In [42]:

```
#import packages

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

from io import StringIO
from collections import Counter
from keras.preprocessing.sequence import pad_sequences
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.model_selection import train_test_split

from sklearn import model_selection, preprocessing, linear_model, naive_bayes,
 metrics, svm, ensemble

from sklearn.linear_model import SGDClassifier

from sklearn.datasets import make_classification

from sklearn.metrics import accuracy_score, f1_score, precision_score, recall_
score, classification_report, confusion_matrix

import re
import nltk

%matplotlib inline
```

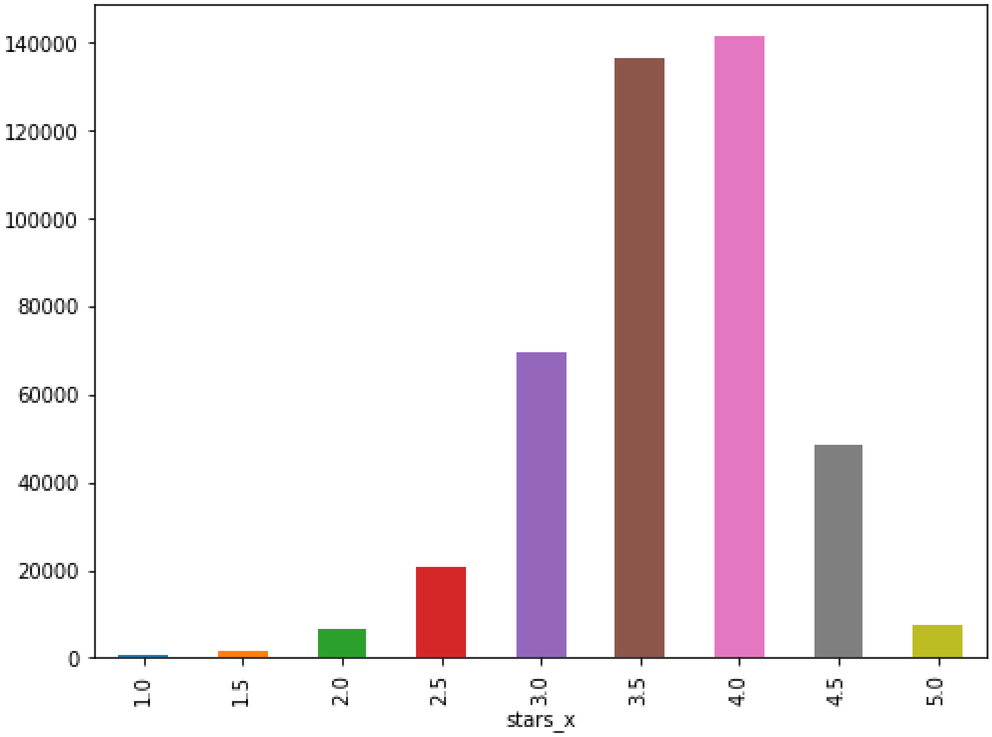
```
/home/iman_lau/anaconda3/lib/python3.5/site-packages/sklearn/ensemble/weight_
boosting.py:29: DeprecationWarning: numpy.core.umath_tests is an internal Num
Py module and should not be imported. It will be removed in a future NumPy re
lease.
  from numpy.core.umath_tests import inner1d
```

In [2]:

