Sentiment Analysis of Tweets: Impossible Burger

Goals:

Part I: Visualize positive and negative tweets in word clouds

Part II: Use positive and negative tweets to train logistic regression machine learning model to predict positive/negative sentiments of more tweets

Import libraries

In [1]:
```
import re
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import string
import nltk
import warnings
warnings.filterwarnings("ignore", category=DeprecationWarning)

%matplotlib inline
```

Part I

Read in training set of tweets

In [2]:
```
train = pd.read_csv('final_impossible_text_training_tweets.csv')
```

In [3]:
```
train
```

Out[3]:

	url	date_and_time	tweet	tweet_id	reply_count	retweet_count	like_count	lang	negative	neutral	positive	compound	sentiment_label
0	https://twitter.com/Kkh291/status/140275690219...	2021-06-09 22:38:02	@me1stVegan2nd They have 2 make a smaller vers...	1402756902191210497	0	0	0	en	0.079	0.726	0.195	0.6249	0
1	https://twitter.com/VictoriaH1962/status/14027...	2021-06-09 22:37:37	@brooklin0000 @DavidMazzieAE @catfishyak Impos...	1402756797979582465	2	0	2	en	0.000	1.000	0.000	0.0000	0
2	https://twitter.com/NliteNinc2/status/14027525...	2021-06-09 22:20:39	@aminorjourney 😬 \n\nMake a fake hen out of Imp...	1402752527892766724	1	0	0	en	0.100	0.769	0.131	0.3612	0
3	https://twitter.com/SonidoMatinal/status/14027...	2021-06-09 22:19:59	🔔 Impossible Burger, la hamburguesa sin carne ...	1402752359986499584	0	0	0	ca	0.231	0.769	0.000	-0.5574	1
4	https://twitter.com/PanXchange/status/14027504...	2021-06-09 22:12:31	In case you missed our recent #blog post, chec...	1402750481257033731	0	1	0	en	0.099	0.901	0.000	-0.2960	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...
29995	https://twitter.com/e4rthmover/status/13057646...	2020-09-15 07:05:27	Loml is officially the impossible burger https...	1305764650080968704	0	0	0	en	0.000	1.000	0.000	0.0000	0
29996	https://twitter.com/edgesportnfit/status/13057...	2020-09-15 06:36:45	@michaelharriot Biggie Smalls doing remix vers...	1305757428101730304	0	0	0	en	0.000	1.000	0.000	0.0000	0
29997	https://twitter.com/cennsith/status/1305736363...	2020-09-15 05:13:03	@t_white_no12 You're a good dude tom, I promis...	1305736363388604417	1	0	0	en	0.000	0.794	0.206	0.8100	0
29998	https://twitter.com/fathueyfreeman/status/1305...	2020-09-15 05:12:02	i can get a impossible/turkey/chicken burger a...	1305736107347378176	0	0	0	en	0.000	0.841	0.159	0.2235	0
29999	https://twitter.com/Oinkpoolooenga/status/1305...	2020-09-15 05:05:34	@saqib_z @nsfwlilpisces @cryst6l I never said ...	1305734480225730561	1	0	0	en	0.038	0.908	0.054	-0.0387	1

30000 rows × 13 columns

In [4]:
```
train_original=train.copy()
```

Read in tweets for test set

In [5]:
```
test = pd.read_csv('impossible_text_training_tweets.csv', skiprows=range(1, 30001))
```

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

Out[6]:

	url	date_and_time	tweet	tweet_id	reply_count	retweet_count	like_count	lang
0	https://twitter.com/sucertamere/status/1305722...	2020-09-15 04:19:23	@Stardogkilledme Thoughts on the impossible bu...	1305722857654226945	0	0	0	en
1	https://twitter.com/chinchlady701/status/13057...	2020-09-15 03:59:43	@jasminelydia17 the thing is one place can hav...	1305717912125218816	0	0	2	en
2	https://twitter.com/coffieluvr/status/13057167...	2020-09-15 03:55:13	@syluwuv RIP WENDYS .. order an impossible bur...	1305716778207719425	0	0	0	en
3	https://twitter.com/BlobCostas/status/13057162...	2020-09-15 03:53:04	@nymillenials What the hell? I ordered an impo...	1305716237318545410	1	0	2	en
4	https://twitter.com/Kirra_Whatever_/status/130...	2020-09-15 03:35:57	the lady at burger king just asked me if i wan...	1305711929219055618	0	0	1	en

