Projeto Final - DS2

Import

In [232]:

```
import sys
import pickle
import pandas as pd
import numpy as np
import warnings
import matplotlib.pyplot as plt
sys.path.append("../tools/")
warnings.filterwarnings("ignore")
```

In [233]:

```
from sklearn.pipeline import Pipeline
from sklearn import preprocessing
from sklearn.decomposition import PCA
from sklearn.model_selection import GridSearchCV,train_test_split,\
                                    StratifiedShuffleSplit
from sklearn.tree import DecisionTreeClassifier
from sklearn.feature_selection import SelectKBest
from sklearn.externals import joblib
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB
from sklearn.grid_search import GridSearchCV
from sklearn.cross_validation import StratifiedShuffleSplit, train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.preprocessing import MinMaxScaler
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
```

In [234]:

```
from time import time
from feature_format import featureFormat, targetFeatureSplit
from tester import dump_classifier_and_data, test_classifier
scaler = MinMaxScaler()
```

Funções

In [307]:

```
def monta_grafico(feat_x, feat_y, titulo, dicionario, cor):
    # Criar um grafico scatter das fetures passadas no parametro
    features = ['poi', feat_x, feat_y]
    data = featureFormat(dicionario, features)

    plt.figure(figsize=(16,7))

    for point in data:
        x = point[1]
        y = point[2]
        if point[0]:
            if cor == 1:
                plt.scatter(x, y, color="red", marker="*")
            else:
                plt.scatter(x, y, color="green", marker=".")
        else:
            if cor == 1:
                plt.scatter(x, y, color='blue', marker=".")
            else:
                plt.scatter(x, y, color="orange", marker="*")


    plt.title(titulo, fontsize=20)
    plt.xlabel(feat_x, fontsize=18)
    plt.ylabel(feat_y, fontsize=18)
    pic = feat_x + feat_y + '.png'
    plt.savefig(pic, transparent=True)
    plt.show()


def monta_feature(features_list):
    features_list = ['poi',
                     'salary',
                     'deferral_payments',
                     'total_payments',
                     'loan_advances',
                     'bonus',
                     'restricted_stock_deferred',
                     'deferred_income',
                     'total_stock_value',
                     'expenses',
                     'exercised_stock_options',
                     'other',
                     'long_term_incentive',
                     'restricted_stock',
                     'director_fees',
                     'to_messages',
                     'from_poi_to_this_person',
                     'from_messages',
                     'from_this_person_to_poi',
                     'shared_receipt_with_poi']
    return features_list

def nova_feature(dataset, features_list):
    nova_feature = ["fraction_from_poi_email", "fraction_to_poi_email"]
    num_features = ["from_poi_to_this_person", "from_this_person_to_poi"]
    den_features = ["to_messages", "from_messages"]

    for x in dataset:
        data = dataset[x]

        for i, feature in enumerate(nova_feature):
            if data["poi"]:
                data[feature] = 'NaN'
            else:
```

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".

In [236]:

```
features_list = []
features_list = monta_feature(features_list)
```

In [237]:

```
print features_list
```

```
['poi', 'salary', 'deferral_payments', 'total_payments', 'loan_advances', 'bo
nus', 'restricted_stock_deferred', 'deferred_income', 'total_stock_value', 'e
xpenses', 'exercised_stock_options', 'other', 'long_term_incentive', 'restric
ted_stock', 'director_fees', 'to_messages', 'from_poi_to_this_person', 'from_
messages', 'from_this_person_to_poi', 'shared_receipt_with_poi']
```

In [238]:

```
#Feature List
#features_list = ['poi',
#                  'salary',
#                  'deferral_payments',
#                  'total_payments',
#                  'loan_advances',
#                  'bonus',
#                  'restricted_stock_deferred',
#                  'deferred_income',
#                  'total_stock_value',
#                  'expenses',
#                  'exercised_stock_options',
#                  'other',
#                  'long_term_incentive',
#                  'restricted_stock',
#                  'director_fees',
#                  'to_messages',
#                  'from_poi_to_this_person',
#                  'from_messages',
#                  'from_this_person_to_poi',
#                  'shared_receipt_with_poi'] # You will need to use more featur
es
```

In [239]:

```
# Carregando o conjunto de dados
with open("final_project_dataset.pkl", "r") as data_file:
#    data_dict = pickle.load(data_file)
    data_dict = pickle.load(open("final_project_dataset.pkl", "r"))
```

In [240]:

```
print "\nQuantidade total de registros: {}\nQuantidade total de features: {}".f
ormat(len(data_dict), len(data_dict["HAUG DAVID L"]))
print "Quantidade de POI's: {}".format(conta_poi(data_dict))
print "Quantidade de não POI's: {}".format(len(data_dict) - conta_poi(data_dict
))
```

```
Quantidade total de registros: 146
Quantidade total de features: 21
Quantidade de POI's: 18
Quantidade de não POI's: 128
```

In [241]:

```
df_enron = pd.DataFrame.from_dict(data_dict, orient = 'index')
```

In [242]:

```
df_enron.head()
```

Out[242]:

	salary	to_messages	deferral_payments	total_payments	exercised_stock_options	bonus
ALLEN PHILLIP K	201955	2902	2869717	4484442	1729541	4175000
BADUM JAMES P	NaN	NaN	178980	182466	257817	NaN
BANNANTINE JAMES M	477	566	NaN	916197	4046157	NaN
BAXTER JOHN C	267102	NaN	1295738	5634343	6680544	1200000
BAY FRANKLIN R	239671	NaN	260455	827696	NaN	400000

5 rows × 21 columns

In [243]:

```
df_enron.sample(5)
```

Out[243]:

	salary	to_messages	deferral_payments	total_payments	exercised_stock_options	bonus
SHERRIFF JOHN R	428780	3187	NaN	4335388	1835558	1500000
DERRICK JR. JAMES V	492375	2181	NaN	550981	8831913	800000
GLISAN JR BEN F	274975	873	NaN	1272284	384728	600000
FOY JOE	NaN	57	181755	181755	343434	NaN
SCRIMSHAW MATTHEW	NaN	NaN	NaN	NaN	759557	NaN