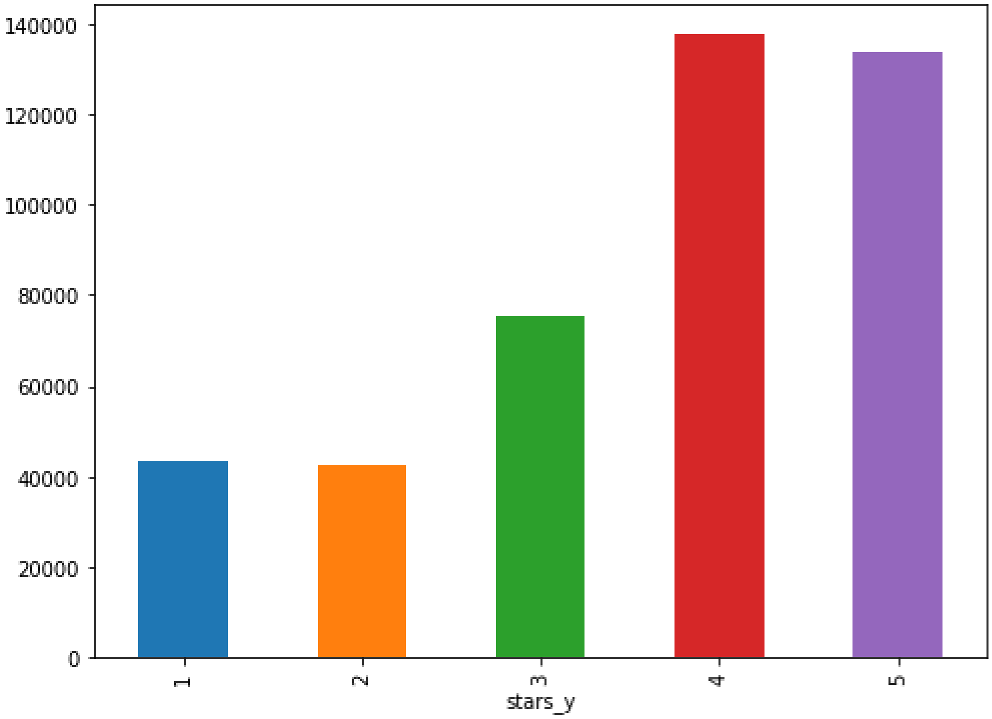
```
#Load in corpus

df = pd.read_csv('data/subset.csv')

# take a peek at the data
print(df.head())
```

```
          address                                         attributes  \
0  631 Bloor St W  {'BusinessParking': "{'garage': False, 'street...
1  631 Bloor St W  {'BusinessParking': "{'garage': False, 'street...
2  631 Bloor St W  {'BusinessParking': "{'garage': False, 'street...
3  631 Bloor St W  {'BusinessParking': "{'garage': False, 'street...
4  631 Bloor St W  {'BusinessParking': "{'garage': False, 'street...

              business_id      categories     city hours  is_open   latitude
\
0  9A2quhZLyWk0akUetBd8hQ  Food, Bakeries  Toronto   NaN        0  43.664378

1  9A2quhZLyWk0akUetBd8hQ  Food, Bakeries  Toronto   NaN        0  43.664378

2  9A2quhZLyWk0akUetBd8hQ  Food, Bakeries  Toronto   NaN        0  43.664378

3  9A2quhZLyWk0akUetBd8hQ  Food, Bakeries  Toronto   NaN        0  43.664378

4  9A2quhZLyWk0akUetBd8hQ  Food, Bakeries  Toronto   NaN        0  43.664378


   longitude            name           ...           stars_x state  cool  \
0 -79.414424  Bnc Cake House           ...               4.0    ON     5
1 -79.414424  Bnc Cake House           ...               4.0    ON     1
2 -79.414424  Bnc Cake House           ...               4.0    ON     0
3 -79.414424  Bnc Cake House           ...               4.0    ON     2
4 -79.414424  Bnc Cake House           ...               4.0    ON     0

         date funny               review_id stars_y  \
0  2009-07-30     5  EeMl58L8N2mWmwjLg09IcQ       5
1  2013-08-02     1  gopANOnehicgh_dAWVoxyA       5
2  2014-06-21     0  PUQYyEXwrpqjtmpG6vIU1g       3
3  2011-07-22     2  LIqVjPT-DiLsPv4U1l6Wcw       3
4  2011-08-13     0  0rU5CA1bDy15_feU7D-WMw       5

                                                text useful  \
0  Hallelujah! I FINALLY FOUND IT! The frozen yog...      5
1  I drop by BnC on a weekly basis to pick up my ...      1
2  My personally experience here wasn't the best,...      0
3  37 °C = 98.6°F\r\nKoreatown establisments disp...      2
4  My husband & I visited Toronto from the U.S. f...      0

                  user_id
0  Tj-6FX0ZnqHEZYO9iFSD4w
1  7OURjtceW40mhpRX9P2dDg
2  qQ4bfJmrfK0iWCZjl8cavQ
3  Wu0yySWcHQ5tZ_59HNiamg
4  UoCtS7YT00XyZtfDi9ZW7A

[5 rows x 23 columns]
```