In [7]:
```
test_original=test.copy()
```

Save test set of tweets (to be used in part II)

In [8]:
```
test_original.to_csv('test_tweets.csv', index=False)
```

Combine training set and test set

In [9]:
```
combine = train.append(test,ignore_index=True)
```

In [10]:
```
combine
```

Out[10]:

	url	date_and_time	tweet	tweet_id	reply_count	retweet_count	like_count	lang	negative	neutral	positive	compound	sentiment_label
0	https://twitter.com/Kkh291/status/140275690219...	2021-06-09 22:38:02	@me1stVegan2nd They have 2 make a smaller vers...	1402756902191210497	0	0	0	en	0.079	0.726	0.195	0.6249	0.0
1	https://twitter.com/VictoriaH1962/status/14027...	2021-06-09 22:37:37	@brooklin0000 @DavidMazzieAE @catfishyak Impos...	1402756797979582465	2	0	2	en	0.000	1.000	0.000	0.0000	0.0
2	https://twitter.com/NliteNinc2/status/14027525...	2021-06-09 22:20:39	@aminorjourney 😬 \n\nMake a fake hen out of Imp...	1402752527892766724	1	0	0	en	0.100	0.769	0.131	0.3612	0.0
3	https://twitter.com/SonidoMatinal/status/14027...	2021-06-09 22:19:59	🔔 Impossible Burger, la hamburguesa sin carne ...	1402752359986499584	0	0	0	ca	0.231	0.769	0.000	-0.5574	1.0
4	https://twitter.com/PanXchange/status/14027504...	2021-06-09 22:12:31	In case you missed our recent #blog post, chec...	1402750481257033731	0	1	0	en	0.099	0.901	0.000	-0.2960	1.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
39994	https://twitter.com/DerQuotenossi/status/14027...	2021-06-09 22:56:14	@maulendemiri ihre Impossible Burger werden au...	1402761483759624192	1	0	1	de	NaN	NaN	NaN	NaN	NaN
39995	https://twitter.com/estebanjq3/status/14027590...	2021-06-09 22:46:24	@thehauer Like an impossible burger?	1402759010479181827	1	0	1	en	NaN	NaN	NaN	NaN	NaN
39996	https://twitter.com/WilmaDickfit6/status/14027...	2021-06-09 22:45:24	@cerebralsymphoy @AnimalJustice6 @AlanAlan5240...	1402758758716092419	0	0	0	en	NaN	NaN	NaN	NaN	NaN
39997	https://twitter.com/xiancommie/status/14027585...	2021-06-09 22:44:24	@TheAmberPicota Yeah, I was pretty impressed b...	1402758505627455488	1	0	1	en	NaN	NaN	NaN	NaN	NaN
39998	https://twitter.com/TheAmberPicota/status/1402...	2021-06-09 22:40:07	The main thing I love about eating vegan is th...	1402757429616648199	3	0	13	en	NaN	NaN	NaN	NaN	NaN

39999 rows × 13 columns

Remove Twitter handles

In [11]:
```
def remove_pattern(text,pattern):

    r = re.findall(pattern,text)

    for i in r:
        text = re.sub(i,"",text)

    return text
```

In [12]:
```
combine['Tidy_Tweets'] = np.vectorize(remove_pattern)(combine['tweet'], "@[\w]*")
```

Remove punctuation, numbers, special characters

In [13]:
```
combine['Tidy_Tweets'] = combine['Tidy_Tweets'].str.replace("[^a-zA-Z#]", " ")
```

...

