In this project I am going to classify fake posts on subreddit from r/TheOnion and r/nottheonion

In [1]:

```
from google.colab import drive
drive.mount('gdrive',force_remount=True)
```

```
Mounted at gdrive
```

In [0]:

```
# Basic libraries
import numpy as np
import pandas as pd
import re
from nltk.corpus import stopwords
from bs4 import BeautifulSoup

# Data Visualization
import matplotlib.pyplot as plt
import seaborn as sns
%config InlineBackend.figure_format = 'retina'
%matplotlib inline

# Natural Language Processing
from sklearn.feature_extraction import stop_words
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer

# Modeling
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.pipeline import Pipeline
from sklearn.naive_bayes import MultinomialNB
from sklearn import metrics
from sklearn.metrics import accuracy_score, recall_score, precision_score, confusion_matrix
```

In [0]:

```
# r/TheOnion DataFrame
df_onion = pd.read_csv('gdrive/My Drive/data/the_onion.csv')

# r/nottheonion DataFrame
df_not_onion = pd.read_csv('gdrive/My Drive/data/not_onion.csv')
```

In [4]:

```
# Show first 3 rows of df_onion
print("Shape:", df_onion.shape)
df_onion.head(3)
```

```
Shape: (14868, 8)
```

Out[4]:

	Unnamed: 0	author	domain	num_comments	score	subreddit	timestamp	title
0	0	Kotaay	google.ca	1	1	TheOnion	1554658622	Jack Nicholson Banned From Sitting Courtside A...
1	1	DisastrousCandy3	theonion.com	3	1	TheOnion	1554600149	NicoDerm Introduces New Nicotine Eye Patch
2	2	SlovenianCat	youtu.be	0	1	TheOnion	1554585700	Last Bastion Of U.S. Economy Succumbs To Pancr...

In [5]:

```
# Show first 3 rows of df_not_onion
print("Shape:", df_not_onion.shape)
df_not_onion.head(3)
```

```
Shape: (15000, 8)
```

Out[5]:

	Unnamed: 0	author	domain	num_comments	score	subreddit	timestamp	title
0	0	drak0bsidian	cnn.com	0	1	nottheonion	1554663925	Suspected rhino poacher is killed by an elepha...
1	1	somefaces	nypost.com	1	1	nottheonion	1554663648	Taliban commander turns himself in to collect ...
2	2	Sombez	nytimes.com	1	1	nottheonion	1554663558	Rhino Poacher Killed by Elephant and Eaten by ...

In [0]:

```
# Decontracting the phrases
def decontracted(phrase):
    # specific
    phrase = re.sub(r"won't", "will not", phrase)
    phrase = re.sub(r"can\'t", "can not", phrase)

    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    return phrase
```

In [0]:

```
def clean_data(dataframe):

    # Drop duplicate rows
    dataframe.drop_duplicates(subset='title', inplace=True)

    # Remove punctation
    dataframe['title'] = dataframe['title'].str.replace('[^\w\s]',' ')

    # Remove numbers
    dataframe['title'] = dataframe['title'].str.replace('[^A-Za-z]',' ')

    # Remove worrds with numbers
    dataframe['title'] = dataframe['title'].str.replace('[^A-Za-z0-9]+',' ')

    # Make sure any double-spaces are single
    dataframe['title'] = dataframe['title'].str.replace('  ',' ')

    # Decontraction
    dataframe['title']= dataframe.apply(lambda row: decontracted(row['title']),axis=1)

    # Transform all text to lowercase
    dataframe['title'] = dataframe['title'].str.lower()

    print("New shape:", dataframe.shape)
    return dataframe.head()
```

In [8]:

```
clean_data(df_not_onion)
```

```
New shape: (12086, 8)
```

Out[8]:

	Unnamed: 0	author	domain	num_comments	score	subreddit	timestamp	title
0	0	drak0bsidian	cnn.com	0	1	nottheonion	1554663925	suspected rhino poacher is killed by an elepha...
1	1	somefaces	nypost.com	1	1	nottheonion	1554663648	taliban commander turns himself in to collect ...
2	2	Sombez	nytimes.com	1	1	nottheonion	1554663558	rhino poacher killed by elephant and eaten by ...
3	3	Bayou-Maharaja	ktoo.org	0	1	nottheonion	1554662778	young shoves female reporter on way to violenc...
4	4	phantommaster1999	buzz.ie	1	1	nottheonion	1554661988	poacher hunting rhinos trampled to death by el...

In [9]:

```
# Call `clean_data(dataframe)` function
clean_data(df_onion)
```

```
New shape: (14189, 8)
```

Out[9]:

	Unnamed: 0	author	domain	num_comments	score	subreddit	timestamp	title
0	0	Kotaay	google.ca	1	1	TheOnion	1554658622	jack nicholson banned from sitting courtside a...
1	1	DisastrousCandy3	theonion.com	3	1	TheOnion	1554600149	nicoderm introduces new nicotine eye patch
2	2	SlovenianCat	youtu.be	0	1	TheOnion	1554585700	last bastion of u s economy succumbs to pancre...
3	3	MyNameIsGriffon	sports.theonion.com	0	386	TheOnion	1554559311	tom izzo calls spartans best team he s ever th...
4	4	MyNameIsGriffon	theonion.com	0	3	TheOnion	1554501708	house democrats formally request trump s tax r...

In [10]:

```
# Create a DataFrame to check nulls
pd.DataFrame([df_onion.isnull().sum(),df_not_onion.isnull().sum()], index=["TheOnion","notheonion"
]).T
```

Out[10]:

	TheOnion	notheonion
Unnamed: 0	0	0
author	0	0
domain	0	0
num_comments	0	0
score	0	0
subreddit	0	0
timestamp	0	0
title	0	0

In [11]:

```
# Convert Unix Timestamp to Datetime
df_onion['timestamp'] = pd.to_datetime(df_onion['timestamp'], unit='s')
df_not_onion['timestamp'] = pd.to_datetime(df_not_onion['timestamp'], unit='s')
```

```
# Show date-range of posts scraped from r/TheOnion and r/nottheonion
print("TheOnion start date:", df_onion['timestamp'].min())
print("TheOnion end date:", df_onion['timestamp'].max())
print("nottheonion start date:", df_not_onion['timestamp'].min())
print("nottheonion end date:", df_not_onion['timestamp'].max())
```

```
TheOnion start date: 2013-10-04 00:38:59
TheOnion end date: 2019-04-07 17:37:02
nottheonion start date: 2019-01-25 01:00:09
nottheonion end date: 2019-04-07 19:05:25
```

