Fake News Classification.

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Dataset: https://www.kaggle.com/clmentbisaillon/fake-and-real-news-dataset (https://www.kaggle.com/clmentbisaillon/fake-and-real-news-dataset)

Workflow:

Part I: Using titles.

- Using TFIDF Vectorizer.
  - Using Naive Bayes Classification.
  - Using Logistic Regression Classification.
- Using Count Vectorizer.
  - Using Naive Bayes Classification.
  - Using Logistic Regression Classification.

Part II: Using texts.

- Using TFIDF Vectorizer.
  - Using Naive Bayes Classification.
  - Using Logistic Regression Classification.
- Using Count Vectorizer.
  - Using Naive Bayes Classification.
  - Using Logistic Regression Classification.

Importing the necessary libraries.

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import os
import nltk
```

Working directory.

In [2]:
```
os.chdir(r'C:\Users\Habeeb\Documents\Sagun\Python\csv files\Fake News')
```

In [3]:
```
fake_raw = pd.read_csv('Fake.csv')
true_raw = pd.read_csv('True.csv')
```

In [4]:
```
fake_raw.dropna(axis =1, inplace=True)
```

In [5]:
```
true_raw.dropna(axis = 1, inplace=True)
```

In [6]:
```
fake_raw.head()
```

Out[6]:

	title	text	subject	date
0	Donald Trump Sends Out Embarrassing New Year'...	Donald Trump just couldn t wish all Americans ...	News	December 31, 2017
1	Drunk Bragging Trump Staffer Started Russian ...	House Intelligence Committee Chairman Devin Nu...	News	December 31, 2017
2	Sheriff David Clarke Becomes An Internet Joke...	On Friday, it was revealed that former Milwauk...	News	December 30, 2017
3	Trump Is So Obsessed He Even Has Obama's Name...	On Christmas day, Donald Trump announced that ...	News	December 29, 2017
4	Pope Francis Just Called Out Donald Trump Dur...	Pope Francis used his annual Christmas Day mes...	News	December 25, 2017

In [7]:
```
true_raw.head()
```

Out[7]:

	title	text	subject	date
0	As U.S. budget fight looms, Republicans flip t...	WASHINGTON (Reuters) - The head of a conservat...	politicsNews	December 31, 2017
1	U.S. military to accept transgender recruits o...	WASHINGTON (Reuters) - Transgender people will...	politicsNews	December 29, 2017
2	Senior U.S. Republican senator: 'Let Mr. Muell...	WASHINGTON (Reuters) - The special counsel inv...	politicsNews	December 31, 2017
3	FBI Russia probe helped by Australian diplomat...	WASHINGTON (Reuters) - Trump campaign adviser ...	politicsNews	December 30, 2017
4	Trump wants Postal Service to charge 'much mor...	SEATTLE/WASHINGTON (Reuters) - President Donal...	politicsNews	December 29, 2017

In [8]:
```
fake_raw.shape
```

Out[8]: (23481, 4)

In [9]:
```
true_raw.shape
```

Out[9]: (21417, 4)

Adding labels of True and False for fake news.

- 0: Fake
- 1: True

In [10]:
```
fake_raw['label'] = np.zeros(fake_raw.shape[0])
```

In [11]:
```
true_raw['label'] = np.ones(true_raw.shape[0])
```

In [12]:
```
true_raw['label'] = true_raw.label.astype(int)
```

In [13]:
```
fake_raw['label'] = fake_raw.label.astype(int)
```

Concatenating two dataframes.

In [14]:
```
merged_df = pd.concat([true_raw, fake_raw], ignore_index=True)
```

In [15]:
```