5 rows × 21 columns

In [244]:

```
df_enron.tail()
```

Out[244]:

	salary	to_messages	deferral_payments	total_payments	exercised_stock_options	bonus	r
WINOKUR JR. HERBERT S	NaN	NaN	NaN	84992	NaN	NaN	
WODRASKA JOHN	NaN	NaN	NaN	189583	NaN	NaN	
WROBEL BRUCE	NaN	NaN	NaN	NaN	139130	NaN	
YEAGER F SCOTT	158403	NaN	NaN	360300	8308552	NaN	
YEAP SOON	NaN	NaN	NaN	55097	192758	NaN	

5 rows × 21 columns

In [245]:

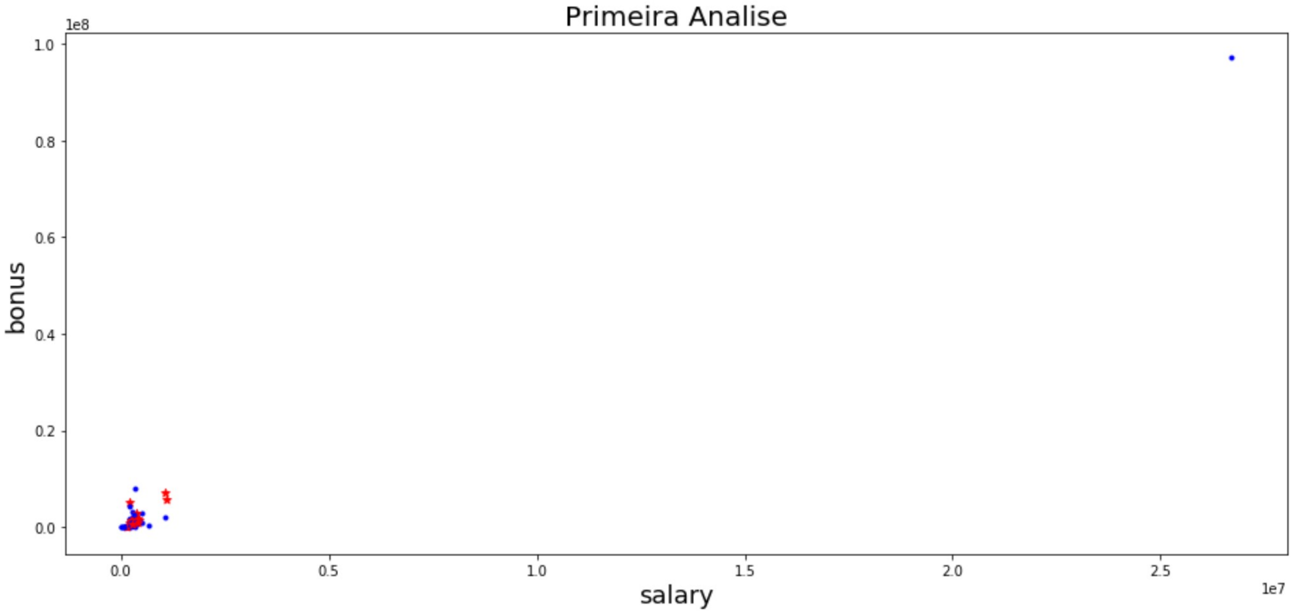
```
df_enron.describe().transpose()
```

Out[245]:

	count	unique	top	freq
salary	146	95	NaN	51
to_messages	146	87	NaN	60
deferral_payments	146	40	NaN	107
total_payments	146	126	NaN	21
exercised_stock_options	146	102	NaN	44
bonus	146	42	NaN	64
restricted_stock	146	98	NaN	36
shared_receipt_with_poi	146	84	NaN	60
restricted_stock_deferred	146	19	NaN	128
total_stock_value	146	125	NaN	20
expenses	146	95	NaN	51
loan_advances	146	5	NaN	142
from_messages	146	65	NaN	60
other	146	93	NaN	53
from_this_person_to_poi	146	42	NaN	60
poi	146	2	False	128
director_fees	146	18	NaN	129
deferred_income	146	45	NaN	97
long_term_incentive	146	53	NaN	80
email_address	146	112	NaN	35
from_poi_to_this_person	146	58	NaN	60

In [246]:

```
monta_grafico("salary", "bonus", "Primeira Analise",data_dict,1)
```



Analise Exploratória

- Visulamente já é possível ver que muitas informações estão faltando
- Isso fica bem evidente quando analisamos por código
- Foi identificado o outliers TOTAL, que nos levou a investigar possíveis pois que não fossem pessoas