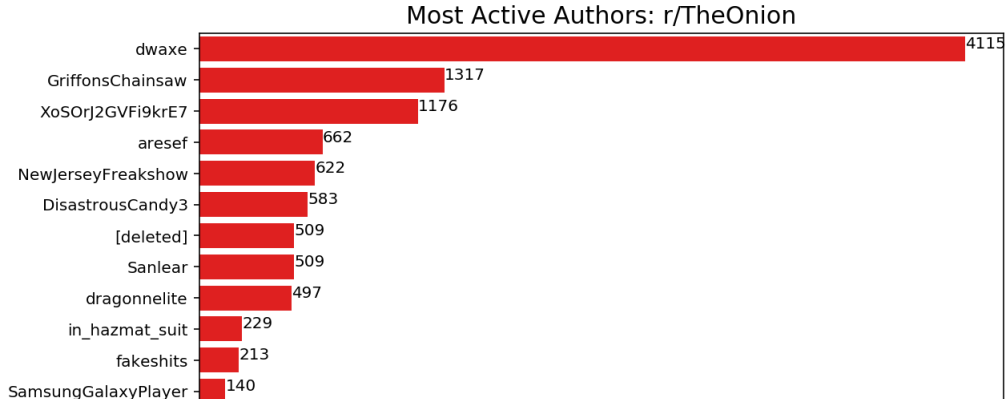
In [0]:

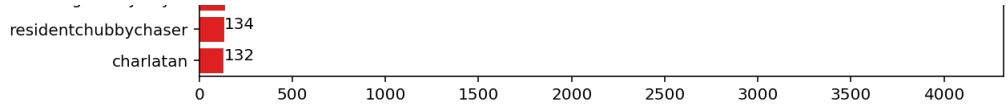
```
# Bar plot function
def bar_plot(x, y, title, color):

    # Set up barplot
    plt.figure(figsize=(9,5))
    g=sns.barplot(x, y, color = color)
    ax=g

    # Label the graph
    plt.title(title, fontsize = 15)
    plt.xticks(fontsize = 10)

    # Enable bar values
    # Code modified from http://robertmitchellv.com/blog-bar-chart-annotations-pandas-mpl.html
    # create a list to collect the plt.patches data
    totals = []

    # find the values and append to list
    for p in ax.patches:
        totals.append(p.get_width())

    # set individual bar lables using above list
    total = sum(totals)

    # set individual bar lables using above list
    for p in ax.patches:
        # get_width pulls left or right; get_y pushes up or down
        ax.text(p.get_width()+.3, p.get_y()+.38, \
                int(p.get_width()), fontsize=10)
```

r/TheOnion: Most Active Authors

In [13]:

```
# Set x values: # of posts
df_onion_authors = df_onion['author'].value_counts()
df_onion_authors = df_onion_authors[df_onion_authors > 100].sort_values(ascending=False)

# Set y values: Authors
df_onion_authors_index = list(df_onion_authors.index)

# Call function
bar_plot(df_onion_authors.values, df_onion_authors_index, 'Most Active Authors: r/TheOnion', 'r')
```



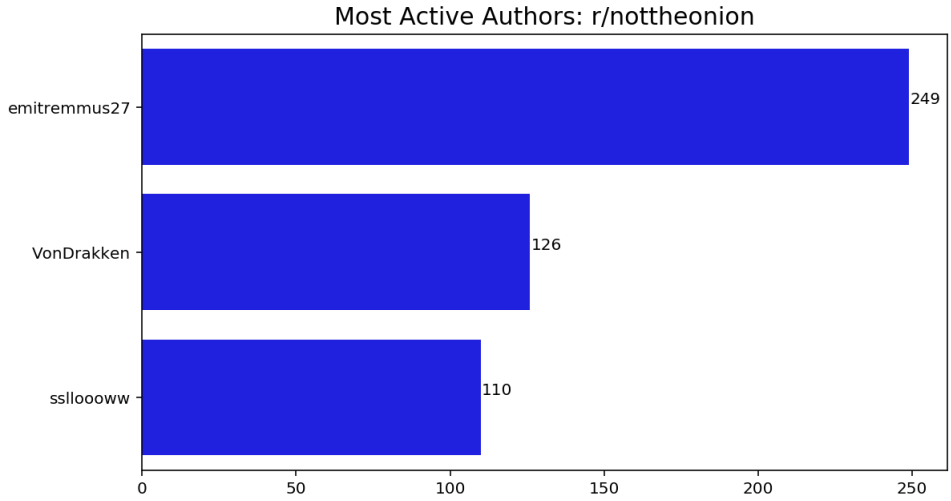


r/The onion has 95k subscribers, but only 14 of them have more than 100 posts

r/nottheonion: Most Active Authors

In [0]:

```
# Set x values: # of posts
df_not_onion_authors = df_not_onion['author'].value_counts()
df_not_onion_authors = df_not_onion_authors[df_not_onion_authors >
100].sort_values(ascending=False)

# Set y values: Authors
df_not_onion_authors_index = list(df_not_onion_authors.index)

# Call function
bar_plot(df_not_onion_authors.values, df_not_onion_authors_index, 'Most Active Authors:
r/nottheonion','b')
```

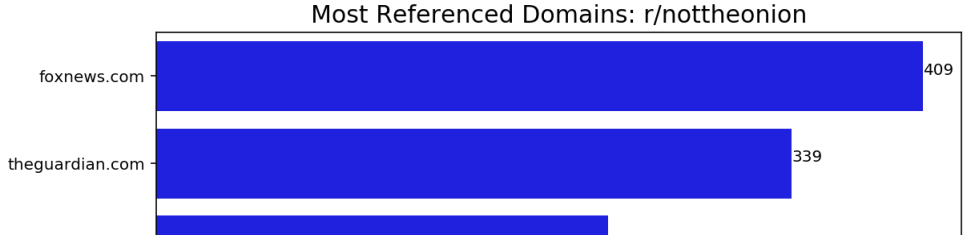


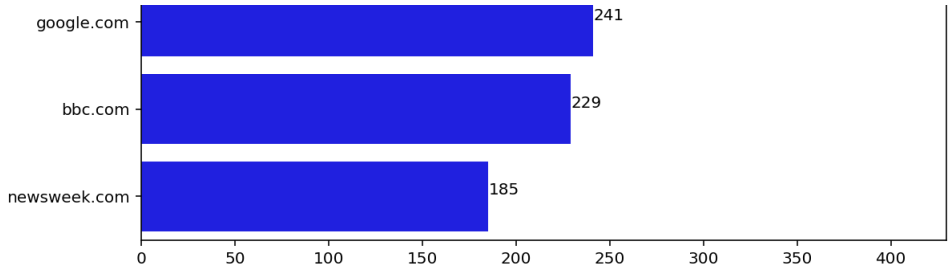
r/the not onion 15million subscribers, but only 3 of them have more than 100 posts

r/nottheonion: Most Referenced Domains

In [0]:

```
# Set x values: # of posts greater than 100
df_nonion_domain = df_not_onion['domain'].value_counts()
df_nonion_domain = df_nonion_domain.sort_values(ascending=False).head(5)

# Set y values: Names of authors
df_nonion_domain_index = list(df_nonion_domain.index)

# Call function
bar_plot(df_nonion_domain.values, df_nonion_domain_index, 'Most Referenced Domains: r/nottheonion'
,'b')
```