df = merged_df.copy()
```

Shuffling the dataframe rows.

In [16]:
```
def shuffle(dataframe, random_state = 100):
    dd = dataframe.copy()
    dd = dd.sample(frac = 1, random_state = 100)
    dd.reset_index(drop = True, inplace = True)
    return dd
```

In [17]:
```
df = shuffle(df)
df.head(20)
```

Out[17]:

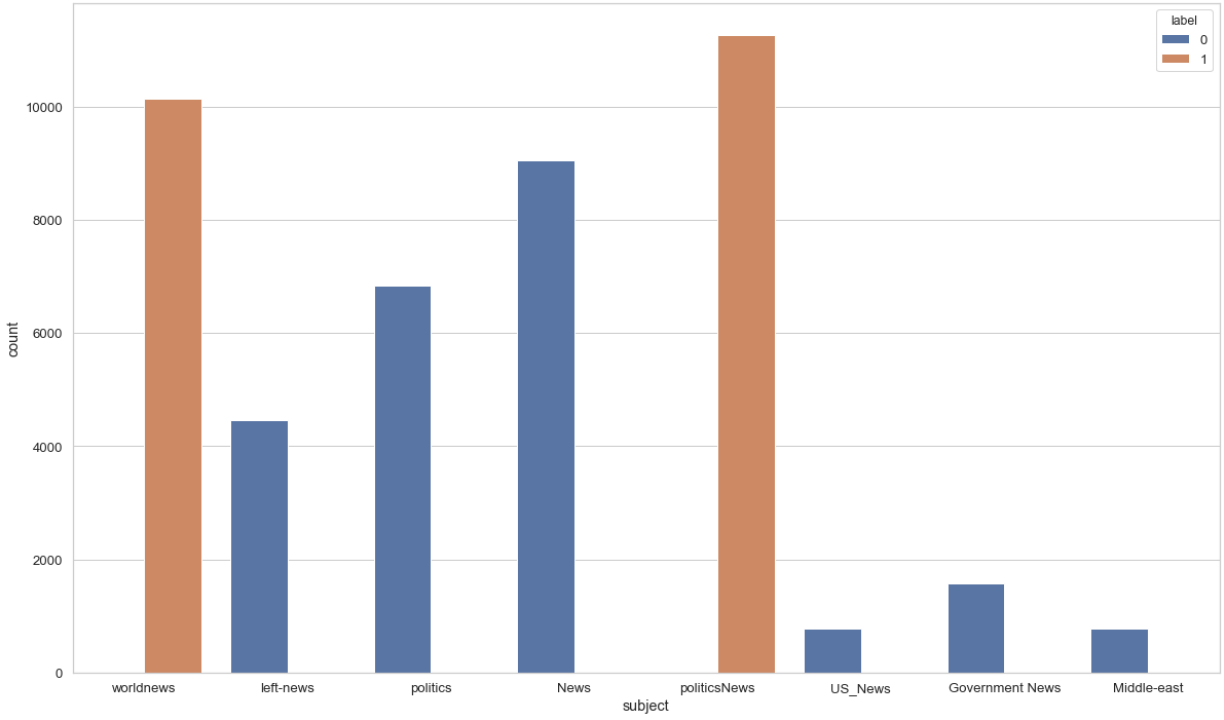
	title	text	subject	date	label
0	China, Pakistan to look at including Afghanist...	BEIJING (Reuters) - China and Pakistan will lo...	worldnews	December 26, 2017	1
1	10 REASONS A VOTE RECOUNT Is A Really Bad Idea...	Watch Jill Stein explain why she s working to ...	left-news	Nov 27, 2016	0
2	DEBBIE WASSERMAN SCHULTZ Planned To Continue P...	Democratic Rep. Debbie Wasserman Schultz seemi...	politics	Jul 29, 2017	0
3	FINALLY: Sheriff Joe Ruled In Contempt Over R...	A Maricopa Country judge has finally stood up ...	News	May 14, 2016	0
4	Obama says he does not think FBI's Comey is tr...	WASHINGTON (Reuters) - President Barack Obama ...	politicsNews	November 5, 2016	1
5	TRUMP WAS RIGHT! Why The Heck Is This Liberal ...	If you watch CNBC at all you know John Harwood...	politics	Oct 28, 2015	0
6	LATE NIGHT HOST Goes Low In Anti-Trump Rant Wi...	COLBERT LANGUAGE WARNING! This late night ho...	politics	May 2, 2017	0
7	South Korea's Moon asks Russia to continue sup...	VLADIVOSTOK, Russia (Reuters) - South Korean P...	worldnews	September 7, 2017	1
8	YOU'LL NEVER BELIEVE WHICH REPUBLICAN JUST CAL...	What kind of leader speaks like this? It s obv...	politics	Aug 27, 2015	0
9	Alabama Senate election winner due to be certi...	WASHINGTON (Reuters) - The outcome of Alabama'...	politicsNews	November 18, 2017	1
10	Trump slow to implement Russia, Iran, North Ko...	WASHINGTON (Reuters) - Two months after signin...	politicsNews	September 29, 2017	1
11	MUST READ: I'm Still Trying To Figure Out How ...	Once you ve read this list, you re going to wa...	left-news	Nov 17, 2017	0
12	U.S. voters deliver mixed results on gun contr...	NEW YORK (Reuters) - Voters rendered a split d...	politicsNews	November 8, 2016	1
13	How Trump's abrupt immigration ban sowed confu...	NEW YORK (Reuters) - After immigration agents ...	politicsNews	January 29, 2017	1
14	Zimbabwe's Mugabe speech was meant to sanitize...	HARARE (Reuters) - Zimbabwe President Robert M...	worldnews	November 20, 2017	1
15	About 30 killed when train derails, catches fi...	KINSHASA (Reuters) - About 30 people were kill...	worldnews	November 13, 2017	1
16	HOW A SIMPLE GLASS OF WATER Could Expose The T...	Every American needs to consider this new evid...	politics	Sep 6, 2016	0
17	THE SIMPSONS Destroy The Idiocy Of The Politic...	The setting for this episode is Yale Universit...	left-news	Apr 18, 2017	0
18	UNREAL! PRO-CUBA TRAVEL AT PBS AND NBC: "Cuba ...	BELOW ARE TWO EXAMPLES OF THE PRO-CUBA SENTIME...	left-news	May 5, 2016	0
19	Merkel settles migrant row with allies to purs...	BERLIN (Reuters) - German Chancellor Angela Me...	worldnews	October 8, 2017	1

In [18]:
```
df.shape
```

Out[18]:
```
(44898, 5)
```

Data Visualization.

In [19]:
```
plt.figure(figsize=(20,12))
sns.set(style = 'whitegrid', font_scale = 1.2)