In [247]:

```
print "Dados: HAUG DAVID L:\n\n{}".format(data_dict["TOTAL"])
print "Dados: LOCKHART EUGENE E:\n\n{}".format(data_dict["LOCKHART EUGENE E"])
print "Dados: THE TRAVEL AGENCY IN THE PARK:\n\n{}".format(data_dict["THE TRAVE
L AGENCY IN THE PARK"])
```

```
Dados: HAUG DAVID L:

{'salary': 26704229, 'to_messages': 'NaN', 'deferral_payments': 32083396, 'to
tal_payments': 309886585, 'exercised_stock_options': 311764000, 'bonus': 9734
3619, 'restricted_stock': 130322299, 'shared_receipt_with_poi': 'NaN', 'restr
icted_stock_deferred': -7576788, 'total_stock_value': 434509511, 'expenses':
5235198, 'loan_advances': 83925000, 'from_messages': 'NaN', 'other': 42667589
, 'from_this_person_to_poi': 'NaN', 'poi': False, 'director_fees': 1398517, '
deferred_income': -27992891, 'long_term_incentive': 48521928, 'email_address'
: 'NaN', 'from_poi_to_this_person': 'NaN'}
Dados: LOCKHART EUGENE E:

{'salary': 'NaN', 'to_messages': 'NaN', 'deferral_payments': 'NaN', 'total_pa
yments': 'NaN', 'exercised_stock_options': 'NaN', 'bonus': 'NaN', 'restricted
_stock': 'NaN', 'shared_receipt_with_poi': 'NaN', 'restricted_stock_deferred'
: 'NaN', 'total_stock_value': 'NaN', 'expenses': 'NaN', 'loan_advances': 'NaN
', 'from_messages': 'NaN', 'other': 'NaN', 'from_this_person_to_poi': 'NaN',
'poi': False, 'director_fees': 'NaN', 'deferred_income': 'NaN', 'long_term_in
centive': 'NaN', 'email_address': 'NaN', 'from_poi_to_this_person': 'NaN'}
Dados: THE TRAVEL AGENCY IN THE PARK:

{'salary': 'NaN', 'to_messages': 'NaN', 'deferral_payments': 'NaN', 'total_pa
yments': 362096, 'exercised_stock_options': 'NaN', 'bonus': 'NaN', 'restricte
d_stock': 'NaN', 'shared_receipt_with_poi': 'NaN', 'restricted_stock_deferred
': 'NaN', 'total_stock_value': 'NaN', 'expenses': 'NaN', 'loan_advances': 'Na
N', 'from_messages': 'NaN', 'other': 362096, 'from_this_person_to_poi': 'NaN'
, 'poi': False, 'director_fees': 'NaN', 'deferred_income': 'NaN', 'long_term_
incentive': 'NaN', 'email_address': 'NaN', 'from_poi_to_this_person': 'NaN'}
```

Task 2: Remove outliers

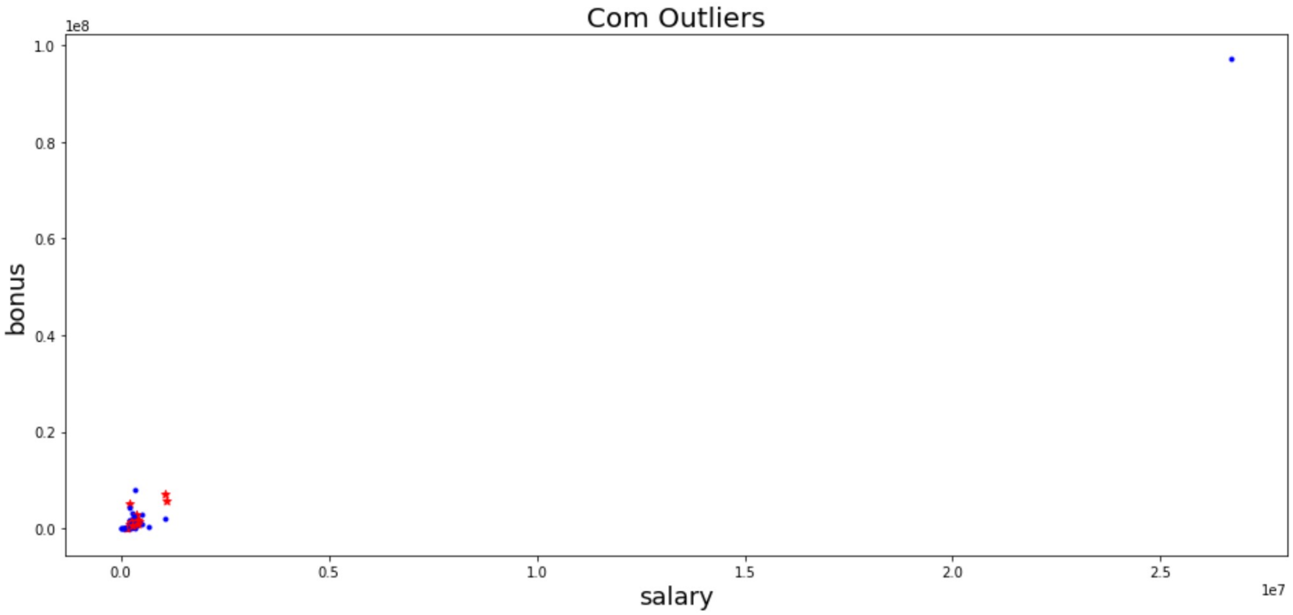
In [248]:

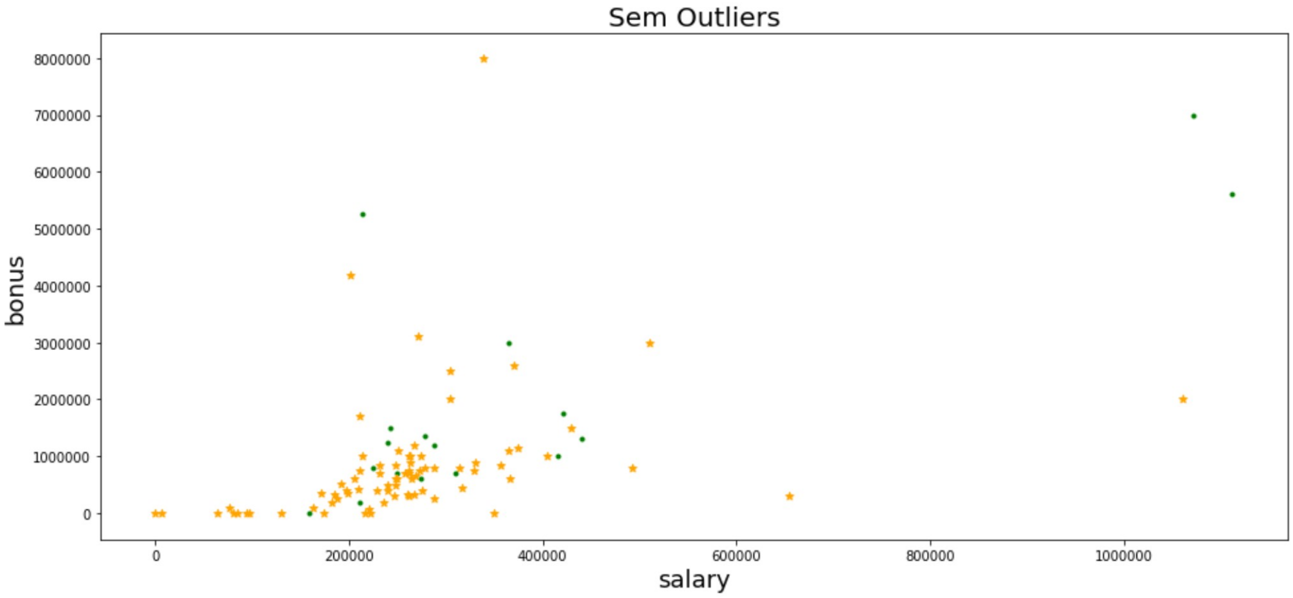
```
# Removendo outliers
with open("final_project_dataset.pkl", "r") as data_file:
    data_dict_woo = pickle.load(data_file)

print "Quantidade total de registros Com outliers: {}\n".format(len(data_dict_w
oo))

data_dict_woo.pop('TOTAL', None) #Não é um funcionário
data_dict_woo.pop('LOCKHART EUGENE E', None) #Não é um funcionário
data_dict_woo.pop('THE TRAVEL AGENCY IN THE PARK', None) #Não é um funcionário

print "Quantidade total de registros Sem outliers: {}\n".format(len(data_dict_w
oo))
```

```
Quantidade total de registros Com outliers: 146

Quantidade total de registros Sem outliers: 143
```