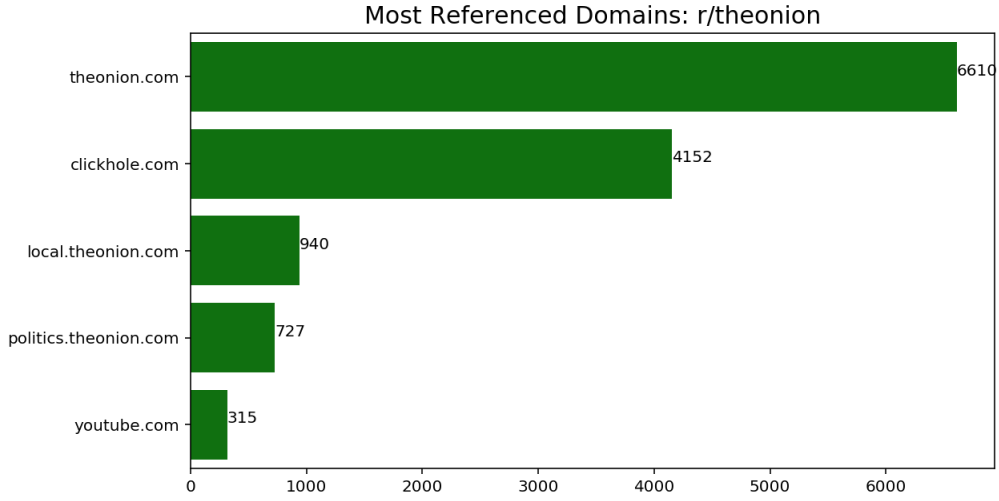


Also unsurprisingly, foxnews.com is the most referenced domain in r/nottheonion!

r/theonion: Most Referenced Domains

In [0]:

```
# Set x values: # of posts greater than 100
df_onion_domain = df_onion['domain'].value_counts()
df_onion_domain = df_onion_domain.sort_values(ascending=False).head(5)

# Set y values: Names of authors
df_onion_domain_index = list(df_onion_domain.index)

# Call function
bar_plot(df_onion_domain.values, df_onion_domain_index, 'Most Referenced Domains: r/theonion','g')
```



Also surprisingly, theonion.com is the most referenced domain in r/theonion!

Natural Language Processing (NLP)

In [14]:

```
# concatenate dataframes
# Combine df_onion & df_not_onion with only 'subreddit' (target) and 'title' (predictor) columns
df = pd.concat([df_onion[['subreddit', 'title']], df_not_onion[['subreddit', 'title']]], axis=0)

#Reset the index
df = df.reset_index(drop=True)

# Preview head of df to show 'TheOnion' titles appear
df.head(2)
```

Out[14]:

	subreddit	title

	subreddit	title
0	TheOnion	jack nicholson banned from sitting courtside a...
1	TheOnion	nicoderm introduces new nicotine eye patch

In [0]:

```
# Preview head of df to show 'nottheonion' titles appear
df.tail(2)
```

Out[0]:

	subreddit	title
26273	nottheonion	farming simulator starts up esports with k pri...
26274	nottheonion	mark zuckerberg killed goat with laser gun and...

Binarize Target `subreddit`

- `TheOnion`: 1
- `nottheonion`: 0

In [15]:

```
# Replace `TheOnion` with 1, `nottheonion` with 0
df["subreddit"] = df["subreddit"].map({"nottheonion": 0, "TheOnion": 1})

# Print shape of df
print(df.shape)

# Preview head of df to show 1s
df.head(2)
```

```
(26275, 2)
```

Out[15]:

	subreddit	title
0	1	jack nicholson banned from sitting courtside a...
1	1	nicoderm introduces new nicotine eye patch

In [0]:

```
# Preview tail of df to show 0s
df.tail(2)
```

Out[0]:

	subreddit	title
26273	0	farming simulator starts up esports with k pri...
26274	0	mark zuckerberg killed goat with laser gun and...

Apply `CountVectorizer()`

In [16]:

```
# Set variables to show TheOnion Titles
mask_on = df['subreddit'] == 1
df_onion_titles = df[mask_on]['title']
```

```
# Instantiate a CountVectorizer
cv1 = CountVectorizer(analyzer='word',stop_words = 'english')

# Fit and transform the vectorizer on our corpus
onion_cvec = cv1.fit_transform(df_onion_titles)

# Convert onion_cvec into a DataFrame
onion_cvec_df = pd.DataFrame(onion_cvec.toarray(),
                    columns=cv1.get_feature_names())

# Inspect head of Onion Titles cvec
print(onion_cvec_df.shape)
print(onion_cvec_df.head(3))
```

```
(14189, 11906)
   aaron  abandon  abandoned  abandoning  ...  zookeeper  zoologists  zuckerberg  zz
0      0        0          0           0  ...          0           0           0   0
1      0        0          0           0  ...          0           0           0   0
2      0        0          0           0  ...          0           0           0   0

[3 rows x 11906 columns]
```

Count Vectorize `df` where `subreddit` is `0`

- `ngram_range = (1,1)`

In [17]:

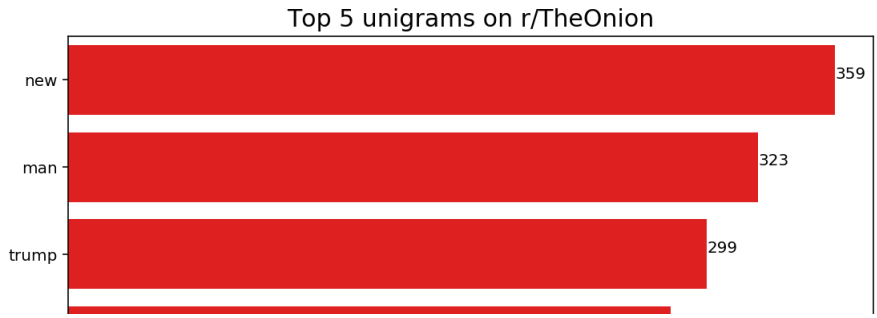
```
# Set variables to show NotTheOnion Titles
mask_no = df['subreddit'] == 0
df_not_onion_titles = df[mask_no]['title']

# Instantiate a CountVectorizer
cv2 = CountVectorizer(stop_words = 'english')

# Fit and transform the vectorizer on our corpus
not_onion_cvec = cv2.fit_transform(df_not_onion_titles)

# Convert onion_cvec into a DataFrame
not_onion_cvec_df = pd.DataFrame(not_onion_cvec.toarray(),
                    columns=cv2.get_feature_names())

# Inspect head of Not Onion Titles cvec
print(not_onion_cvec_df.shape)
```