sns.countplot(df['subject'], hue = df['label'])
plt.show()
```



Cleaning the text.

In [20]:
```
import re
from nltk.corpus import stopwords
from nltk.stem.porter import PorterStemmer
```

In [21]:
```
nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\Habeeb\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

Out[21]:
```
True
```

In [22]:
```
def clean_data(text):
    processed = re.sub('[^a-zA-Z0-9]', ' ' , text, flags = re.IGNORECASE)
    # We can use '\W' (non - alphanumeric character or non - word character) inst
    processed = processed.replace('  ', ' ')
    processed = processed.replace('   ', ' ')
    processed = processed.replace('    ', ' ')
    processed = processed.replace('u s', 'united states')
    #Convert into LowerCase.
    processed = processed.lower()

    #Stemming.
    '''ps = PorterStemmer()
    processed = processed.split()
    processed = [ps.stem(word) for word in processed if not word in set(stopwords
    '''
    return processed
```

In [23]:
```
df['title_processed'] = df['title'].apply(lambda x: clean_data(x))
df['text_processed'] = df['text'].apply(lambda x: clean_data(x))
```

Making a column named 'month'.

In [24]:
```
df['month'] = df['date'].apply(lambda mydate: re.findall('[a-zA-Z]{3,}', mydate)[
```

Taking only the first three letters of the month names.

In [25]:
```
df['month'] =df['month'].apply(lambda mymonth:  mymonth[:3])
```

In [26]:
```
df.head(2)
```

Out[26]:

	title	text	subject	date	label	title_processed	text_processed	month
0	China, Pakistan to look at including Afghanist...	BEIJING (Reuters) - China and Pakistan will lo...	worldnews	December 26, 2017	1	china pakistan to look at including afghanista...	beijing reuters china and pakistan will look ...	Dec
1	10 REASONS A VOTE RECOUNT Is A Really Bad Idea...	Watch Jill Stein explain why she s working to ...	left-news	Nov 27, 2016	0	10 reasons a vote recount is a really bad idea...	watch jill stein explain why she s working to ...	Nov

Part I: Using the Titles of the news for the

classification.

Get independent feature.

In [27]:
```
X = df['title_processed'].iloc[:].values
```

Get dependent feature.

In [28]:
```
y = df['label'].iloc[:].values
```

1. Using TFIDF vectorizer to get independent features.

In [29]:
```
from sklearn.feature_extraction.text import TfidfVectorizer as TFIDF
```

In [30]:
```
tfidf = TFIDF(stop_words= set(stopwords.words('english')),
              max_features=10000,
              ngram_range=(1,3))
```

In [31]:
```
X_vectorized = tfidf.fit_transform(X).toarray()
```

Train - Test split.

In [32]:
```
from sklearn.model_selection import train_test_split
```

In [33]:
```
X_train, X_test, y_train, y_test = train_test_split(X_vectorized, y, test_size =
```

1.a. Classification: Multinomial Bayes.

In [34]:
```
from sklearn.naive_bayes import MultinomialNB
classifier=MultinomialNB(alpha = 1.0)
```

In [35]:
```
classifier.fit(X_train, y_train)
```

Out[35]:
```
MultinomialNB()
```

In [36]:
```
predictions = classifier.predict(X_test)
```

Function: Confusion Matrix.