In [249]:

```
monta_grafico("salary", "bonus", "Com Outliers",data_dict,1)
monta_grafico("salary", "bonus", "Sem Outliers",data_dict_woo,2)
```





In [250]:

```
df_enron_woo = pd.DataFrame.from_dict(data_dict_woo, orient = 'index')
df_enron_woo.describe().transpose()
```

Out[250]:

	count	unique	top	freq
salary	143	94	NaN	49
to_messages	143	87	NaN	57
deferral_payments	143	39	NaN	105
total_payments	143	124	NaN	20
exercised_stock_options	143	101	NaN	42
bonus	143	41	NaN	62
restricted_stock	143	97	NaN	34
shared_receipt_with_poi	143	84	NaN	57
restricted_stock_deferred	143	18	NaN	126
total_stock_value	143	124	NaN	18
expenses	143	94	NaN	49
loan_advances	143	4	NaN	140
from_messages	143	65	NaN	57
other	143	91	NaN	52
from_this_person_to_poi	143	42	NaN	57
poi	143	2	False	125
director_fees	143	17	NaN	127
deferred_income	143	44	NaN	95
long_term_incentive	143	52	NaN	78
email_address	143	112	NaN	32
from_poi_to_this_person	143	58	NaN	57

```
In [251]: df_enron_woo.head(20)
```

Out[251]:

	salary	to_messages	deferral_payments	total_payments	exercised_stock_options	bonus
ALLEN PHILLIP K	201955	2902	2869717	4484442	1729541	4175000
BADUM JAMES P	NaN	NaN	178980	182466	257817	NaN
BANNANTINE JAMES M	477	566	NaN	916197	4046157	NaN
BAXTER JOHN C	267102	NaN	1295738	5634343	6680544	1200000
BAY FRANKLIN R	239671	NaN	260455	827696	NaN	400000
BAZELIDES PHILIP J	80818	NaN	684694	860136	1599641	NaN
BECK SALLY W	231330	7315	NaN	969068	NaN	700000
BELDEN TIMOTHY N	213999	7991	2144013	5501630	953136	5249999
BELFER ROBERT	NaN	NaN	-102500	102500	3285	NaN
BERBERIAN DAVID	216582	NaN	NaN	228474	1624396	NaN
BERGSIEKER RICHARD P	187922	383	NaN	618850	NaN	250000
BHATNAGAR SANJAY	NaN	523	NaN	15456290	2604490	NaN
BIBI PHILIPPE A	213625	1607	NaN	2047593	1465734	1000000
BLACHMAN JEREMY M	248546	2475	NaN	2014835	765313	850000
BLAKE JR. NORMAN P	NaN	NaN	NaN	1279	NaN	NaN
BOWEN JR RAYMOND M	278601	1858	NaN	2669589	NaN	1350000
BROWN MICHAEL	NaN	1486	NaN	49288	NaN	NaN
BUCHANAN HAROLD G	248017	1088	NaN	1054637	825464	500000
BUTTS ROBERT H	261516	NaN	NaN	1271582	NaN	750000
BUY RICHARD B	330546	3523	649584	2355702	2542813	900000

20 rows × 21 columns

In [252]:

```
sumariza_valores(data_dict_woo)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 143 entries, 0 to 142
Data columns (total 21 columns):
salary                       94 non-null float64
to_messages                  86 non-null float64
deferral_payments            38 non-null float64
total_payments               123 non-null float64
exercised_stock_options      101 non-null float64
bonus                        81 non-null float64
restricted_stock             109 non-null float64
shared_receipt_with_poi      86 non-null float64
restricted_stock_deferred    17 non-null float64
total_stock_value            125 non-null float64
expenses                     94 non-null float64
loan_advances                3 non-null float64
from_messages                86 non-null float64
other                        91 non-null float64
from_this_person_to_poi      86 non-null float64
poi                          143 non-null bool
director_fees                16 non-null float64
deferred_income              48 non-null float64
long_term_incentive          65 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: 22.6+ KB
```

In [253]:

```
#df_graph_enron = df_enron_woo.copy()
df_graph_enron = df_enron_woo.describe().transpose()
```

In [254]:

```
df_graph_enron.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 21 entries, salary to from_poi_to_this_person
Data columns (total 4 columns):
count     21 non-null object
unique    21 non-null object
top       21 non-null object
freq      21 non-null object
dtypes: object(4)
memory usage: 840.0+ bytes
```

In [ ]:

In [255]:

```
# Processo de criação de coluna com a diferença entre o total de registros unic
os
#e registros duplicados/Não atribuídos

nan_dupl_col = []


def nan_dupl(reg):
    qty_nan_dupl = reg['count'] - reg['unique']
    nan_dupl_col.append(qty_nan_dupl)

df_graph_enron.apply(nan_dupl, axis=1)
df_graph_enron['nan_dupl'] = nan_dupl_col
```

In [256]:
```
df_graph_enron.drop(['count', 'top', 'freq'], axis=1, inplace=True)

df_graph_enron.head()
```

Out[256]:

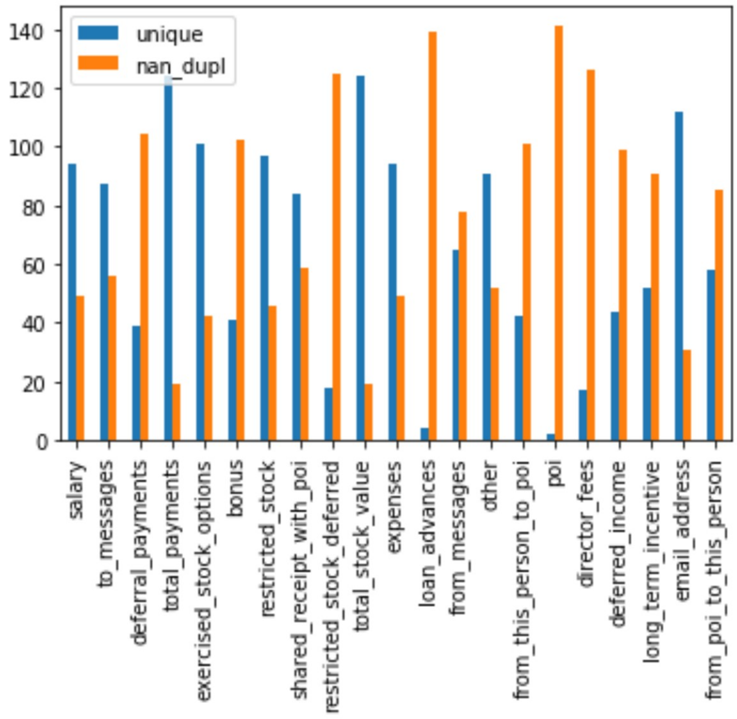
	unique	nan_dupl
salary	94	49
to_messages	87	56
deferral_payments	39	104
total_payments	124	19
exercised_stock_options	101	42

In [257]:
```
df_graph_enron.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 21 entries, salary to from_poi_to_this_person
Data columns (total 2 columns):
unique      21 non-null object
nan_dupl    21 non-null int64
dtypes: int64(1), object(1)
memory usage: 504.0+ bytes
```

In [258]:
```
df_graph_enron.plot.bar()
```

Out[258]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1ca3b940>
```

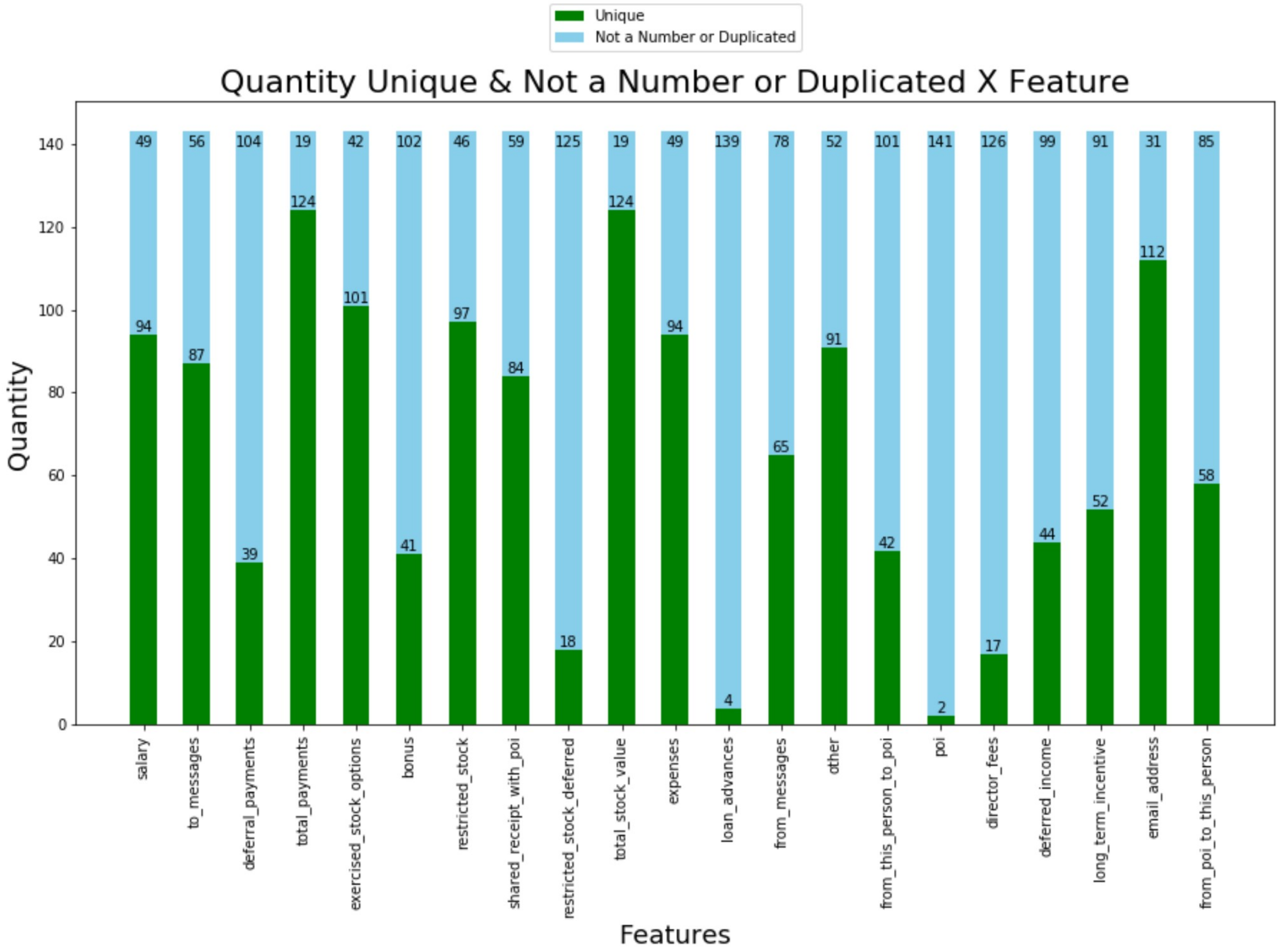


In [259]:
```
labels_graph = list(df_graph_enron.index.values)
print labels_graph
```

