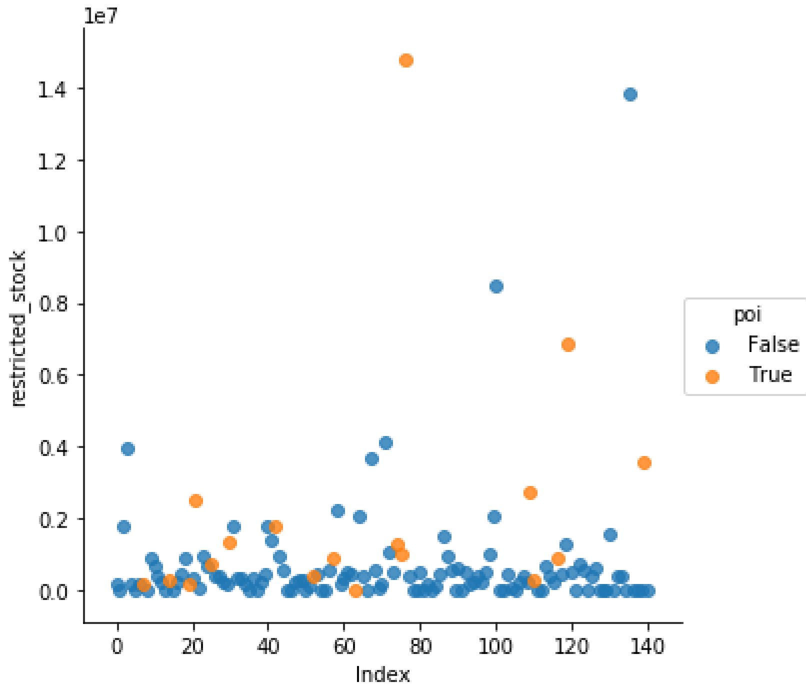

1e7
other
Index
poi
False
True

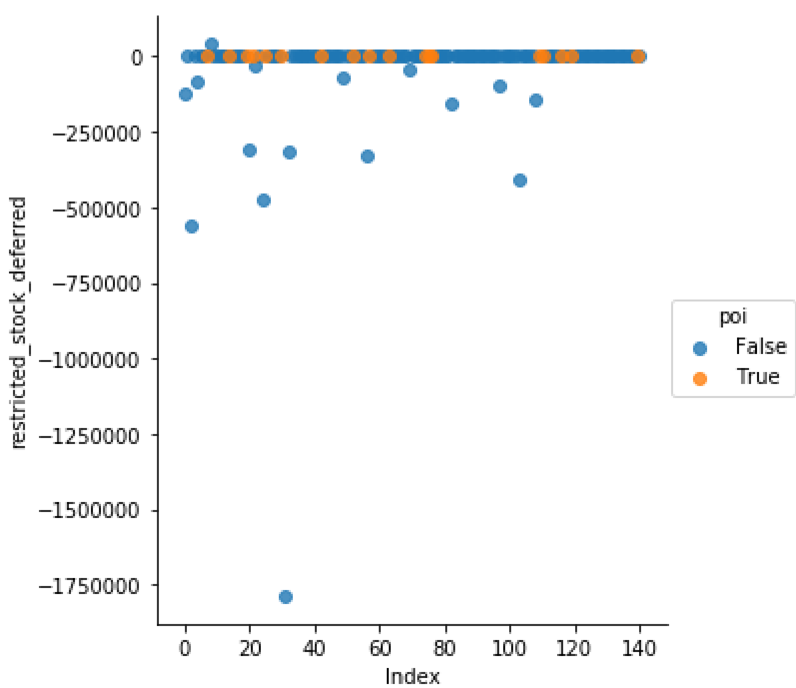

expenses
Index
poi
False
True

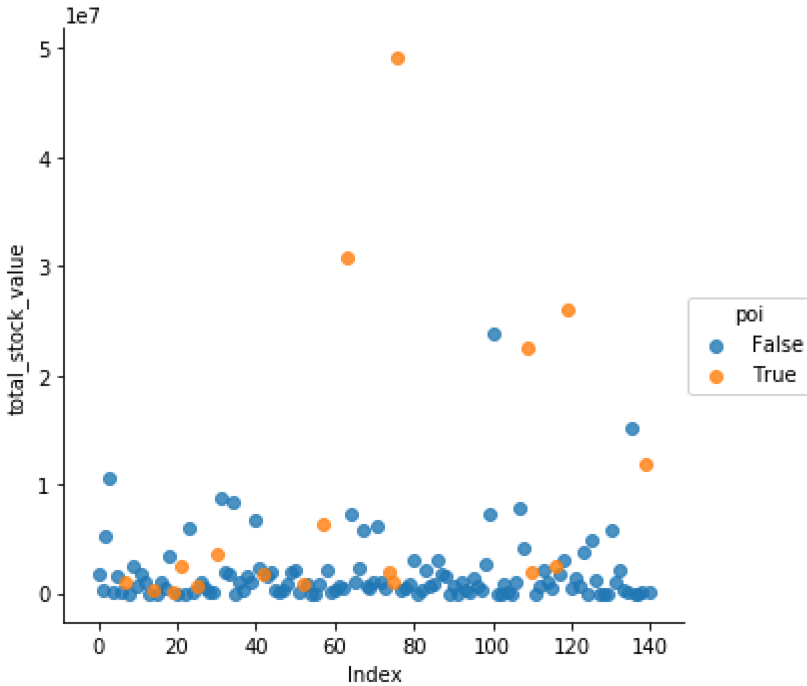

director_fees
Index
poi
False
True