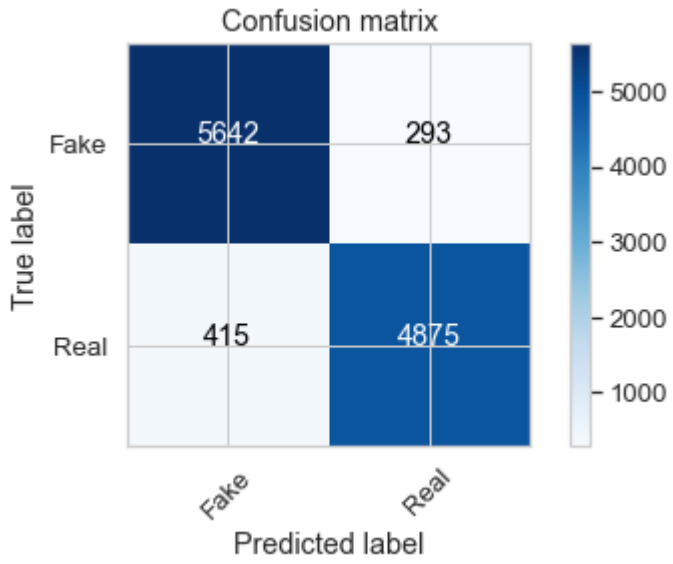
In [37]:
```
from sklearn import metrics
import itertools
```

In [38]:
```
def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):
    """
    See full source and example:
    http://scikit-learn.org/stable/auto_examples/model_selection/plot_confusion_m

    This function prints and plots the confusion matrix.
    Normalization can be applied by setting `normalize=True`.
    """
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized confusion matrix")
    else:
        print('Confusion matrix, without normalization')

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, cm[i, j],
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

In [39]:
```
cm = metrics.confusion_matrix(y_test, predictions)
```

In [40]:
```
plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



Accuracy Score:

In [41]:
```
def accuracy_check(print_values = True):
    if print_values == True:
        print('Accuracy (in %) = ',round(float(metrics.accuracy_score(y_test, pre
        print('ROC - AUC Score (in %) = ',round(float(metrics.roc_auc_score(y_tes
        print('F1 - Score (in %) = ',round(float(metrics.f1_score(y_test, predict

    '''acc_dict = dict()
    acc_dict['Accuracy Score'] = metrics.accuracy_score(y_test, predictions
    acc_dict['ROC - AUC Score'] = metrics.roc_auc_score(y_test, predictions)
    acc_dict['F1 - Score'] = metrics.f1_score(y_test, predictions) '''
    return (round(float(metrics.accuracy_score(y_test, predictions) ) *100, 2),
            round(float(metrics.roc_auc_score(y_test, predictions) ) *100, 2),
            round(float(metrics.f1_score(y_test, predictions) ) *100, 2)
           )
```

In [42]:
```
accuracy_check(True)
```

```
Accuracy (in %) =  93.69 %
ROC - AUC Score (in %) =  93.61 %
F1 - Score (in %) =  93.23 %
```

Out[42]: (93.69, 93.61, 93.23)

In [43]:
```
title_naive_bayes_tfidf = dict()
title_naive_bayes_tfidf['accuracy'], title_naive_bayes_tfidf['roc_auc'], title_na
```

1.b. Classification: Logistic Regression.

In [44]:
```
from sklearn.linear_model import LogisticRegression

classifier = LogisticRegression(C= 0.1)
```

In [45]:
```
classifier.fit(X_train, y_train)
```

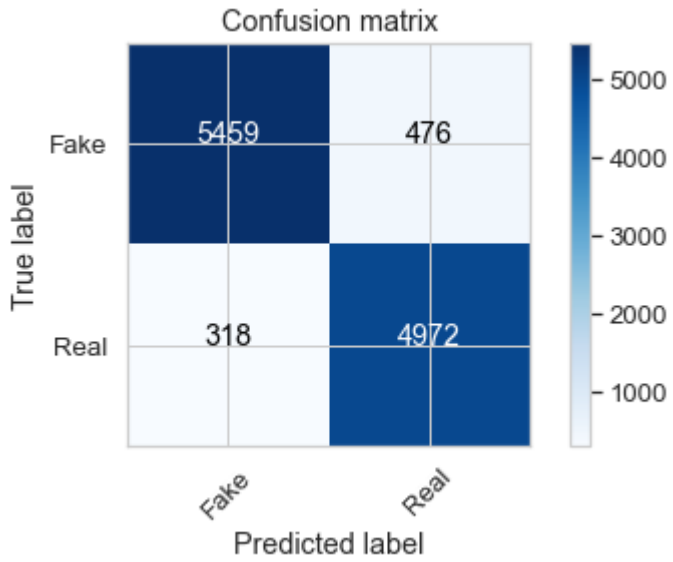
Out[45]: LogisticRegression(C=0.1)

In [46]:
```
predictions = classifier.predict(X_test)
```

Confusion Matrix.