Remove short words

In [14]:
```
combine['Tidy_Tweets'] = combine['Tidy_Tweets'].apply(lambda x: ' '.join([w for w in x.split() if len(w)>3]))
```

Tokenize tweets

In [15]:
```
tokenized_tweet = combine['Tidy_Tweets'].apply(lambda x: x.split())
```

Stem tweets

In [16]:
```
from nltk import PorterStemmer
ps = PorterStemmer()
```

In [17]:
```
tokenized_tweet = tokenized_tweet.apply(lambda x: [ps.stem(i) for i in x])
```

Recombine tokens

In [18]:
```
for i in range(len(tokenized_tweet)):
    tokenized_tweet[i] = ' '.join(tokenized_tweet[i])
```

In [19]:
```
combine['Tidy_Tweets'] = tokenized_tweet
```

Tidy Tweets

In [20]:
```
combine
```

Out[20]:

	url	date_and_time	tweet	tweet_id	reply_count	retweet_count	like_count	lang	negative	neutral	positive	compound	sentiment_label	Tidy_Tweets
0	https://twitter.com/Kkh291/status/140275690219...	2021-06-09 22:38:02	@me1stVegan2nd They have 2 make a smaller vers...	1402756902191210497	0	0	0	en	0.079	0.726	0.195	0.6249	0.0	they have make smaller version imposs burger s...
1	https://twitter.com/VictoriaH1962/status/14027...	2021-06-09 22:37:37	@brooklin0000 @DavidMazzieAE @catfishyak Impos...	1402756797979582465	2	0	2	en	0.000	1.000	0.000	0.0000	0.0	imposs burger
2	https://twitter.com/NliteNinc2/status/14027525...	2021-06-09 22:20:39	@aminorjourney 😁\n\nMake a fake hen out of Imp...	1402752527892766724	1	0	0	en	0.100	0.769	0.131	0.3612	0.0	make fake imposs burger meat coyot goe chicken...
3	https://twitter.com/SonidoMatinal/status/14027...	2021-06-09 22:19:59	🔔 Impossible Burger, la hamburguesa sin carne ...	1402752359986499584	0	0	0	ca	0.231	0.769	0.000	-0.5574	1.0	imposs burger hamburguesa carn creada laborato...
4	https://twitter.com/PanXchange/status/14027504...	2021-06-09 22:12:31	In case you missed our recent #blog post, chec...	1402750481257033731	0	1	0	en	0.099	0.901	0.000	-0.2960	1.0	case miss recent #blog post check #hemp probab...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
39994	https://twitter.com/DerQuotenossi/status/14027...	2021-06-09 22:56:14	@maulendemiri ihre Impossible Burger werden au...	1402761483759624192	1	0	1	de	NaN	NaN	NaN	NaN	NaN	ihr imposs burger werden selben grill rinderbu...
39995	https://twitter.com/estebanjq3/status/14027590...	2021-06-09 22:46:24	@thehauer Like an impossible burger?	1402759010479181827	1	0	1	en	NaN	NaN	NaN	NaN	NaN	like imposs burger
39996	https://twitter.com/WilmaDickfit6/status/14027...	2021-06-09 22:45:24	@cerebralsymphoy @AnimalJustice6 @AlanAlan5240...	1402758758716092419	0	0	0	en	NaN	NaN	NaN	NaN	NaN	should backsid honey look like imposs burger p...
39997	https://twitter.com/xiancommie/status/14027585...	2021-06-09 22:44:24	@TheAmberPicota Yeah, I was pretty impressed b...	1402758505627455488	1	0	1	en	NaN	NaN	NaN	NaN	NaN	yeah pretti impress their imposs burger
39998	https://twitter.com/TheAmberPicota/status/1402...	2021-06-09 22:40:07	The main thing I love about eating vegan is th...	1402757429616648199	3	0	13	en	NaN	NaN	NaN	NaN	NaN	main thing love about eat vegan that give damn...