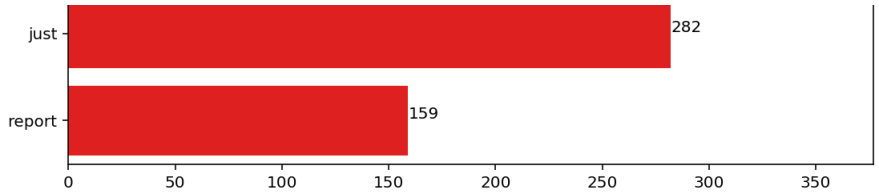
```
(12086, 14451)
```

r/TheOnion: Top 5 Unigrams

In [0]:

```
# Set up variables to contain top 5 most used words in Onion
onion_wc = onion_cvec_df.sum(axis = 0)
onion_top_5 = onion_wc.sort_values(ascending=False).head(5)

# Call function
bar_plot(onion_top_5.values, onion_top_5.index, 'Top 5 unigrams on r/TheOnion','r')
```

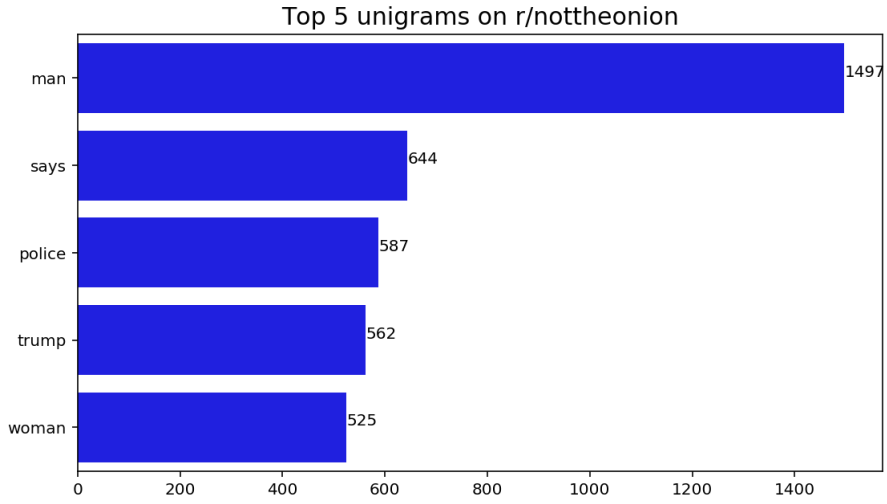




r/nottheonion: Top 5 Unigrams

In [0]:

```
# Set up variables to contain top 5 most used words in Onion
nonion_wc = not_onion_cvec_df.sum(axis = 0)
nonion_top_5 = nonion_wc.sort_values(ascending=False).head(5)

# Call function
bar_plot(nonion_top_5.values, nonion_top_5.index, 'Top 5 unigrams on r/nottheonion','b')
```



Common unigrams between not_the_onion and the_onion

In [0]:

```
# Create list of unique words in top five
not_onion_5_set = set(nonion_top_5.index)
onion_5_set = set(onion_top_5.index)

# Return common words
common_unigrams = onion_5_set.intersection(not_onion_5_set)
common_unigrams
```

Out[0]:

```
{'man', 'trump'}
```

'man' and 'trump' are the two top common words

Count Vectorize `df` where `subreddit` is `1`

- `ngram_range = (2,2)`

In [0]:

```
# Set variables to show TheOnion Titles
mask = df['subreddit'] == 1
df_onion_titles = df[mask]['title']
```

```
# Instantiate a CountVectorizer
cv = CountVectorizer(stop_words = 'english', ngram_range=(2,2))

# Fit and transform the vectorizer on our corpus
onion_cvec = cv.fit_transform(df_onion_titles)

# Convert onion_cvec into a DataFrame
onion_cvec_df = pd.DataFrame(onion_cvec.toarray(),
                    columns=cv.get_feature_names())

# Inspect head of Onion Titles cvec
print(onion_cvec_df.shape)
```

```
(14868, 35668)
```

In [0]:

```
### Count Vectorize `df` where `subreddit` is `0`
# ngram_range = (2,2)

# Set variables to show NotTheOnion Titles
mask = df['subreddit'] == 0
df_not_onion_titles = df[mask]['title']

# Instantiate a CountVectorizer
cv = CountVectorizer(stop_words = 'english', ngram_range=(2,2))

# Fit and transform the vectorizer on our corpus
not_onion_cvec = cv.fit_transform(df_not_onion_titles)

# Convert onion_cvec into a DataFrame
not_onion_cvec_df = pd.DataFrame(not_onion_cvec.toarray(),
                    columns=cv.get_feature_names())

# Inspect head of Not Onion Titles cvec
print(not_onion_cvec_df.shape)
```

r/TheOnion: Top 5 Bigrams

In [0]:

```
# Set up variables to contain top 5 most used bigrams in r/TheOnion
onion_wc = onion_cvec_df.sum(axis = 0)
onion_top_5 = onion_wc.sort_values(ascending=False).head(5)

# Call function
bar_plot(onion_top_5.values, onion_top_5.index, 'Top 5 bigrams on r/TheOnion','r')
```

In [0]:

```
### r/nottheonion: Top 5 Bigrams
```

In [0]:

```
# Set up variables to contain top 5 most used bigrams in r/nottheonion
nonion_wc = not_onion_cvec_df.sum(axis = 0)
nonion_top_5 = nonion_wc.sort_values(ascending=False).head(5)

# Call function
bar_plot(nonion_top_5.values, nonion_top_5.index, 'Top 5 bigrams on r/nottheonion','b')
```

In [0]:

```
### Common Bigrams between Top 5 in r/TheOnion & r/nottheonion

not_onion_5_list = set(nonion_top_5.index)
onion_5_list = set(onion_top_5.index)

# Return common words
common_bigrams = onion_5_list.intersection(not_onion_5_list)
```

common_bigrams

Take out `{'man', 'new', 'old', 'people', 'say', 'trump', 'woman', 'year'}` from dataset when modeling, since these words occur frequently in both subreddits.

Create custom `stop_words` to include common frequent words

Referencing the common most-used words, add them to a customized `stop_words` list.