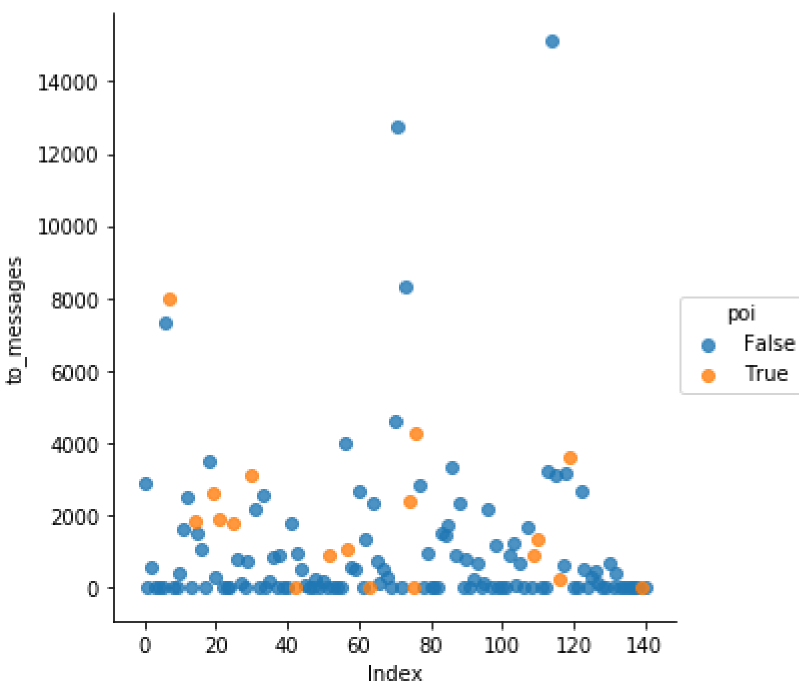

1e8
total_payments
Index
poi
False
True

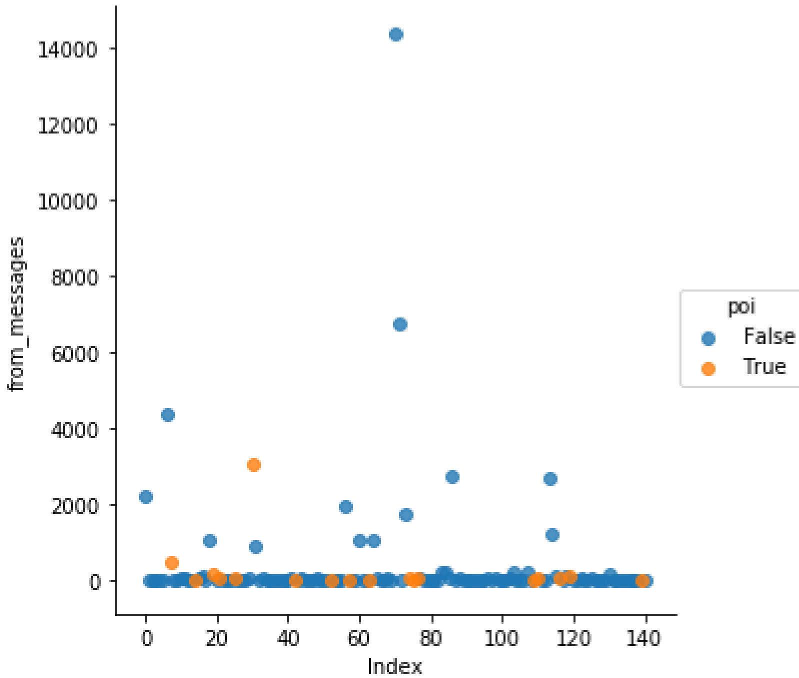

1e7
exercised_stock_options
Index
poi
False
True


1e7
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
restricted_stock