In [47]:
```
cm = metrics.confusion_matrix(y_test, predictions)

plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



In [48]:
```
accuracy_check()
```

```
Accuracy (in %) =  92.93 %
ROC - AUC Score (in %) =  92.98 %
F1 - Score (in %) =  92.61 %
```

Out[48]:
```
(92.93, 92.98, 92.61)
```

In [49]:
```
title_log_reg_tfidf = dict()
title_log_reg_tfidf['accuracy'], title_log_reg_tfidf['roc_auc'], title_log_reg_tf
```

2. Using Count Vectorizer to get independent features.

In [50]:
```
from sklearn.feature_extraction.text import CountVectorizer as CV
```

In [51]:
```
cv = CV(stop_words= set(stopwords.words('english')),
                max_features=10000,
                ngram_range=(1,3))
```

In [52]:
```
X_vectorized = cv.fit_transform(X).toarray()
```

Train - Test split.

In [53]:
```
X_train, X_test, y_train, y_test = train_test_split(X_vectorized, y, test_size =
```

2.a. Classification: Multinomial Bayes.

In [104]:
```
from sklearn.naive_bayes import MultinomialNB
classifier=MultinomialNB(alpha = 1.0)
```

In [105]:
```
classifier.fit(X_train, y_train)
```

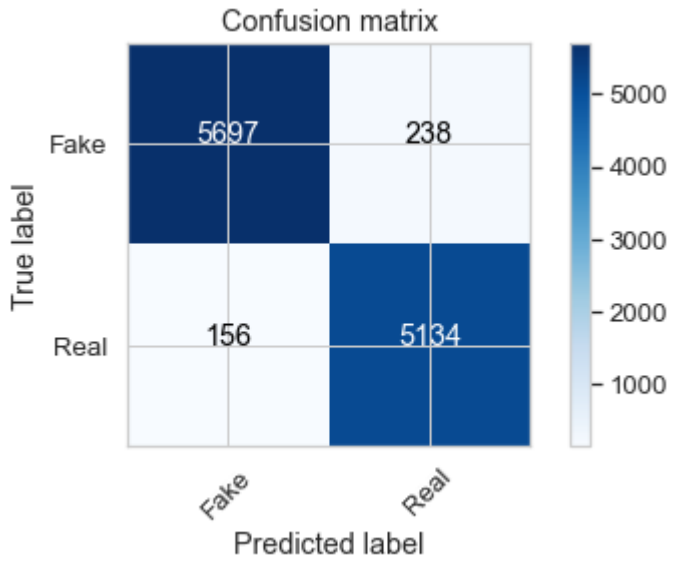
Out[105]:
```
MultinomialNB()
```

In [106]:
```
predictions = classifier.predict(X_test)
```

Confusion Matrix.

In [107]:
```
cm = metrics.confusion_matrix(y_test, predictions)

plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



In [108]:
```
accuracy_check()
```

```
Accuracy (in %) =  96.49 %
ROC - AUC Score (in %) =  96.52 %
F1 - Score (in %) =  96.3 %
```

Out[108]:
```
(96.49, 96.52, 96.3)
```

In [109]:
```
title_naive_bayes_cv = dict()
title_naive_bayes_cv['accuracy'], title_naive_bayes_cv['roc_auc'], title_naive_ba
```

2.b. Classification: Logistic Regression.

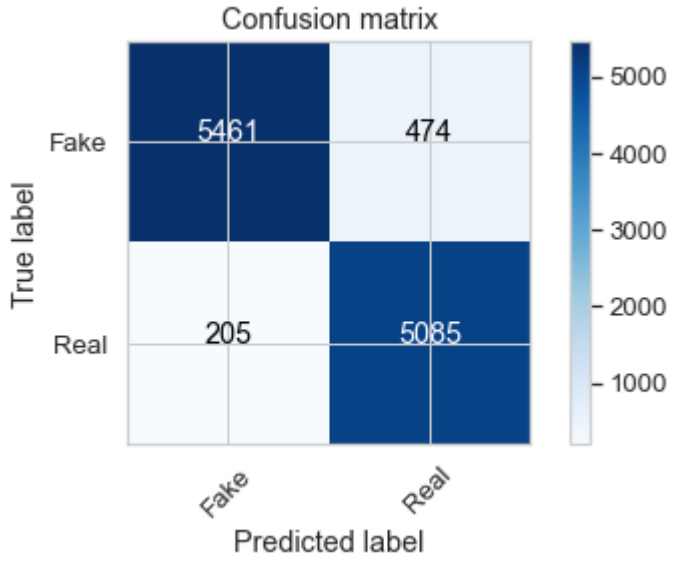
In [60]:
```
from sklearn.linear_model import LogisticRegression

classifier = LogisticRegression(C= 0.1)
```

In [61]:
```
classifier.fit(X_train, y_train)

predictions = classifier.predict(X_test)
```

Confusion Matrix.