39999 rows × 14 columns

In [21]:
```
from wordcloud import WordCloud
from PIL import Image
import urllib
import requests
```

In [22]:
```
stopwords = ['imposs burger', 'imposs', 'burger', 'beyond', 'beyond burger', 'http', 'thi', 'carn', 'that', 'hamburguesa', 'impossibleburg', 'tri', 'they']
```

Create word cloud of tweets with positive compound sentiment

In [23]:
```
all_words_positive = ' '.join(text for text in combine['Tidy_Tweets'][combine['compound']>0])
```

In [24]:
```
wc_positive = WordCloud(background_color='white', height=1500, width=4000, stopwords=stopwords).generate(all_words_positive)
```

In [25]:
```
plt.figure(figsize=(50,50))
plt.imshow(wc_positive)
plt.axis('off')
plt.show()
```

In [26]:
```
wc_positive.to_file('impossible_wc_positive.png')
```

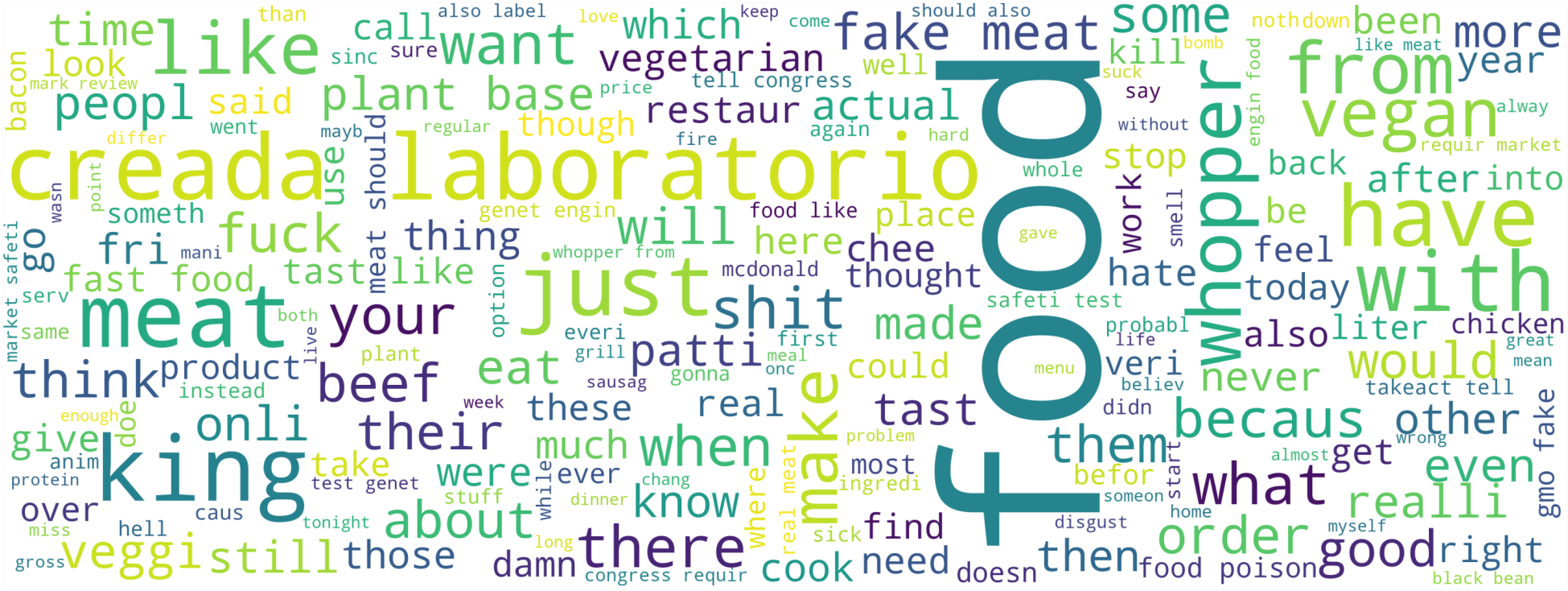
Out[26]:
```
<wordcloud.wordcloud.WordCloud at 0x7fa0586a8970>
```

Create word cloud of tweets with negative compound sentiment

In [27]:
```
all_words_negative = ' '.join(text for text in combine['Tidy_Tweets'][combine['compound']<0])
```

In [28]:
```
wc_negative = WordCloud(background_color='white', height=1500, width=4000, stopwords=stopwords).generate(all_words_negative)
```

In [29]:
```
plt.figure(figsize=(50,50))
plt.imshow(wc_negative)
plt.axis('off')
plt.show()
```