0
20
40
60
80
100
120
140
Index
poi
False
True

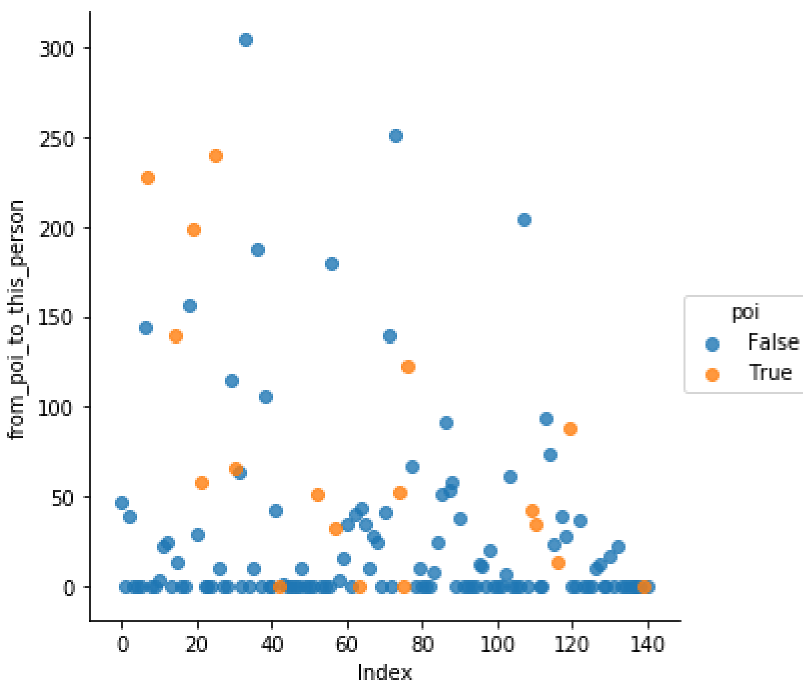

0
−250000
−500000
−750000
−1000000
−1250000
−1500000
−1750000
restricted_stock_deferred
0
20
40
60
80
100
120
140
Index
poi
False
True