In [25]:
```
#distribution of restaurant ratings
fig = plt.figure(figsize=(8,6))
df.groupby('stars_x').business_id.count().plot.bar(ylim=0)
plt.show()
```



In [24]:
```
#distribution of reviews
fig = plt.figure(figsize=(8,6))
df.groupby('stars_y').text.count().plot.bar(ylim=0)
plt.show()
```



In [4]:

```
# normalize function

wpt = nltk.WordPunctTokenizer()
stop_words = nltk.corpus.stopwords.words('english')

def normalize_document(doc):
    # lower case and remove special characters\whitespaces
    #doc = re.sub(r'[^a-zA-Z\s]', '', doc, re.I)
    doc = re.sub(r'[^a-zA-Z0-9\s]', '', doc, re.I)
    doc = doc.lower()
    doc = doc.strip()
    # tokenize document
    tokens = wpt.tokenize(doc)
    # filter stopwords out of document
    filtered_tokens = [token for token in tokens if token not in stop_words]
    # re-create document from filtered tokens
    doc = ' '.join(filtered_tokens)
    doc = ''.join(i for i in doc if not i.isdigit())
    return doc

normalize_corpus = np.vectorize(normalize_document)
```

In [5]:

```
# new dataframe of just reviews and star ratings

col = ['stars_y', 'text']
df = df[col]
df = df[pd.notnull(df['text'])]

df.columns = ['stars_y', 'text']

df.head()
```

Out[5]:

	stars_y	text
0	5	Hallelujah! I FINALLY FOUND IT! The frozen yog...
1	5	I drop by BnC on a weekly basis to pick up my ...
2	3	My personally experience here wasn't the best,...
3	3	37 °C = 98.6°F\r\nKoreatown establisments disp...
4	5	My husband & I visited Toronto from the U.S. f...

In [6]:
```
# normalize corpus

norm_df = normalize_corpus(df['text'])
norm_df
```

Out[6]:
```
array(["hallelujah finally found frozen yogurt launched red mango pinkberry c
raze states . ( google .) canadian incarnation goes name yogoberri discovered
inside tiny korean bakery along bloor street ' k - town . uninitiated , froze
n yogurt tart less sweet tcby kind . plain vanilla yogurt ' toppings ; fresh
fruit , nuts , cereal ... weird - looking powders never tried . small (  oz
.) $  .  +  cents per topping . medium (  oz .) including three toppings $  .
  . used eat frozen yogurt time lived korea practically weeping joy reunited
today . shameless plea : go eat lots chain multiply open branch near home . t
hanks ! ( fyi ,  stars yogurt . ' tried anything else bakery .) ** eta : dear
fro yo gods , thanks opening blushberry closer home . xoxo , susan c .**",
       "drop bnc weekly basis pick favourite buns korean bread go mid afterno
on good popular buns sold . also cakes - best green tea cake . tried bing - s
oo , dessert ice shavings , milk , red bean fruits . ' simply amazing perfect
summer . ' must try !",
       'personally experience wasnt best drink watered , tapioca bubble tea l
ittle harden . people working friendly nice , decently quiet atmosphere . goo
d place come sit chill chatting away friends .',
       ...,
       'good place get fresh quick indian food places serve authentic indian
reasonable price fast service however , would like suggest couple things  . c
hola poori combo - poori less quantity mix veg chana masala good , serve bigg
er poori  pooris  . butter chicken spicy chicken combo okay . give quantity s
auce rice .  . tried new introductory dish chicken biryani flavoured meat ric
e . would suggest increase quantity rice give . $  .  get sufficient amount r
ice fill . tandoori chicken looks yummy , going try next time . overall , goo
d place quick delicious treat . would go back .',
       'really quiet pm say , place new ( name signs previous place still ) g
etting pm lunch , \' really fair give   star review . first , get rid name /
signs anything shows \' previous shawarma place , door stopped going . though
t wrong place . second , chime bell something let know someone came place . w
alked peek kitchen / prep area , guy \' know someone . third , seems serve ch
icken veg . \' seems meat . guess \' alright , people like chicken ... oh fis
h ! seems place . services ... weird , ordered meal combo ($  .  ) picture se
e , mix salad , piece papadum , rice green pea , potato veg , meat sauce , sw
eet . ask choose chicken , spicy one butter chicken main . rice \' anything g
reen . salad given explain ran . papadum . sweet , right beside stove , serve
r ask " want sweets ?" twice reply yes yes , put box top rice . item shown me
nu , included , \' explain find something substitue . samosa added without as
king wanted , weird , hole inthe middle , try check see filling done , though
t samosa made cooked fillings ? may really caught guard . may really good nor
mal lunch hours . review benefit doubt goes toward place . back another lunch
, hopefully inthe regular lunch hours .',
       'little bit pricy based quality food ok dessert tastes really wired'],
      dtype='<U4692')
```