In [30]:
```
wc_negative.to_file('impossible_wc_negative.png')
```

Out[30]:
```
<wordcloud.wordcloud.WordCloud at 0x7fa0415c9460>
```

In [31]:
```
def Hashtags_Extract(x):
    hashtags=[]

    for i in x:
        ht = re.findall(r'#(\w+)',i)
        hashtags.append(ht)

    return hashtags
```

Extract hashtags from tweets with positive compound sentiment

In [32]:
```
ht_positive = Hashtags_Extract(combine['Tidy_Tweets'][combine['compound']>0])
```

In [33]:
```
ht_positive
```

Out[33]:
```
[[],
 [],
 [],
 ['imposs', 'burger', 'myownrecip'],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
```

In [34]:
```
ht_positive_unnest = sum(ht_positive,[])
```

In [35]:
```
ht_positive_unnest
```

Out[35]:
```
['imposs',
 'burger',
 'myownrecip',
 'shitamdavadeat',
 'quantumburg',
 'crueltyfre',
 'helpmehelpy',
 'burgerk',
 'impossibleburg',
 'eatdantanna',
 'burger',
 'veganburg',
 'atlvegan',
 'atlantavegan',
 'atlvegan',
 'impossiblefood',
 'plantbas',
 'vegan',
 'whopper',
```

Extract hashtags from tweets with negative compound sentiment

In [36]:
```
ht_negative = Hashtags_Extract(combine['Tidy_Tweets'][combine['compound']<0])
```

In [37]:
```
1 ht_negative
```

Out[37]:
```
[[],
 ['blog', 'hemp', 'impossibleburg'],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
```

In [38]:
```
1 ht_negative_unnest = sum(ht_negative,[])
```

In [39]:
```
1 ht_negative_unnest
```

Out[39]:
```
['blog',
 'hemp',
 'impossibleburg',
 'burgerk',
 'impossibleburg',
 'impossibleburg',
 'burger',
 'food',
 'impossibleburg',
 'artoftheburg',
 'themetropolitianmuseum',
 'themetro',
 'dupontcircl',
 'willheeverreturn',
 'doghau',
 'burgerk',
 'mcdonald',
 'maggi',
 'noodl',
```

Frequency of hashtags from tweets with positive compound sentiment

In [40]:
```
1 word_freq_positive = nltk.FreqDist(ht_positive_unnest)
```

In [41]:
```
1 word_freq_positive
```

Out[41]:
```
FreqDist({'impossibleburg': 469, 'vegan': 138, 'plantbas': 93, 'burger': 73, 'imposs': 52, 'vegetarian': 50, 'podcast': 48, 'marri': 48, 'chat': 48, 'life': 48, ...})
```

In [42]:
```
1 df_positive = pd.DataFrame({'Hashtags':list(word_freq_positive.keys()),'Count':list(word_freq_positive.values())})
```

In [43]:
```
1 sorted_df_positive = df_positive.sort_values(by='Count', ascending=False)
```

In [44]:
```
sorted_df_positive
```

Out[44]:

	Hashtags	Count
8	impossibleburg	469
15	vegan	138
14	plantbas	93
1	burger	73
0	imposs	52
...	...	...
583	makingmemori	1
582	bt	1
581	mothersday	1
580	veganfoodi	1
1481	cancelledaf	1

1482 rows × 2 columns

Frequency of hashtags from tweets with negative compound sentiment

In [45]:
```
word_freq_negative = nltk.FreqDist(ht_negative_unnest)
```

In [46]:
```
word_freq_negative
```

Out[46]:
```
FreqDist({'gmo': 108, 'impossibleburg': 93, 'vegan': 40, 'plantbas': 23, 'wewereher': 19, 'takeact': 17, 'burger': 14, 'vegetarian': 14, 'burgerk': 11, 'imposs': 10, ...})
```

In [47]:
```
df_negative = pd.DataFrame({'Hashtags':list(word_freq_negative.keys()),'Count':list(word_freq_negative.values())})
```

In [48]:
```
sorted_df_negative = df_negative.sort_values(by='Count', ascending=False)
```

In [49]:
```
sorted_df_negative
```

Out[49]:

	Hashtags	Count
84	gmo	108
2	impossibleburg	93
49	vegan	40
40	plantbas	23
399	wewereher	19
...	...	...
181	radio	1
180	dotheimpossibledav	1
179	burnvegan	1
178	supercarnivor	1
500	realfood	1