In [0]:

```
# Create lists
custom = stop_words.ENGLISH_STOP_WORDS
custom = list(custom)
common_unigrams = list(common_unigrams)
common_bigrams = list(common_bigrams)

# Append unigrams to list
for i in common_unigrams:
    custom.append(i)


# Append bigrams to list
for i in common_bigrams:
    split_words = i.split(" ")
    for word in split_words:
        custom.append(word)
```

Set `X` (predictor) and `y` (target) variables

In [0]:

```
X = df['title']
y = df['subreddit']
```

In [0]:

```
### Train/Test Split
X_train, X_test, y_train, y_test = train_test_split(X,
                                                    y,
                                                    random_state=42,
                                                    stratify=y)
```

In [20]:

```
### Model 1: CountVectorizer & Logistic Regression (Best Coefficient Interpretability)
pipe = Pipeline([('cvec', CountVectorizer()),
                 ('lr', LogisticRegression(solver='liblinear'))])

# Tune GridSearchCV
pipe_params = {'cvec__ngram_range': [(1,1), (2,2), (1,3)],
               'lr__C': [0.01, 1]}

gs = GridSearchCV(pipe, param_grid=pipe_params, cv=3)
gs.fit(X_train, y_train);
print("Best score:", gs.best_score_)
print("Train score", gs.score(X_train, y_train))
print("Test score", gs.score(X_test, y_test))

gs.best_params_
```

```
Best score: 0.8531411752765655
Train score 0.9618897797625089
Test score 0.8652762977622165
```

Out[20]:

```
{'cvec__ngram_range': (1, 1), 'lr__C': 1}
```

In [21]:

```
### Model 2: TfidfVectorize & Logistic Regression
pipe = Pipeline([('tvect', TfidfVectorizer()),
                 ('lr', LogisticRegression(solver='liblinear'))])

# Tune GridSearchCV
pipe_params = {'tvect__max_df': [.75, .98, 1.0],
               'tvect__min_df': [2, 3, 5],
               'tvect__ngram_range': [(1,1), (1,2), (1,3)],
               'lr__C': [1]}

gs = GridSearchCV(pipe, param_grid=pipe_params, cv=3)
gs.fit(X_train, y_train);
print("Best score:", gs.best_score_)
print("Train score", gs.score(X_train, y_train))
print("Test score", gs.score(X_test, y_test))

gs.best_params_
```

```
Best score: 0.8438546635542474
Train score 0.911651273723739
Test score 0.8558380270969707
```

Out[21]:

```
{'lr__C': 1,
 'tvect__max_df': 0.75,
 'tvect__min_df': 3,
 'tvect__ngram_range': (1, 3)}
```

In [22]:

```
pipe = Pipeline([('cvec', CountVectorizer()),
                 ('nb', MultinomialNB())])

# Tune GridSearchCV
pipe_params = {'cvec__ngram_range': [(1,1),(1,3)],
               'nb__alpha': [.36, .6]}

gs = GridSearchCV(pipe, param_grid=pipe_params, cv=3)
gs.fit(X_train, y_train);
print("Best score:", gs.best_score_)
print("Train score", gs.score(X_train, y_train))
print("Test score", gs.score(X_test, y_test))

gs.best_params_
```

```
Best score: 0.8878514158124429
Train score 0.9970059880239521
Test score 0.8972446338864363
```

Out[22]:

```
{'cvec__ngram_range': (1, 3), 'nb__alpha': 0.36}
```

My best model is countvectorizer with multinomialNB() and accuracy 89.72%

In [23]:

```
# Best Models
#Instantiate the classifier with best hyperparameter and vectorizer
nb = MultinomialNB(alpha = 0.36)
cvec = CountVectorizer(ngram_range= (1, 3))

# Fit and transform the vectorizor
cvec.fit(X_train)

Xcvec_train = cvec.transform(X_train)
Xcvec_test = cvec.transform(X_test)
```

```
# Fit the classifier
nb.fit(Xcvec_train,y_train)

# Create the predictions for Y training data
preds = nb.predict(Xcvec_test)

print(nb.score(Xcvec_test, y_test))
```

```
0.8972446338864363
```

In [24]:

```
# Create a confusion matrix
cnf_matrix = metrics.confusion_matrix(y_test, preds)
cnf_matrix
```

Out[24]:

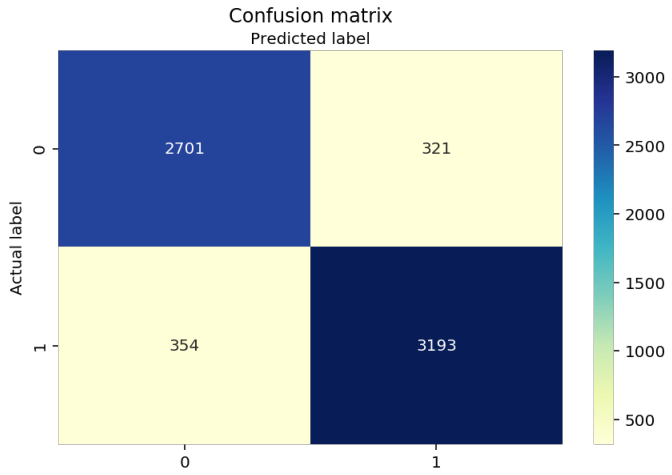
```
array([[2701,  321],
       [ 354, 3193]])
```

In [25]:

```
# Code from https://www.datacamp.com/community/tutorials/understanding-logistic-regression-python

# name  of classes
class_names=[0,1]

# Set fig and axes
fig, ax = plt.subplots()
tick_marks = np.arange(len(class_names))
plt.xticks(tick_marks, class_names)
plt.yticks(tick_marks, class_names)

# Create heatmap
sns.heatmap(pd.DataFrame(cnf_matrix), annot=True, cmap="YlGnBu" ,fmt='g')
ax.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion matrix', y=1.1)
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
```

Out[25]:

```
Text(0.5, 257.44, 'Predicted label')
```



In [0]:

```
# Assign True Neg, False Pos, False Neg, True Pos variables
cnf_matrix = np.array(cnf_matrix).tolist()

tn_fp, fn_tp = cnf_matrix
```

```
tn, fp = tn_fp
fn, tp = fn_tp
```

In [27]:

```
# Print Scores

print("Accuracy:",round(metrics.accuracy_score(y_test, preds)*100, 2),'%')
print("Precision:",round(metrics.precision_score(y_test, preds)*100, 2), '%')
print("Recall:",round(metrics.recall_score(y_test, preds)*100, 2), '%')
print("Specificity:", round((tn/(tn+fp))*100, 2), '%')
print("Misclassification Rate:", round((fp+fn)/(tn+fp+fn+tn)*100, 2), '%')
```

```
Accuracy: 89.72 %
Precision: 90.87 %
Recall: 90.02 %
Specificity: 89.38 %
Misclassification Rate: 11.11 %
```

The most model to optimize for accuracy in detecting fake news and absurd news uses CountVectorizer and MultinomialNB. The optimal parameters for this model are where `ngram_range` = (1,3) and `alpha` = 0.36.