In [62]:
```
cm = metrics.confusion_matrix(y_test, predictions)

plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



In [63]:
```
accuracy_check()
```

```
Accuracy (in %) =  93.95 %
ROC - AUC Score (in %) =  94.07 %
F1 - Score (in %) =  93.74 %
```

Out[63]:
```
(93.95, 94.07, 93.74)
```

In [64]:
```
title_log_reg_cv = dict()
title_log_reg_cv['accuracy'], title_log_reg_cv['roc_auc'], title_log_reg_cv['f1_s
```

Part II: Using the Text of the news for the classification.

Get independent feature.

In [65]:
```
X = df['text_processed'].iloc[:].values
```

Get dependent feature.

In [66]:
```
y = df['label'].iloc[:].values
```

1. Using TFIDF vectorizer to get independent features.

In [67]:
```
from sklearn.feature_extraction.text import TfidfVectorizer as TFIDF

tfidf = TFIDF(stop_words= set(stopwords.words('english')),
              max_features=10000,
              ngram_range=(1,3))
```

In [68]:
```
X_vectorized = tfidf.fit_transform(X).toarray()
```

Train - Test split.

In [69]:
```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X_vectorized, y, test_size =
```

1.a. Classification: Multinomial Bayes.

In [70]:
```
from sklearn.naive_bayes import MultinomialNB
classifier=MultinomialNB(alpha = 1.0)
```

In [71]:
```
classifier.fit(X_train, y_train)
```

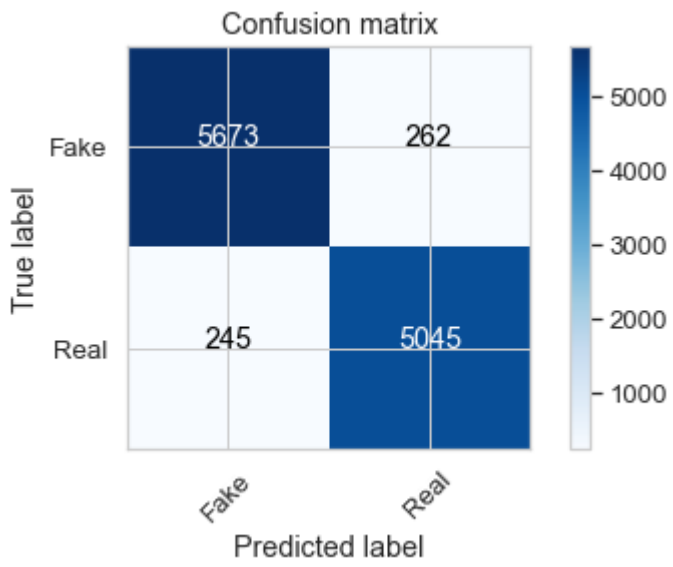
Out[71]:
```
MultinomialNB()
```

In [72]:
```
predictions = classifier.predict(X_test)
```

Confusion Matrix.

In [73]:
```
cm = metrics.confusion_matrix(y_test, predictions)

plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



Accuracy Score:

In [74]:
```
accuracy_check(True)
```

```
Accuracy (in %) =  95.48 %
ROC - AUC Score (in %) =  95.48 %
F1 - Score (in %) =  95.22 %
```

Out[74]:
```
(95.48, 95.48, 95.22)
```

In [75]:
```
text_naive_bayes_tfidf = dict()
text_naive_bayes_tfidf['accuracy'], text_naive_bayes_tfidf['roc_auc'], text_naive
```

1.b. Classification: Logistic Regression.

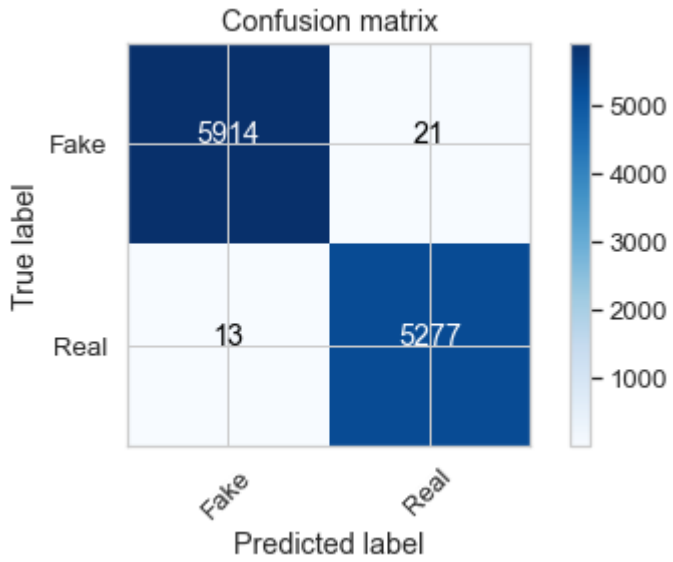
In [127]:
```
from sklearn.linear_model import LogisticRegression

classifier = LogisticRegression(C= 0.1)
```

In [128]:
```
classifier.fit(X_train, y_train)

predictions = classifier.predict(X_test)
```

Confusion Matrix.