501 rows × 2 columns

In [50]:
```
import dataframe_image as dfi
```

In [51]:
```
dfi.export(sorted_df_positive, 'impossible_df_positive.png', max_rows=30)
```

In [52]:
```
dfi.export(sorted_df_negative, 'impossible_df_negative.png', max_rows=30)
```

Part II

Create bag-of-words feature matrix

In [53]:
```
from sklearn.feature_extraction.text import CountVectorizer
```

In [54]:
```
bow_vectorizer = CountVectorizer(max_df=0.90, min_df=2, max_features=1000, stop_words='english')
```

In [55]:
```
bow = bow_vectorizer.fit_transform(combine['Tidy_Tweets'])
```

In [56]:
```
df_bow = pd.DataFrame(bow.todense())
df_bow
```

Out[56]:

	0	1	2	3	4	5	6	7	8	9	...	990	991	992	993	994	995	996	997	998	999
0	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
39994	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
39995	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
39996	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
39997	0	0	0	0	0	0	0	0	0	0	...	0	0	0	1	0	0	0	0	0	0
39998	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0

39999 rows × 1000 columns

Create TF-IDF feature matrix

In [57]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
```

In [58]:
```
tfidf=TfidfVectorizer(max_df=0.90, min_df=2,max_features=1000,stop_words='english')
```

In [59]:
```
tfidf_matrix=tfidf.fit_transform(combine['Tidy_Tweets'])
```

In [60]:
```
df_tfidf = pd.DataFrame(tfidf_matrix.todense())
df_tfidf
```

Out[60]:

	0	1	2	3	4	5	6	7	8	9	...	990	991	992	993	994	995	996	997	998	999
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
39994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
39995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
39996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0
39997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.559408	0.0	0.0	0.0	0.0	0.0	0.0
39998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	0.0

39999 rows × 1000 columns

Split into training set and validation set

In [61]:
```
train_bow = bow[:30000]
train_bow.todense()
```

Out[61]:
```
matrix([[0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        ...,
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0]])
```

In [62]:
```
train_tfidf_matrix = tfidf_matrix[:30000]
train_tfidf_matrix.todense()
```

Out[62]:
```
matrix([[0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        ...,
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.]])
```

In [63]:
```
from sklearn.model_selection import train_test_split
```

In [64]:
```
x_train_bow, x_valid_bow, y_train_bow, y_valid_bow = train_test_split(train_bow,train['sentiment_label'],test_size=0.3,random_state=2)
```

In [65]:
```
x_train_tfidf, x_valid_tfidf, y_train_tfidf, y_valid_tfidf = train_test_split(train_tfidf_matrix,train['sentiment_label'],test_size=0.3,random_state=17)
```

Import F1 score to assess performance of machine learning models

In [66]:
```
from sklearn.metrics import f1_score
```

Part II: Logistic Regression

In [67]:
```