- Accuracy: 89.72%
- Precision: 90.87%
- Recall: 90.02%
- Specificity: 89.38%
- Misclassification Rate: 11.11%

Sample Topic modeling

In [0]:

```
from pprint import pprint
import gensim
import gensim.corpora as corpora
from gensim.utils import simple_preprocess
from gensim.models import CoherenceModel
```

In [0]:

```
# spacy for lemmatization
import spacy
!pip install pyLDAvis
```

In [0]:

```
# Plotting tools
import pyLDAvis
import pyLDAvis.gensim  # don't skip this
import matplotlib.pyplot as plt
%matplotlib inline
import warnings
warnings.filterwarnings("ignore",category=DeprecationWarning)
```

In [32]:

```
def sent_to_words(sentences):
    for sentence in sentences:
        yield(gensim.utils.simple_preprocess(str(sentence), deacc=True))

data_words = list(sent_to_words(df['title']))

print(data_words[:1])
```

```
[['jack', 'nicholson', 'banned', 'from', 'sitting', 'courtside', 'after', 'spilling',
'tupperware', 'full', 'of', 'homemade', 'chili']]
```

In [33]:

```
# Unigram and bigrams
# Build the bigram and trigram models
bigram = gensim.models.Phrases(data_words, min_count=5, threshold=100) # higher threshold fewer phr
ases.
trigram = gensim.models.Phrases(bigram[data_words], threshold=100)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/models/phrases.py:598: UserWarning: For a faster imp
lementation, use the gensim.models.phrases.Phraser class
  warnings.warn("For a faster implementation, use the gensim.models.phrases.Phraser class")
```

In [34]:

```
# Faster way to get a sentence clubbed as a trigram/bigram
bigram_mod = gensim.models.phrases.Phraser(bigram)
trigram_mod = gensim.models.phrases.Phraser(trigram)

# See trigram example
print(trigram_mod[bigram_mod[data_words[0]]])
```

```
['jack', 'nicholson', 'banned', 'from', 'sitting', 'courtside', 'after', 'spilling', 'tupperware',
'full', 'of', 'homemade', 'chili']
```

In [35]:

```
def make_bigrams(texts):
    return [bigram_mod[doc] for doc in texts]

# Form Bigrams
data_words_bigrams = make_bigrams(data_words)
def lemmatization(texts, allowed_postags=['NOUN', 'ADJ', 'VERB', 'ADV']):
    """https://spacy.io/api/annotation"""
    texts_out = []
    for sent in texts:
        doc = nlp(" ".join(sent))
        texts_out.append([token.lemma_ for token in doc if token.pos_ in allowed_postags])
    return texts_out
# Initialize spacy 'en' model, keeping only tagger component (for efficiency)
# python3 -m spacy download en
nlp = spacy.load('en', disable=['parser', 'ner'])

# Do lemmatization keeping only noun, adj, vb, adv
data_lemmatized = lemmatization(data_words_bigrams, allowed_postags=['NOUN', 'ADJ', 'VERB', 'ADV'])

print(data_lemmatized[:1])
```

```
[['jack', 'nicholson', 'ban', 'sit', 'courtside', 'spill', 'tupperware', 'full', 'homemade', 'chil
i']]
```

In [36]:

```
# Create Dictionary
id2word = corpora.Dictionary(data_lemmatized)

# Create Corpus
texts = data_lemmatized

# Term Document Frequency
corpus = [id2word.doc2bow(text) for text in texts]
# View
print(corpus[:1])
```

```
[[(0, 1), (1, 1), (2, 1), (3, 1), (4, 1), (5, 1), (6, 1), (7, 1), (8, 1), (9, 1)]]
```

Gensim creates a unique id for each word in the document. The produced corpus shown above is a mapping of (word_id, word_frequency).

For example, (0, 1) above implies, word id 0 occurs once in the first document. Likewise, word id 1 occurs twice and so on.

This is used as the input by the LDA model.

Building LDA model

In [37]:

```
lda_model = gensim.models.ldamodel.LdaModel(corpus=corpus,
                                            id2word=id2word,
                                            num_topics=10,
                                            random_state=100,
                                            update_every=1,
                                            chunksize=100,
                                            passes=10,
                                            alpha='auto',
                                            per_word_topics=True)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/models/ldamodel.py:804: RuntimeWarning: divide by ze
ro encountered in double_scalars
  perwordbound = self.bound(chunk, subsample_ratio=subsample_ratio) / (subsample_ratio *
corpus_words)
```

In [38]:

```
# Print the Keyword in the 20 topics
pprint(lda_model.print_topics())
doc_lda = lda_model[corpus]
```

```
[(0,
  '0.046*"trump" + 0.045*"use" + 0.033*"new" + 0.021*"name" + 0.017*"white" + '
  '0.016*"don" + 0.014*"bear" + 0.013*"own" + 0.011*"porn" + 0.011*"know"'),
 (1,
  '0.029*"arrest" + 0.018*"can" + 0.017*"dog" + 0.016*"do" + 0.012*"bill" + '
  '0.011*"home" + 0.011*"consent" + 0.011*"car" + 0.010*"tell" + '
  '0.010*"accuse"'),
 (2,
  '0.182*"be" + 0.113*"man" + 0.032*"get" + 0.029*"not" + 0.018*"florida" + '
  '0.017*"kill" + 0.014*"claim" + 0.013*"charge" + 0.012*"child" + '
  '0.010*"ask"'),
 (3,
  '0.125*"say" + 0.044*"will" + 0.030*"year" + 0.022*"take" + 0.019*"black" + '
  '0.017*"gun" + 0.015*"end" + 0.014*"think" + 0.012*"shoot" + 0.012*"turn"'),
 (4,
  '0.070*"woman" + 0.019*"student" + 0.018*"now" + 0.018*"give" + '
  '0.018*"school" + 0.017*"try" + 0.015*"just" + 0.013*"drug" + 0.012*"keep" + '
  '0.012*"kid"'),
 (5,
  '0.080*"police" + 0.029*"make" + 0.023*"sell" + 0.023*"fire" + '
  '0.017*"officer" + 0.012*"shutdown" + 0.012*"butt" + 0.012*"case" + '
  '0.011*"hit" + 0.011*"crime"'),
 (6,
  '0.042*"call" + 0.024*"steal" + 0.023*"stop" + 0.021*"cop" + '
  '0.019*"president" + 0.014*"only" + 0.013*"drive" + 0.011*"plane" + '
  '0.010*"marijuana" + 0.010*"washington"'),
 (7,
  '0.028*"state" + 0.027*"gay" + 0.025*"sue" + 0.021*"win" + 0.017*"former" + '
  '0.015*"re" + 0.014*"white_house" + 0.013*"buy" + 0.013*"warn" + '
  '0.011*"hold"'),
 (8,
  '0.051*"have" + 0.029*"find" + 0.028*"want" + 0.020*"day" + 0.020*"die" + '
  '0.018*"go" + 0.016*"sex" + 0.016*"help" + 0.015*"pay" + 0.014*"fight"'),
 (9,
  '0.029*"people" + 0.026*"parent" + 0.025*"life" + 0.023*"world" + '
  '0.021*"ban" + 0.021*"game" + 0.018*"save" + 0.017*"show" + 0.015*"force" + '
  '0.015*"plan"')]
```