In [26]:
```
header = ["stars_y"]
df.to_csv('output.csv', columns = header, index = False)
```

In [7]:

```
cv = CountVectorizer(binary=False, min_df=0.0, max_df=1.0, ngram_range=(1,2))
features = cv.fit_transform(norm_df)

features.shape
```

Out[7]:

```
(706731, 9682018)
```

In [35]:

```
# binarize reviews
df['stars'] = (df['stars_y'] > 3).astype(int)

labels = df.stars
```

In [36]:

```
# build train and test datasets

X_train, X_test, y_train, y_test = train_test_split(features, labels, test_siz
e=0.33, random_state=42)
```

In [8]:

```
def train_model(classifier, feature_vector_train, label, feature_vector_valid
):
    # fit the training dataset on the classifier
    classifier.fit(feature_vector_train, label)

    # predict the labels on validation dataset
    predictions = classifier.predict(feature_vector_valid)

    return predictions
```

In [38]:

```
# Naive Bayes
predictions = train_model(naive_bayes.MultinomialNB(), X_train, y_train, X_tes
t)

accuracy = accuracy_score(y_test, predictions)
F1 = f1_score(y_test, predictions)
precision = precision_score(y_test, predictions)
recall = recall_score(y_test, predictions)

print ("NB:")
print ("Accuracy: ", accuracy)
print ("F1: ", F1)
print ("Precision: ", precision)
print ("Recall: ", recall)
```

```
NB:
Accuracy:  0.8496968553566988
F1:  0.8817700428344969
Precision:  0.8400683787049176
Recall:  0.9278281731328876
```

In [39]:

```
# Logistic Regression
predictions = train_model(linear_model.LogisticRegression(), X_train, y_train,
 X_test)

accuracy = accuracy_score(y_test, predictions)
F1 = f1_score(y_test, predictions)
precision = precision_score(y_test, predictions)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-39-6054f38f2311> in <module>()
      5 F1 = f1_score(y_test, predictions)
      6 precision = precision_score(y_test, predictions)
----> 7 recall = recall_score((y_test, predictions))
      8 
      9 print ("LR:")

TypeError: recall_score() missing 1 required positional argument: 'y_pred'
```

In [40]:

```
recall = recall_score(y_test, predictions)

print ("LG:")
print ("Accuracy: ", accuracy)
print ("F1: ", F1)
print ("Precision: ", precision)
print ("Recall: ", recall)
```

```
LG:
Accuracy:  0.8749003095762835
F1:  0.8980316501705531
Precision:  0.8845650707095744
Recall:  0.9119145976179323
```

In [ ]:

```
# Random Forest
predictions = train_model(ensemble.RandomForestClassifier(), X_train, y_train,
 X_test)

accuracy = accuracy_score(y_test, predictions)
F1 = f1_score(y_test, predictions)
precision = precision_score(y_test, predictions)
recall = recall_score(y_test, predictions)

print ("RF:")
print ("Accuracy: ", accuracy)
print ("F1: ", F1)
print ("Precision: ", precision)
print ("Recall: ", recall)
```

In [ ]:

```
# Stochastic Gradient Descent
predictions = train_model(SGDClassifier(), X_train, y_train, X_test)

accuracy = accuracy_score(y_test, predictions)
F1 = f1_score(y_test, predictions)
precision = precision_score(y_test, predictions)
recall = recall_score(y_test, predictions)

print ("SGD:")
print ("Accuracy: ", accuracy)
print ("F1: ", F1)
print ("Precision: ", precision)
print ("Recall: ", recall)
```

In [ ]:

```

```