from sklearn.linear_model import LogisticRegression
```

In [68]:
```
Log_Reg = LogisticRegression(random_state=0,solver='lbfgs')
```

Fit model with bag-of-words features

In [69]:
```
Log_Reg.fit(x_train_bow, y_train_bow)
```

...

Predict probabilities of tweets having positive or negative classification for bag-of-words features

In [70]:
```
prediction_bow = Log_Reg.predict_proba(x_valid_bow)
prediction_bow
```

Out[70]:
```
array([[0.9863071 , 0.0136929 ],
       [0.90353362, 0.09646638],
       [0.8484917 , 0.1515083 ],
       ...,
       [0.96049171, 0.03950829],
       [0.56915717, 0.43084283],
       [0.94526566, 0.05473434]])
```

In [71]:
```
prediction_int = prediction_bow[:,1]>=0.3
```

In [72]:
```
prediction_int = prediction_int.astype(np.int)
prediction_int
```

Out[72]:
```
array([0, 0, 0, ..., 0, 1, 0])
```

F1 score for bag-of-words features

In [73]:
```
log_bow = f1_score(y_valid_bow, prediction_int)
log_bow
```

Out[73]:
```
0.6493894841764266
```

Fit model with TF-IDF features

In [74]:
```
Log_Reg.fit(x_train_tfidf,y_train_tfidf)
```

Out[74]:
```
LogisticRegression(random_state=0)
```

Predict probabilities of tweets having positive or negative classification for TF-IDF features

In [75]:
```
prediction_tfidf = Log_Reg.predict_proba(x_valid_tfidf)
prediction_tfidf
```

Out[75]:
```
array([[0.71125541, 0.28874459],
       [0.84980344, 0.15019656],
       [0.86254584, 0.13745416],
       ...,
       [0.96874022, 0.03125978],
       [0.442632  , 0.557368  ],
       [0.45972733, 0.54027267]])
```

In [76]:
```
prediction_int = prediction_tfidf[:,1]>=0.3
```

In [77]:
```
prediction_int = prediction_int.astype(np.int)
prediction_int
```

Out[77]:
```
array([0, 0, 0, ..., 0, 1, 1])
```

F1 score for TF-IDF features

In [78]:
```
log_tfidf = f1_score(y_valid_tfidf, prediction_int)
log_tfidf
```

Out[78]: 0.6655129789864029

Part II: XGBoost

In [84]:
```
from xgboost import XGBClassifier
```

Fit model with bag-of-words features

In [85]:
```
model_bow = XGBClassifier(random_state=22,learning_rate=0.9)
```

In [86]:
```
model_bow.fit(x_train_bow, y_train_bow)
```

...

Predict probabilities of tweets having positive or negative classification for bag-of-words features

In [87]:
```
xgb = model_bow.predict_proba(x_valid_bow)
xgb
```

Out[87]:
```
array([[0.9906486 , 0.00935134],
       [0.98487866, 0.01512134],
       [0.9166703 , 0.08332965],
       ...,
       [0.971484  , 0.02851602],
       [0.44976425, 0.55023575],
       [0.9542348 , 0.04576521]], dtype=float32)
```

In [88]:
```
xgb=xgb[:,1]>=0.3
```

In [89]:
```
xgb_int=xgb.astype(np.int)
```

F1 score for bag-of-words features

In [90]:
```
xgb_bow=f1_score(y_valid_bow,xgb_int)
xgb_bow
```

Out[90]: 0.63905325443787

Fit model with TF-IDF features

In [91]:
```
model_tfidf = XGBClassifier(random_state=29,learning_rate=0.7)
```

In [92]:
```
model_tfidf.fit(x_train_tfidf, y_train_tfidf)
```

...

Predict probabilities of tweets having positive or negative classification for TF-IDF features