In topic 0, we find that word 'trump' is having weight 0.046 higher than other words weight in topic 0. So we can conclude that it is biased towards a person called 'TRUMP'

In topic 1, we find that word 'arrest' is having weight 0.029 higher than other words weight in topic 1. So we can conclude that it is biased towards a crime or police in general

Sample Trend analysis

In [0]:

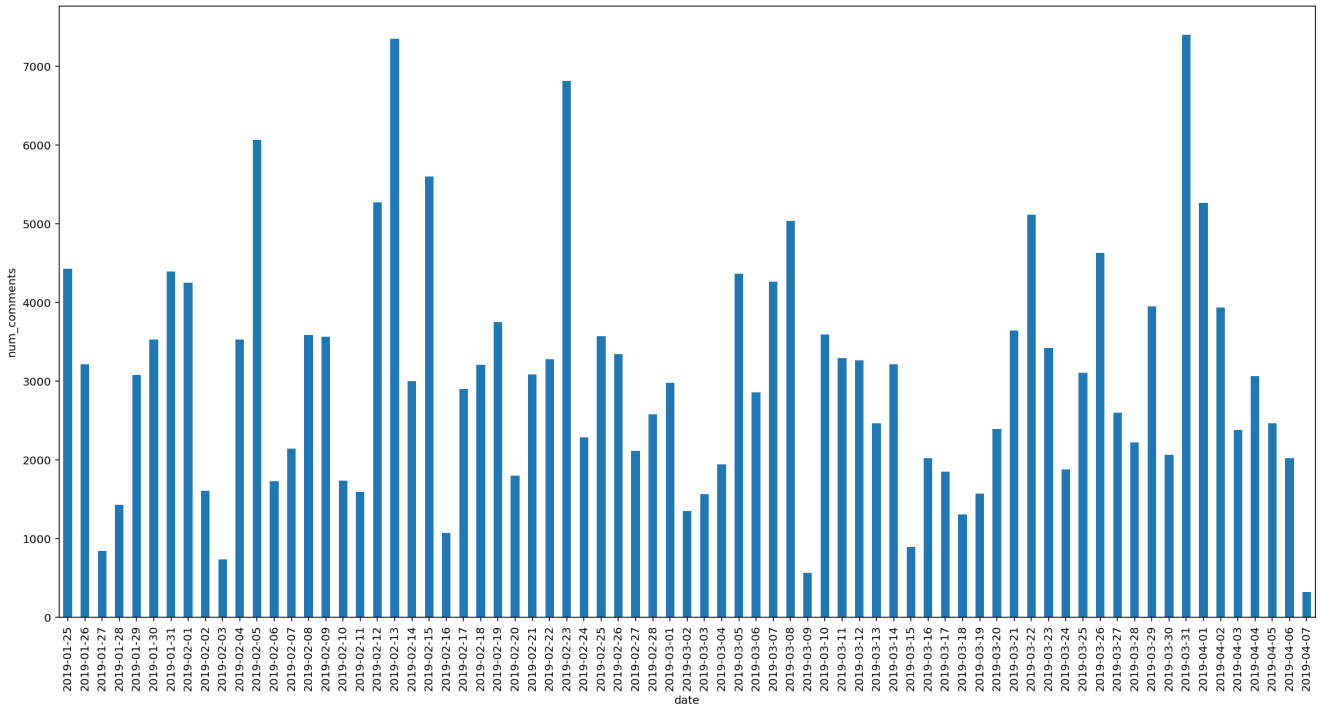
```
df_not_onion['date'] = df_not_onion['timestamp'].dt.date
```

In [40]:

```
# Trend Analysis
plt.figure(figsize=(20,10))
df_not_onion.groupby('date').num_comments.sum().plot(kind='bar')
plt.ylabel('num_comments')
```

Out[40]:

```
Text(0, 0.5, 'num_comments')
```



The analysis shows that we have 7500(approx.) comments, which is the maximum number of comments.

The reason might be on 13-2-2019(wednesday), there was a attack on Iranian Revolutionary Guards and 27 of the guards were killed

The reason might be on 13-2-2019(wednesday),NASA lost communation on "ROVER" ,which was deployed for 'MISSION OF MARS'

Sample Question Answer generation

In [0]:

```
from textblob import TextBlob
import nltk
from textblob import Word
import sys
```