In [129]:
```
cm = metrics.confusion_matrix(y_test, predictions)

plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



In [130]:
```
accuracy_check()
```

```
Accuracy (in %) =  99.7 %
ROC - AUC Score (in %) =  99.7 %
F1 - Score (in %) =  99.68 %
```

Out[130]:
```
(99.7, 99.7, 99.68)
```

In [131]:
```
text_log_reg_tfidf = dict()
text_log_reg_tfidf['accuracy'], text_log_reg_tfidf['roc_auc'], text_log_reg_tfidf
```

2. Using Count Vectorizer to get independent features.

In [81]:
```
from sklearn.feature_extraction.text import CountVectorizer as CV

cv = CV(stop_words= set(stopwords.words('english')),
              max_features=10000,
              ngram_range=(1,3))
```

In [82]:
```
X_vectorized = cv.fit_transform(X).toarray()
```

Train - Test split.

In [83]:
```
X_train, X_test, y_train, y_test = train_test_split(X_vectorized, y, test_size =
```

2.a. Classification: Multinomial Bayes.

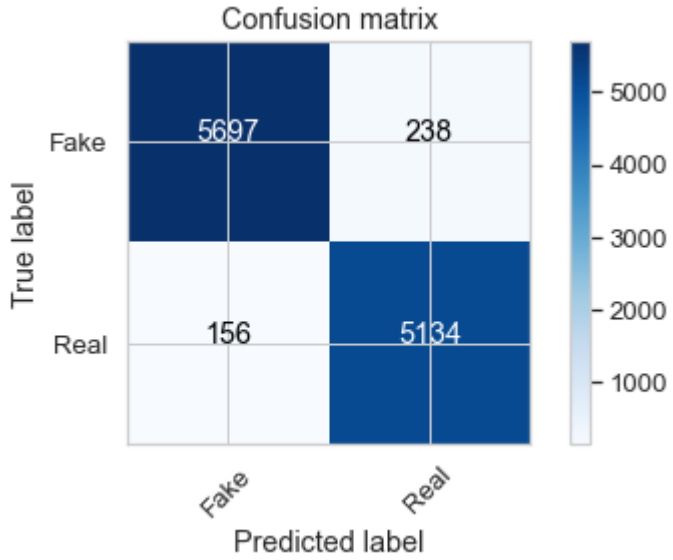
In [84]:
```
from sklearn.naive_bayes import MultinomialNB
classifier=MultinomialNB(alpha = 1.0)
```

In [85]:
```
classifier.fit(X_train, y_train)

predictions = classifier.predict(X_test)
```

Confusion Matrix.

In [86]:
```
cm = metrics.confusion_matrix(y_test, predictions)

plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



In [87]:
```
accuracy_check()
```

```
Accuracy (in %) =  96.49 %
ROC - AUC Score (in %) =  96.52 %
F1 - Score (in %) =  96.3 %
```

Out[87]: (96.49, 96.52, 96.3)

In [88]:
```
text_naive_bayes_cv = dict()
text_naive_bayes_cv['accuracy'], text_naive_bayes_cv['roc_auc'], text_naive_bayes
```

2.b. Classification: Logistic Regression.

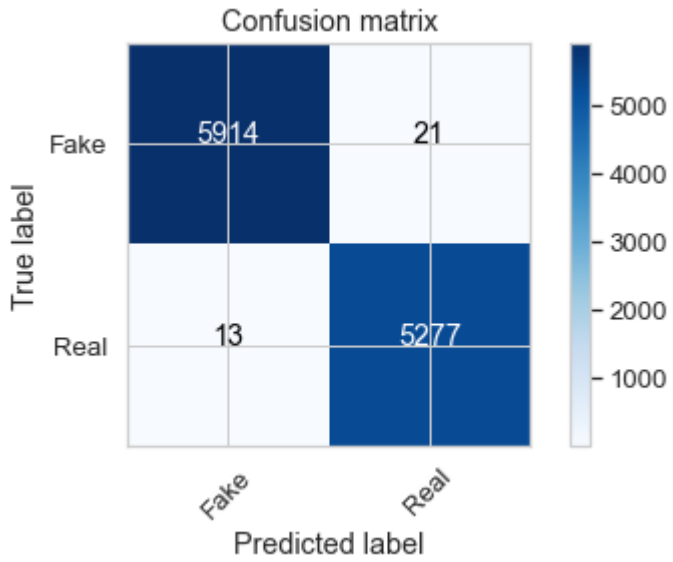
In [89]:
```
from sklearn.linear_model import LogisticRegression

classifier = LogisticRegression(C= 0.1)
```

In [90]:
```
classifier.fit(X_train, y_train)

predictions = classifier.predict(X_test)
```

Confusion Matrix.