1e7
5
4
3
2
1
0
total_stock_value
0
20
40
60
80
100
120
140
Index
poi
False
True

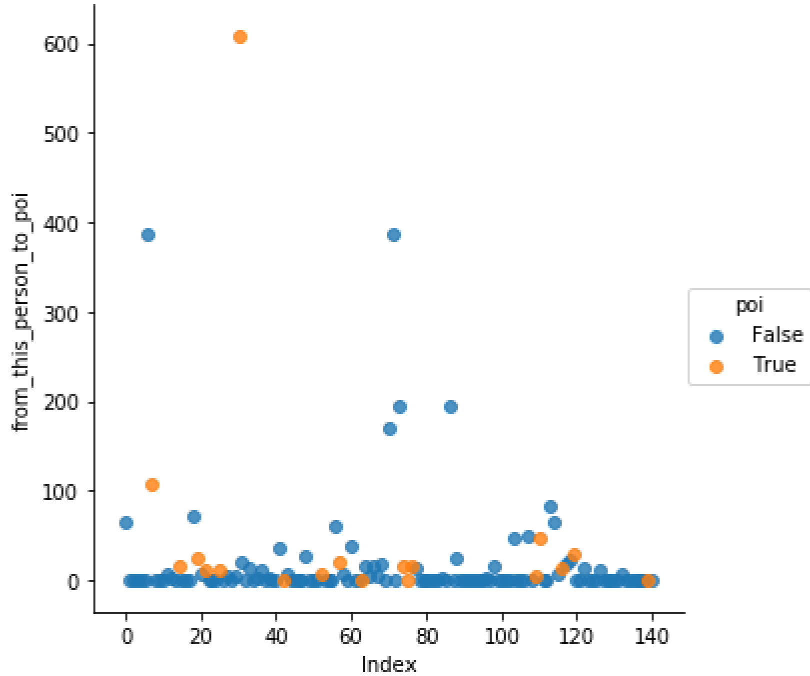

14000
12000
10000
8000
6000
4000
2000
0
to_messages
0
20
40
60
80
100
120
140
Index
poi
False
True

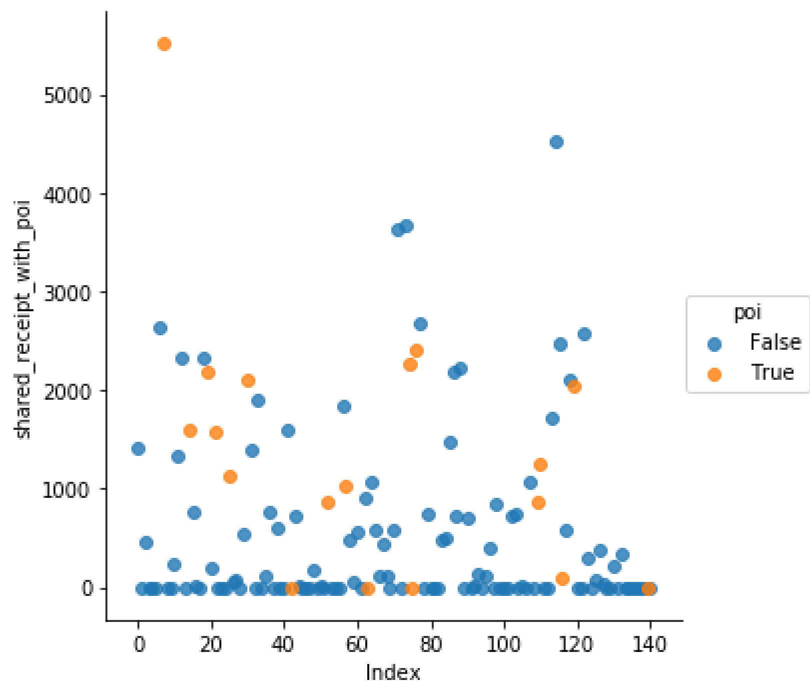


from_messages
Index
poi
False
True



from_poi_to_this_person
Index
poi
False
True





In [30]:
```
my_dataset = df.T.to_dict()
```

SVM com todas a Features

In [409]:
```
data = featureFormat(my_dataset, features_list, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [405]:
```
from sklearn import svm
svm = Pipeline([('scaler',StandardScaler()),('selector',SelectKBest()),('svm',
svm.SVC())])
param_grid = ([{'svm__C': [1,50,100,1000],
                'svm__gamma': [0.5, 0.1],
                'svm__degree':[1,2],
                'svm__kernel': ['rbf','poly'],
                'selector__k':range(1,len(features_list))}])

svm_clf = GridSearchCV(svm, param_grid, scoring='recall', cv = 5).fit(features
, labels).best_estimator_

tester.test_classifier(svm_clf, my_dataset, features_list)
```

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```