```
['salary', 'to_messages', 'deferral_payments', 'total_payments', 'exercised_s
tock_options', 'bonus', 'restricted_stock', 'shared_receipt_with_poi', 'restr
icted_stock_deferred', 'total_stock_value', 'expenses', 'loan_advances', 'fro
m_messages', 'other', 'from_this_person_to_poi', 'poi', 'director_fees', 'def
erred_income', 'long_term_incentive', 'email_address', 'from_poi_to_this_pers
on']
```

In [260]:

```
bar_1 = df_graph_enron['unique']
bar_2 = df_graph_enron['nan_dupl']
x_pos = np.arange(len(bar_1))

plt2 = plt

plt.figure(figsize=(15,8))

#plt.rcParams["figure.figsize"] = [15,8]
#plt.rcParams["legend.frameon"] = True
#plt.rcParams["legend.handletextpad"] = 1
#plt.rcParams["legend.borderaxespad"] = 60

first_bar = plt.bar(x_pos, bar_1, 0.5, color='green')
second_bar = plt.bar(x_pos, bar_2, 0.5, color='skyblue', bottom=bar_1)
plt.title('Quantity Unique & Not a Number or Duplicated X Feature', fontsize=22
)
plt.xlabel('Features', fontsize=18)
plt.ylabel('Quantity', fontsize=18)

# Definir posição e labels no eixo X
plt.xticks(x_pos, (labels_graph), rotation=90)

def autolabel(rects, xpos='center'):
    """
    Attach a text label above each bar in *rects*, displaying its height.

    *xpos* indicates which side to place the text w.r.t. the center of
    the bar. It can be one of the following {'center', 'right', 'left'}.
    """

    xpos = xpos.lower()  # normalize the case of the parameter
    ha = {'center': 'center', 'right': 'left', 'left': 'right'}
    offset = {'center': 0.5, 'right': 0.57, 'left': 0.43}  # x_txt = x + w*off


    if rects == first_bar:
        for rect in rects:
            height = rect.get_height()
            plt.text(rect.get_x() + rect.get_width()*offset[xpos], 1.00*height,
                    '{}'.format(height), ha=ha[xpos], va='bottom')
    else:
        for rect in rects:
            height = rect.get_height()
            plt.text(rect.get_x() + rect.get_width()*offset[xpos], 1.00*138.5,
                    '{}'.format(height), ha=ha[xpos], va='bottom')


autolabel(first_bar, "center")
autolabel(second_bar, "center")

plt.legend(labels=['Unique','Not a Number or Duplicated'], loc=8, borderaxespad
= 47 )

plt.show()
```



In [ ]:

Task 3: Create new feature(s)

In [283]:

```
# Salvando o conjunto de dados
#df_enron_woo = pd.DataFrame.from_dict(data_dict_woo, orient = 'index')
#df_enron_woo.replace(to_replace='NaN', value=0.0, inplace=True)
my_dataset = data_dict_woo
#my_dataset = df_enron_woo.to_dict('index')
```

In [284]:

```
#Feature List
features_list = ['poi',
                 'salary',
                 'deferral_payments',
                 'total_payments',
                 'loan_advances',
                 'bonus',
                 'restricted_stock_deferred',
                 'deferred_income',
                 'total_stock_value',
                 'expenses',
                 'exercised_stock_options',
                 'other',
                 'long_term_incentive',
                 'restricted_stock',
                 'director_fees',
                 'to_messages',
                 'from_poi_to_this_person',
                 'from_messages',
                 'from_this_person_to_poi',
                 'shared_receipt_with_poi'] # You will need to use more feature
s

features_list = nova_feature(data_dict_woo, features_list)
print features_list
```

```
['poi', 'salary', 'deferral_payments', 'total_payments', 'loan_advances', 'bo
nus', 'restricted_stock_deferred', 'deferred_income', 'total_stock_value', 'e
xpenses', 'exercised_stock_options', 'other', 'long_term_incentive', 'restric
ted_stock', 'director_fees', 'to_messages', 'from_poi_to_this_person', 'from_
messages', 'from_this_person_to_poi', 'shared_receipt_with_poi', 'fraction_fr
om_poi_email', 'fraction_to_poi_email']
```

In [285]:

```
print "Testando novos features adicionados:\n"
testa_nova_feature(data_dict_woo, "DIETRICH JANET R", features_list[-2:])
```

```
Testando novos features adicionados:

DIETRICH JANET R
- fraction_from_poi_email = 0.1186 (305 / 2572)
- fraction_to_poi_email = 0.2222 (14 / 63)
```

In [286]:

```
# Extraindo as features e os labels do conjunto de dados
data = featureFormat(my_dataset, features_list, sort_keys = True)
labels, features = targetFeatureSplit(data)
```

In [287]:

```
# Criando Min/Max Scaler
from sklearn import preprocessing
scaler = preprocessing.MinMaxScaler()
# Scale Features
features = scaler.fit_transform(features)
```

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,
- you'll need to use Pipelines. For more info: http://scikit-learn.org/stable/modules/pipeline.html (http://scikit-learn.org/stable/modules/pipeline.html)