In [91]:
```
cm = metrics.confusion_matrix(y_test, predictions)

plot_confusion_matrix(cm, classes=['Fake', 'Real'])
```

```
Confusion matrix, without normalization
```



In [92]:
```
accuracy_check()
```

```
Accuracy (in %) =  99.7 %
ROC - AUC Score (in %) =  99.7 %
F1 - Score (in %) =  99.68 %
```

Out[92]: (99.7, 99.7, 99.68)

In [93]:
```
text_log_reg_cv = dict()
text_log_reg_cv['accuracy'], text_log_reg_cv['roc_auc'], text_log_reg_cv['f1_scor
```

Summarizing the results.

I. Using TITLES.

In [113]:
```
summary_title_accuracy = pd.DataFrame({
    'TFIDF': [title_naive_bayes_tfidf['accuracy'], title_log_reg_tfidf['accuracy'
    'Count_Vectorizer': [title_naive_bayes_cv['accuracy'], title_log_reg_cv['accu
}, index=['Naive Bayes', 'Logistic Regression'])
```

In [114]:
```
summary_title_roc_auc = pd.DataFrame({
    'TFIDF': [title_naive_bayes_tfidf['roc_auc'], title_log_reg_tfidf['roc_auc']]
    'Count_Vectorizer': [title_naive_bayes_cv['roc_auc'], title_log_reg_cv['roc_a
}, index=['Naive Bayes', 'Logistic Regression'])
```

In [115]:
```
summary_title_f1_score = pd.DataFrame({
    'TFIDF': [title_naive_bayes_tfidf['f1_score'], title_log_reg_tfidf['f1_score'
    'Count_Vectorizer': [title_naive_bayes_cv['f1_score'], title_log_reg_cv['f1_s
}, index=['Naive Bayes', 'Logistic Regression'])
```

In [125]:
```
print('Accuracy using TITLES: \n')
print(summary_title_accuracy)
print('\n-------------------------------------\n')
print('ROC - AUC Score using TITLES: \n')
print(summary_title_roc_auc)
print('\n-------------------------------------\n')
print('F1 Score using TITLES: \n')
print(summary_title_f1_score)
print('\n-------------------------------------\n')
```

```
Accuracy using TITLES:

                     TFIDF  Count_Vectorizer
Naive Bayes          93.69             96.49
Logistic Regression  92.93             93.95

-------------------------------------

ROC - AUC Score using TITLES:

                     TFIDF  Count_Vectorizer
Naive Bayes          93.61             96.52
Logistic Regression  92.98             94.07

-------------------------------------

F1 Score using TITLES:

                     TFIDF  Count_Vectorizer
```

II. Using TEXTS.

In [132]:
```
summary_text_accuracy = pd.DataFrame({
    'TFIDF': [text_naive_bayes_tfidf['accuracy'], text_log_reg_tfidf['accuracy']]
    'Count_Vectorizer': [text_naive_bayes_cv['accuracy'], text_log_reg_cv['accura
}, index=['Naive Bayes', 'Logistic Regression'])

summary_text_roc_auc = pd.DataFrame({
    'TFIDF': [text_naive_bayes_tfidf['roc_auc'], text_log_reg_tfidf['roc_auc']],
    'Count_Vectorizer': [text_naive_bayes_cv['roc_auc'], text_log_reg_cv['roc_auc
}, index=['Naive Bayes', 'Logistic Regression'])

summary_text_f1_score = pd.DataFrame({
    'TFIDF': [text_naive_bayes_tfidf['f1_score'], text_log_reg_tfidf['f1_score']]
    'Count_Vectorizer': [text_naive_bayes_cv['f1_score'], text_log_reg_cv['f1_scc
}, index=['Naive Bayes', 'Logistic Regression'])
```

In [135]:
```
print('Accuracy using text: \n')
print(summary_text_accuracy)
print('\n-------------------------------------\n')
print('ROC - AUC Score using text: \n')
print(summary_text_roc_auc)
print('\n-------------------------------------\n')
print('F1 Score using text: \n')
print(summary_text_f1_score)
print('\n-------------------------------------\n')
```

```
Accuracy using text:

                     TFIDF  Count_Vectorizer
Naive Bayes          95.48             96.49
Logistic Regression  99.70             99.70

-------------------------------------

ROC - AUC Score using text:

                     TFIDF  Count_Vectorizer
Naive Bayes          95.48             96.52
Logistic Regression  99.70             99.70

-------------------------------------

F1 Score using text:

                     TFIDF  Count_Vectorizer
Naive Bayes          95.22             96.30
Logistic Regression  99.68             99.68

-------------------------------------
```

Logistic Regression using text gives the best results.

The End.