```
Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('selector', SelectKBest(k=18, score_func=<function f_classif at 0x00000
0000C331828>)), ('svm', SVC(C=50, cache_size=200, class_weight=None, coef0=0.
0,
  decision_function_shape='ovr', degree=2, gamma=0.1, kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False))])
        Accuracy: 0.83957       Precision: 0.40509      Recall: 0.26250 F1:
0.31857 F2: 0.28238
        Total predictions: 14000        True positives:  525    False positiv
es:  771        False negatives: 1475   True negatives: 11229
```

In [375]:

```
best_features = []
for i, feature in enumerate(svm_clf.get_params()['selector'].scores_):
        best_features.append([features_list[1:][i],feature])
pd_feature= pd.DataFrame(best_features,index = np.arange(1,len(best_features)+
1),columns  = ['Feature','Score'])

best_features = ['poi'] + pd_feature.nlargest(18,'Score')['Feature'].tolist()
pd_feature.nlargest(18,'Score')
```

Out[375]:

	Feature	Score
2	bonus	38.898768
1	salary	25.596746
11	exercised_stock_options	25.349842
14	total_stock_value	24.103581
3	long_term_incentive	21.175191
4	deferred_income	16.713754
17	from_poi_to_this_person	14.166948
19	shared_receipt_with_poi	14.136210
10	total_payments	10.286364
12	restricted_stock	8.246575
7	other	7.997446
6	loan_advances	7.206451
8	expenses	5.142709
18	from_this_person_to_poi	4.553716
15	to_messages	3.038600
9	director_fees	1.893497
13	restricted_stock_deferred	0.855352
5	deferral_payments	0.079225

SVM com as features e paramentros selecionados pelo GridSearchCV

In [376]:
```
data = featureFormat(my_dataset, best_features, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [377]:
```
from sklearn import svm
svm = Pipeline([('scaler',StandardScaler()), ('svm',svm.SVC())])

param_grid = ([{'svm__C': [50],
                'svm__gamma': [0.1],
                'svm__degree':[2],
                'svm__kernel': ['poly']}])

svm_clf = GridSearchCV(svm, param_grid, scoring='recall', cv = 10).fit(feature
s, labels).best_estimator_

tester.test_classifier(svm_clf, my_dataset,best_features)
```

```
Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('svm', SVC(C=50, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=2, gamma=0.1, kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False))])
        Accuracy: 0.84071       Precision: 0.41127      Recall: 0.26650 F1:
0.32342 F2: 0.28668
        Total predictions: 14000        True positives:  533    False positiv
es:  763        False negatives: 1467   True negatives: 11237
```

SVM com as novas Features

In [410]:
```
total_features = []
total_features += features_list + new_features

data = featureFormat(my_dataset,total_features, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [411]:
```
from sklearn import svm
svm = Pipeline([('scaler',StandardScaler()),('selector',SelectKBest()),('svm',
svm.SVC())])
param_grid = ([{'svm__C': [1,50,100,1000],
                'svm__gamma': [0.5, 0.1],
                'svm__degree':[1,2],
                'svm__kernel': ['rbf','poly'],
                'selector__k':range(1,len(total_features))}])

svm_clf = GridSearchCV(svm, param_grid, scoring='recall', cv = 5).fit(features
, labels).best_estimator_

tester.test_classifier(svm_clf, my_dataset, total_features)
```

```
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Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('selector', SelectKBest(k=13, score_func=<function f_classif at 0x00000
0000C331828>)), ('svm', SVC(C=1000, cache_size=200, class_weight=None, coef0=
0.0,
  decision_function_shape='ovr', degree=2, gamma=0.1, kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False))])
        Accuracy: 0.81300       Precision: 0.34219      Recall: 0.33500 F1:
0.33855 F2: 0.33641
        Total predictions: 14000        True positives:  670    False positiv
es: 1288        False negatives: 1330   True negatives: 10712
```

In [412]:
```
best_features = []
for i, feature in enumerate(svm_clf.get_params()['selector'].scores_):
        best_features.append([total_features[1:][i],feature])
pd_feature= pd.DataFrame(best_features,index = np.arange(1,len(best_features)+
1),columns  = ['Feature','Score'])