In [0]:

```
verbose= True
def parse(string):
    """
    Parse a paragraph. Devide it into sentences and try to generate quesstions from each
sentences.
    """

    try:
        txt = TextBlob(string)
        # Each sentence is taken from the string input and passed to genQuestion() to generate
questions.
        for sentence in txt.sentences:
            genQuestion(sentence)

    except Exception as e:
        raise e



def genQuestion(line):
    """
    outputs question from the given text
    """


    if type(line) is str:     # If the passed variable is of type string.
        line = TextBlob(line) # Create object of type textblob.blob.TextBlob

    bucket = {}               # Create an empty dictionary


    for i,j in enumerate(line.tags):  # line.tags are the parts-of-speach in English
        if j[1] not in bucket:
            bucket[j[1]] = i  # Add all tags to the dictionary or bucket variable

    if verbose:               # In verbose more print the key,values of dictionary
        print('\n','-'*20)
        print(line ,'\n')
        print("TAGS:",line.tags, '\n')
        print(bucket)

    question = ''             # Create an empty string

    # These are the english part-of-speach tags used in this demo program.
    #.....................................................................
    # NNS     Noun, plural
    # JJ  Adjective
    # NNP     Proper noun, singular
    # VBG     Verb, gerund or present participle
    # VBN     Verb, past participle
    # VBZ     Verb, 3rd person singular present
    # VBD     Verb, past tense
    # IN      Preposition or subordinating conjunction
    # PRP     Personal pronoun
    # NN  Noun, singular or mass
    #.....................................................................

    # Create a list of tag-combination

    l1 = ['NNP', 'VBG', 'VBZ', 'IN']
    l2 = ['NNP', 'VBG', 'VBZ']


    l3 = ['PRP', 'VBG', 'VBZ', 'IN']
    l4 = ['PRP', 'VBG', 'VBZ']
    l5 = ['PRP', 'VBG', 'VBD']
```

```
    l6 = ['NNP', 'VBG', 'VBD']
    l7 = ['NN', 'VBG', 'VBZ']

    l8 = ['NNP', 'VBZ', 'JJ']
    l9 = ['NNP', 'VBZ', 'NN']

    l10 = ['NNP', 'VBZ']
    l11 = ['PRP', 'VBZ']
    l12 = ['NNP', 'NN', 'IN']
    l13 = ['NN', 'VBZ']


    # With the use of conditional statements the dictionary is compared with the list created abov
e


    if all(key in  bucket for key in l1): #'NNP', 'VBG', 'VBZ', 'IN' in sentence.
        question = 'What' + ' ' + line.words[bucket['VBZ']] +' '+ line.words[bucket['NNP']]+ ' '+
line.words[bucket['VBG']] + '?'


    elif all(key in  bucket for key in l2): #'NNP', 'VBG', 'VBZ' in sentence.
        question = 'What' + ' ' + line.words[bucket['VBZ']] +' '+ line.words[bucket['NNP']] +' '+
line.words[bucket['VBG']] + '?'


    elif all(key in  bucket for key in l3): #'PRP', 'VBG', 'VBZ', 'IN' in sentence.
        question = 'What' + ' ' + line.words[bucket['VBZ']] +' '+ line.words[bucket['PRP']]+ ' '+
line.words[bucket['VBG']] + '?'


    elif all(key in  bucket for key in l4): #'PRP', 'VBG', 'VBZ' in sentence.
        question = 'What ' + line.words[bucket['PRP']] +' '+  ' does ' + line.words[bucket['VBG']]+
' '+  line.words[bucket['VBG']] + '?'

    elif all(key in  bucket for key in l7): #'NN', 'VBG', 'VBZ' in sentence.
        question = 'What' + ' ' + line.words[bucket['VBZ']] +' '+ line.words[bucket['NN']] +' '+
line.words[bucket['VBG']] + '?'

    elif all(key in bucket for key in l8): #'NNP', 'VBZ', 'JJ' in sentence.
        question = 'What' + ' ' + line.words[bucket['VBZ']] + ' ' + line.words[bucket['NNP']] + '?'

    elif all(key in bucket for key in l9): #'NNP', 'VBZ', 'NN' in sentence
        question = 'What' + ' ' + line.words[bucket['VBZ']] + ' ' + line.words[bucket['NNP']] + '?'

    elif all(key in bucket for key in l11): #'PRP', 'VBZ' in sentence.
        if line.words[bucket['PRP']] in ['she','he']:
            question = 'What' + ' does ' + line.words[bucket['PRP']].lower() + ' ' +
line.words[bucket['VBZ']].singularize() + '?'

    elif all(key in bucket for key in l10): #'NNP', 'VBZ' in sentence.
        question = 'What' + ' does ' + line.words[bucket['NNP']] + ' ' + line.words[bucket['VBZ']].
singularize() + '?'

    elif all(key in bucket for key in l13): #'NN', 'VBZ' in sentence.
        question = 'What' + ' ' + line.words[bucket['VBZ']] + ' ' + line.words[bucket['NN']] + '?'

    # When the tags are generated 's is split to ' and s. To overcome this issue.
    if 'VBZ' in bucket and line.words[bucket['VBZ']] == "'":
        question = question.replace(" ' ","'s ")

    # Print the genetated questions as output.
    if question != '':
        print('\n', 'Question: ' + question )
```

In [0]:

```
import nltk
nltk.download('punkt')
nltk.download('averaged_perceptron_tagger')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package averaged_perceptron_tagger to
```

```
[nltk_data]     /root/nltk_data...
[nltk_data]   Unzipping taggers/averaged_perceptron_tagger.zip.
```

Out[0]:

```
True
```

In [0]:

```
parse('Bansoori is an Indian classical instrument. Akhil plays Bansoori and Guitar.')
```

```
 --------------------
Bansoori is an Indian classical instrument.

TAGS: [('Bansoori', 'NNP'), ('is', 'VBZ'), ('an', 'DT'), ('Indian', 'JJ'), ('classical', 'JJ'), ('
instrument', 'NN')]

{'NNP': 0, 'VBZ': 1, 'DT': 2, 'JJ': 3, 'NN': 5}

 Question: What is Bansoori?

 --------------------
Akhil plays Bansoori and Guitar.

TAGS: [('Akhil', 'NNP'), ('plays', 'VBZ'), ('Bansoori', 'NNP'), ('and', 'CC'), ('Guitar', 'NNP')]

{'NNP': 0, 'VBZ': 1, 'CC': 3}

 Question: What does Akhil play?
```

Sample Sentiment Analysis

In [0]:

```
import nltk

nltk.download('vader_lexicon')
from nltk.sentiment.vader import SentimentIntensityAnalyzer
sid = SentimentIntensityAnalyzer()

for_sentiment =df['title'][0]

ss = sid.polarity_scores(for_sentiment)
for k in ss:
    print('{0}: {1}, '.format(k, ss[k]), end='')
```

```
[nltk_data] Downloading package vader_lexicon to /root/nltk_data...
neg: 0.2, neu: 0.8, pos: 0.0, compound: -0.4588,
```

we can use these 4 things as features/attributes (neg, neu, pos, compound) neg: 0.2, neu: 0.8, pos: 0.0, compound: -0.4588

The above sentence is having negative impact, because of the word 'banned' therfore we get negative score of 0.2 for that sentence,positve score of 0.0

In [0]:

```
# Sentiment analysis for all the posts
l1=[]
l2=[]
l3=[]
l4=[]
sid = SentimentIntensityAnalyzer()
for i in range(0,len(df)):
    for_sentiment = df['title'][i]
    ss = sid.polarity_scores(for_sentiment)
    l1.append(ss.get('neg'))
    l2.append(ss.get('neu'))
    l3.append(ss.get('pos'))
```

```
    l4.append(ss.get('compound'))
df['neg']=l1
df['neu']=l2
df['pos']=l3
df['compound']=l4
print(df.head(3))
```

```
  subreddit                                              title  ...  pos  compound
0  TheOnion  jack nicholson banned from sitting courtside a...  ...  0.0   -0.4588
1  TheOnion         nicoderm introduces new nicotine eye patch  ...  0.0    0.0000
2  TheOnion  last bastion of u s economy succumbs to pancre...  ...  0.0   -0.6597

[3 rows x 6 columns]
```