```
In [288]: #features_train, features_test, labels_train, labels_test = \
          #    train_test_split(features, labels, test_size=0.3, random_state=42)
```

```
In [289]: #skbest = SelectKBest(k=10)  # try best value to fit
          #sk_trans = skbest.fit_transform(features_train, labels_train)
          #indices = skbest.get_support(True)
          #print skbest.scores_
```

```
In [290]: #for index in indices:
          #     print 'features: %s score: %f' % (features_list[index + 1], skbest.scores
          _[index])
          #print ""
```

```
In [291]: ##print "GaussianNB"
          ## GaussianNB
          #clf = GaussianNB()
          #clf.fit(features_train, labels_train)
          #prediction = clf.predict(features_test)
          #print ("Accuracy GaussianNB =", accuracy_score(prediction0, labels_test))
```

```
In [292]: #print "KNeighborsClassifier"
          # KNeighborsClassifier
          #clf = KNeighborsClassifier()
          #clf = KNeighborsClassifier(algorithm = 'auto',leaf_size = 20,n_neighbors = 3,w
          eights = 'uniform')
          #clf.fit(features_train, labels_train)
          #prediction = clf.predict(features_test)
          #print "Accuracy KNeighborsClassifier =", accuracy_score(prediction, labels_tes
          t)
```

```
In [293]: #print "SVC"
          # SVC
          #clf = SVC(kernel = 'linear',max_iter = 10000,random_state = 42)
          #clf.fit(features_train, labels_train)
          #prediction = clf.predict(features_test)
          #print "Accuracy SVC =", accuracy_score(prediction, labels_test)
```

```
In [294]: #print "AdaBoostClassifier"
          #clf = AdaBoostClassifier(DecisionTreeClassifier(max_depth=1, min_samples_leaf=
          2, class_weight='balanced'),
          #                          n_estimators=50, learning_rate=.8)
          #clf.fit(features_train, labels_train)
          #prediction = clf.predict(features_test)
          #print "Accuracy AdaBoostClassifier =", accuracy_score(prediction, labels_test)
```

In [295]:

```
accuracy(False, features_list)
```

```
['poi', 'salary', 'deferral_payments', 'total_payments', 'loan_advances', 'bo
nus', 'restricted_stock_deferred', 'deferred_income', 'total_stock_value', 'e
xpenses', 'exercised_stock_options', 'other', 'long_term_incentive', 'restric
ted_stock', 'director_fees', 'to_messages', 'from_poi_to_this_person', 'from_
messages', 'from_this_person_to_poi', 'shared_receipt_with_poi']

========== skbest.scores_ ==========
[1.58587309e+01 9.98239959e-03 8.95913665e+00 7.03793280e+00
 3.07287746e+01 7.27124110e-01 8.79220385e+00 1.06338520e+01
 4.18072148e+00 9.68004143e+00 3.20445914e+00 7.55511978e+00
 8.05830631e+00 1.64109793e+00 2.61618300e+00 4.95866668e+00
 4.35374099e-01 1.11208239e-01 1.07225708e+01]
========== ============ ==========

========== features - score ==========
features: salary score: 15.858731
features: total_payments score: 8.959137
features: loan_advances score: 7.037933
features: bonus score: 30.728775
features: deferred_income score: 8.792204
features: total_stock_value score: 10.633852
features: exercised_stock_options score: 9.680041
features: long_term_incentive score: 7.555120
features: restricted_stock score: 8.058306
features: shared_receipt_with_poi score: 10.722571
========== ==================== ==========

Accuracy GaussianNB  = 0.88372
Accuracy KNeighborsClassifier  = 0.90698
Accuracy SVC = 0.88372
Accuracy AdaBoostClassifier = 0.81395
```

In [296]:

```
accuracy(True, features_list)
```

```
['poi', 'salary', 'deferral_payments', 'total_payments', 'loan_advances', 'bo
nus', 'restricted_stock_deferred', 'deferred_income', 'total_stock_value', 'e
xpenses', 'exercised_stock_options', 'other', 'long_term_incentive', 'restric
ted_stock', 'director_fees', 'to_messages', 'from_poi_to_this_person', 'from_
messages', 'from_this_person_to_poi', 'shared_receipt_with_poi', 'fraction_fr
om_poi_email', 'fraction_to_poi_email']
Testando novos features adicionados:

DIETRICH JANET R
- fraction_from_poi_email = 0.1186 (305 / 2572)
- fraction_to_poi_email = 0.2222 (14 / 63)


========== skbest.scores_ ==========
[1.58587309e+01 9.98239959e-03 8.95913665e+00 7.03793280e+00
 3.07287746e+01 7.27124110e-01 8.79220385e+00 1.06338520e+01
 4.18072148e+00 9.68004143e+00 3.20445914e+00 7.55511978e+00
 8.05830631e+00 1.64109793e+00 2.61618300e+00 4.95866668e+00
 4.35374099e-01 1.11208239e-01 1.07225708e+01 3.90983633e+00
 2.88172795e+00]
========== ============ ==========

========== features - score ==========
features: salary score: 15.858731
features: total_payments score: 8.959137
features: loan_advances score: 7.037933
features: bonus score: 30.728775
features: deferred_income score: 8.792204
features: total_stock_value score: 10.633852
features: exercised_stock_options score: 9.680041
features: long_term_incentive score: 7.555120
features: restricted_stock score: 8.058306
features: shared_receipt_with_poi score: 10.722571
========== ==================== ==========

Accuracy GaussianNB  = 0.88372
Accuracy KNeighborsClassifier  = 0.90698
Accuracy SVC = 0.88372
Accuracy AdaBoostClassifier = 0.95349
```

In [297]:

```
data = {"Algorithms":["GaussianNB","KNeighborsClassifier",
"SVC","AdaBoostClassifier",
"GaussianNB","KNeighborsClassifier",
"SVC","AdaBoostClassifier"                    ],
"New Features":["N","N","N","N","S","S","S","S"],
"Accuracy":[0.88372,0.90698,0.88372,0.81395,0.88372,0.90698,0.88372,0.95349],
}
#Accuracy GaussianNB  = 0.88372
#Accuracy KNeighborsClassifier  = 0.90698
#Accuracy SVC = 0.88372
#Accuracy AdaBoostClassifier = 0.81395
#Accuracy GaussianNB  = 0.88372
#Accuracy KNeighborsClassifier  = 0.90698
#Accuracy SVC = 0.88372
#Accuracy AdaBoostClassifier = 0.95349
algorithms = pd.DataFrame(data, columns = ["Algorithms", "New Features", "Accuracy",])
algorithms
```

Out[297]:

	Algorithms	New Features	Accuracy
0	GaussianNB	N	0.88372
1	KNeighborsClassifier	N	0.90698
2	SVC	N	0.88372
3	AdaBoostClassifier	N	0.81395
4	GaussianNB	S	0.88372
5	KNeighborsClassifier	S	0.90698
6	SVC	S	0.88372
7	AdaBoostClassifier	S	0.95349

Task 5: Tune your classifier

```
Tune your classifierto 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:
```

In [212]:

```
# Testar os classificadores
#print '\n'
#print '########## Testar and Tunning Classifiers ##########'
# See "pipeline_classificador" for MinMaxScaling, SelectKBest and Logistic Regression tuning

# Classifiers tested but not using - Logistic_Regression, RandomForestClassifier, DecisionTreeClassifier

#cross_val = pipeline_classificador('randomforest',9, features_list)
#print 'Melhores Parametros: ', cross_val.best_params_
#clf = cross_val.best_estimator_
```

In [ ]:

```

```

In [281]:

```
clf = AdaBoostClassifier(DecisionTreeClassifier(max_depth=1, min_samples_leaf=2
, class_weight='balanced'),
                         n_estimators=50, learning_rate=.8)

#clf.fit(features_train, labels_train)
#prediction = clf.predict(features_test)
#print "Accuracy AdaBoostClassifier =", accuracy_score(prediction, labels_test)


# Validate model precision, recall and F1-score
test_classifier(clf, my_dataset, features_list)
```

```
AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=2,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.8, n_estimators=50, random_state=None)
        Accuracy: 0.91393       Precision: 0.71014      Recall: 0.59900 F1: 0
.64985  F2: 0.61835
        Total predictions: 15000        True positives: 1198    False positiv
es:  489        False negatives:  802   True negatives: 12511
```

In [308]:

```
for k in range(1,11):
    print "========== kbest = ", k, "="*10, "Ini"

    t0 = time()
    adaboost_kbest(k, True, features_list)

    print "tempo de treinamento:", round(time()-t0, 3), "s"
    print "========== kbest = ", k, "="*10,"Fim"
```

```
========== kbest =  1 ========== Ini
New Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.91247       Precision: 0.70313      Recall: 0.59450 F1: 0
.64427  F2: 0.61346
        Total predictions: 15000        True positives: 1189    False positiv
es:  502        False negatives:  811   True negatives: 12498

tempo de treinamento: 76.154 s
========== kbest =  1 ========== Fim
========== kbest =  2 ========== Ini
New Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.91260       Precision: 0.70397      Recall: 0.59450 F1: 0
.64462  F2: 0.61358
        Total predictions: 15000        True positives: 1189    False positiv
es:  500        False negatives:  811   True negatives: 12500

tempo de treinamento: 76.127 s
========== kbest =  2 ========== Fim
========== kbest =  3 ========== Ini
New Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.91260       Precision: 0.70373      Recall: 0.59500 F1: 0
.64481  F2: 0.61397
        Total predictions: 15000        True positives: 1190    False positiv
es:  501        False negatives:  810   True negatives: 12499

tempo de treinamento: 76.195 s
========== kbest =  3 ========== Fim
========== kbest =  4 ========== Ini
New Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.91267       Precision: 0.70414      Recall: 0.59500 F1: 0
```

```
In [309]: for k in range(1,11):
              print "========== kbest = ", k, "="*10, "Ini"
              t0 = time()
              adaboost_kbest(k, False, features_list)
              print "tempo de treinamento:", round(time()-t0, 3), "s"
              print "========== kbest = ", k, "="*10,"Fim"
```

```
========== kbest =  1 ========== Ini
Default Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.83180       Precision: 0.35888      Recall: 0.33250 F1: 0
.34519  F2: 0.33746
        Total predictions: 15000        True positives:  665    False positiv
es: 1188        False negatives: 1335   True negatives: 11812

tempo de treinamento: 75.729 s
========== kbest =  1 ========== Fim
========== kbest =  2 ========== Ini
Default Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.83167       Precision: 0.35864      Recall: 0.33300 F1: 0
.34535  F2: 0.33783
        Total predictions: 15000        True positives:  666    False positiv
es: 1191        False negatives: 1334   True negatives: 11809

tempo de treinamento: 75.607 s
========== kbest =  2 ========== Fim
========== kbest =  3 ========== Ini
Default Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.83167       Precision: 0.35849      Recall: 0.33250 F1: 0
.34501  F2: 0.33739
        Total predictions: 15000        True positives:  665    False positiv
es: 1190        False negatives: 1335   True negatives: 11810

tempo de treinamento: 75.715 s
========== kbest =  3 ========== Fim
========== kbest =  4 ========== Ini
Default Features

AdaBoostClassifier(algorithm='SAMME.R',
          base_estimator=DecisionTreeClassifier(class_weight='balanced', crit
erion='gini', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_split=1e-07, min_samples_leaf=3,
            min_samples_split=2, min_weight_fraction_leaf=0.0,
            presort=False, random_state=None, splitter='best'),
          learning_rate=0.95, n_estimators=50, random_state=None)
        Accuracy: 0.83193       Precision: 0.35942      Recall: 0.33300 F1: 0
```

Task 6: Dump your classifier, dataset, and features_list

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.

In [103]:

```
dump_classifier_and_data(clf, my_dataset, features_list)
```

Refrências

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```
In [ ]:
```

```
In [ ]:
```