best_features = ['poi'] + pd_feature.nlargest(13,'Score')['Feature'].tolist()
pd_feature.nlargest(13,'Score')
```

Out[412]:

	Feature	Score
2	bonus	38.898768
1	salary	25.596746
11	exercised_stock_options	25.349842
14	total_stock_value	24.103581
20	p_bonus	23.829780
3	long_term_incentive	21.175191
4	deferred_income	16.713754
17	from_poi_to_this_person	14.166948
19	shared_receipt_with_poi	14.136210
23	p_shared_poi	10.745080
10	total_payments	10.286364
12	restricted_stock	8.246575
7	other	7.997446

SVM com as novas features e paramentros selecionados pelo GridSearchCV

In [413]:
```
data = featureFormat(my_dataset, best_features, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [414]:
```
from sklearn import svm
svm = Pipeline([('scaler',StandardScaler()), ('svm',svm.SVC())])

param_grid = ([{'svm__C': [1000],
                'svm__gamma': [0.1],
                'svm__degree':[2],
                'svm__kernel': ['poly']}])

svm_clf = GridSearchCV(svm, param_grid, scoring='recall',cv = 5).fit(features,
 labels).best_estimator_

tester.test_classifier(svm_clf, my_dataset,best_features)
```

```
Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('svm', SVC(C=1000, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=2, gamma=0.1, kernel='poly',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False))])
        Accuracy: 0.82886       Precision: 0.39919      Recall: 0.39200 F1:
0.39556 F2: 0.39342
        Total predictions: 14000        True positives:  784    False positiv
es: 1180        False negatives: 1216   True negatives: 10820
```

In [415]:
```
best_features
```

Out[415]:
```
['poi',
 'bonus',
 'salary',
 'exercised_stock_options',
 'total_stock_value',
 'p_bonus',
 'long_term_incentive',
 'deferred_income',
 'from_poi_to_this_person',
 'shared_receipt_with_poi',
 'p_shared_poi',
 'total_payments',
 'restricted_stock',
 'other']
```

Random Forest com todas as features

In [384]:
```
data = featureFormat(my_dataset, features_list, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [385]:
```
rfm = Pipeline([('scaler',StandardScaler()),('selector',SelectKBest()),('rf',R
andomForestClassifier())])
param_grid = ([{'rf__n_estimators': [3,4,5],
                'selector__k':range(1,len(features_list))}])
rf_clf = GridSearchCV(rfm, param_grid, scoring='recall',cv = 5).fit(features,
labels).best_estimator_

tester.test_classifier(rf_clf, my_dataset, features_list)
```

```
C:\Users\Daniel Vieira\Anaconda3\envs\py2\lib\site-packages\sklearn\feature_s
election\univariate_selection.py:113: UserWarning: Features [5] are constant.
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  UserWarning)
```

```
Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('selector', SelectKBest(k=12, score_func=<function f_classif at 0x00000
0000C331828>)), ('rf', RandomForestClassifier(bootstrap=True, class_weight=No
ne, criterion='gini',
            max_depth=None, max_features='auto', max...n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False))])
        Accuracy: 0.83514       Precision: 0.39231      Recall: 0.28050 F1:
0.32711 F2: 0.29745
        Total predictions: 14000        True positives:  561    False positiv
es:  869        False negatives: 1439   True negatives: 11131
```

In [386]:

```python
best_features = []
for i, feature in enumerate(rf_clf.get_params()['selector'].scores_):
        best_features.append([total_features[1:][i],feature])
pd_feature= pd.DataFrame(best_features,index = np.arange(1,len(best_features)+
1),columns  = ['Feature','Score'])

best_features = ['poi'] + pd_feature.nlargest(11,'Score')['Feature'].tolist()
pd_feature.nlargest(11,'Score')
```

Out[386]:

	Feature	Score
2	bonus	38.898768
1	salary	25.596746
11	exercised_stock_options	25.349842
14	total_stock_value	24.103581
3	long_term_incentive	21.175191
4	deferred_income	16.713754
17	from_poi_to_this_person	14.166948
19	shared_receipt_with_poi	14.136210
10	total_payments	10.286364
12	restricted_stock	8.246575
7	other	7.997446

Random Forest com as features e paramentros selecionados pelo GridSearchCV

In [387]:

```python
data = featureFormat(my_dataset, best_features, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [389]:
```
rfm = Pipeline([('scaler',StandardScaler()),('rf',RandomForestClassifier())])
param_grid = ([{'rf__n_estimators': [3]}])
rf_clf = GridSearchCV(rfm, param_grid, scoring='recall',cv = 5).fit(features,
labels).best_estimator_

tester.test_classifier(rf_clf, my_dataset, best_features)
```

```
Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('rf', RandomForestClassifier(bootstrap=True, class_weight=None, criteri
on='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
      ...n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False))])
        Accuracy: 0.83650       Precision: 0.39552      Recall: 0.27350 F1:
0.32338 F2: 0.29148
        Total predictions: 14000        True positives:  547    False positiv
es:  836        False negatives: 1453   True negatives: 11164
```

RandomForest usando novas features

In [397]:
```
total_features = []
total_features += features_list + new_features

data = featureFormat(my_dataset,total_features, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [398]:
```
rfm = Pipeline([('scaler',StandardScaler()),('selector',SelectKBest()),('rf',R
andomForestClassifier())])
param_grid = ([{'rf__n_estimators': [3,4,5],
                'selector__k':range(1,len(features_list))}])
rf_clf = GridSearchCV(rfm, param_grid, scoring='recall', cv = 5).fit(features,
 labels).best_estimator_

tester.test_classifier(rf_clf, my_dataset, total_features)
```

```
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```

```
Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('selector', SelectKBest(k=5, score_func=<function f_classif at 0x000000
000C331828>)), ('rf', RandomForestClassifier(bootstrap=True, class_weight=Non
e, criterion='gini',
            max_depth=None, max_features='auto', max_...n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False))])
        Accuracy: 0.83479       Precision: 0.38971      Recall: 0.27650 F1:
0.32349 F2: 0.29356
        Total predictions: 14000        True positives:  553    False positiv
es:  866        False negatives: 1447   True negatives: 11134
```

In [399]:

```
best_features = []
for i, feature in enumerate(rf_clf.get_params()['selector'].scores_):
        best_features.append([total_features[1:][i],feature])
pd_feature= pd.DataFrame(best_features,index = np.arange(1,len(best_features)+
1),columns  = ['Feature','Score'])

best_features = ['poi'] + pd_feature.nlargest(5,'Score')['Feature'].tolist()
pd_feature.nlargest(5,'Score')
```

Out[399]:

	Feature	Score
2	bonus	38.898768
1	salary	25.596746
11	exercised_stock_options	25.349842
14	total_stock_value	24.103581
20	p_bonus	23.829780

Testando com as Features e paramentros selecionados pelo GridSearchCV

In [400]:

```
data = featureFormat(my_dataset,best_features, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [401]:
```
rfm = Pipeline([('scaler',StandardScaler()),('rf',RandomForestClassifier())])
param_grid = ([{'rf__n_estimators': [3]}])
rf_clf = GridSearchCV(rfm, param_grid, scoring='recall', cv = 5).fit(features,
 labels).best_estimator_

tester.test_classifier(rf_clf, my_dataset, best_features)
```

```
Pipeline(memory=None,
     steps=[('scaler', StandardScaler(copy=True, with_mean=True, with_std=Tru
e)), ('rf', RandomForestClassifier(bootstrap=True, class_weight=None, criteri
on='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
      ...n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False))])
        Accuracy: 0.82031       Precision: 0.38859      Recall: 0.29300 F1:
0.33409 F2: 0.30816
        Total predictions: 13000        True positives:  586    False positiv
es:  922        False negatives: 1414   True negatives: 10078
```