In [93]:
```
xgb_tfidf=model_tfidf.predict_proba(x_valid_tfidf)
xgb_tfidf
```

Out[93]:
```
array([[0.81401116, 0.18598883],
       [0.8624071 , 0.13759291],
       [0.8798419 , 0.1201581 ],
       ...,
       [0.9726147 , 0.02738531],
       [0.10355604, 0.89644396],
       [0.54655373, 0.4534463 ]], dtype=float32)
```

In [94]:
```
xgb_tfidf=xgb_tfidf[:,1]>=0.3
```

In [95]:
```
xgb_int_tfidf=xgb_tfidf.astype(np.int)
```

F1 score for TF-IDF features

In [96]:
```
score=f1_score(y_valid_tfidf,xgb_int_tfidf)
score
```

Out[96]:
```
0.6396682117589656
```

Part II: Decision Trees

In [97]:
```
from sklearn.tree import DecisionTreeClassifier
dct = DecisionTreeClassifier(criterion='entropy', random_state=1)
```

Fit model with bag-of-words features

In [98]:
```
dct.fit(x_train_bow,y_train_bow)
```

Out[98]:
```
DecisionTreeClassifier(criterion='entropy', random_state=1)
```

Predict probabilities of tweets having positive or negative classification for bag-of-words features

In [99]:
```
dct_bow = dct.predict_proba(x_valid_bow)
dct_bow
```

Out[99]:
```
array([[1., 0.],
       [1., 0.],
       [1., 0.],
       ...,
       [1., 0.],
       [0., 1.],
       [1., 0.]])
```

In [100]:
```
dct_bow=dct_bow[:,1]>=0.3
```

In [101]:
```
dct_int_bow=dct_bow.astype(np.int)
```

F1 score for bag-of-words features

In [102]:
```
dct_score_bow=f1_score(y_valid_bow,dct_int_bow)
dct_score_bow
```

Out[102]:
```
0.5555813413785101
```

Fit model with TF-IDF

In [103]:
```
dct.fit(x_train_tfidf,y_train_tfidf)
```

Out[103]:
```
DecisionTreeClassifier(criterion='entropy', random_state=1)
```

Predict probabilities of tweets having positive or negative classification for TF-IDF features

In [104]:
```
dct_tfidf = dct.predict_proba(x_valid_tfidf)
dct_tfidf
```

Out[104]:
```
array([[1.        , 0.        ],
       [1.        , 0.        ],
       [0.92893924, 0.07106076],
       ...,
       [1.        , 0.        ],
       [0.        , 1.        ],
       [0.        , 1.        ]])
```

In [105]:
```
dct_tfidf=dct_tfidf[:,1]>=0.3
```

In [106]:
```
dct_int_tfidf=dct_tfidf.astype(np.int)
```

F1 score for TF-IDF features

In [107]:
```
dct_score_tfidf=f1_score(y_valid_tfidf,dct_int_tfidf)
dct_score_tfidf
```

Out[107]:
```
0.573525813555175
```

Part II: Model Comparison

In [108]:
```
Algo_1 = ['LogisticRegression(Bag-of-Words)','XGBoost(Bag-of-Words)','DecisionTree(Bag-of-Words)']
```

In [109]:
```
score_1 = [log_bow,xgb_bow,dct_score_bow]
```

In [110]:
```
compare_1 = pd.DataFrame({'Model':Algo_1,'F1_Score':score_1},index=[i for i in range(1,4)])
```

F1 score of different models using bag-of-words features

In [111]:
```
compare_1.T
```

Out[111]:

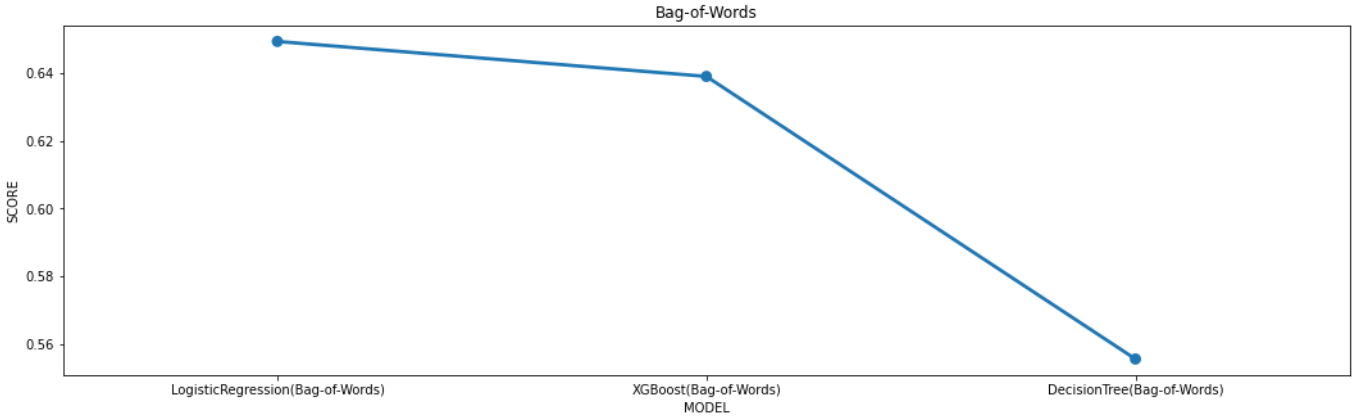
	1	2	3
Model	LogisticRegression(Bag-of-Words)	XGBoost(Bag-of-Words)	DecisionTree(Bag-of-Words)
F1_Score	0.649389	0.639053	0.555581

In [112]:
```
plt.figure(figsize=(18,5))

sns.pointplot(x='Model',y='F1_Score',data=compare_1)

plt.title('Bag-of-Words')
plt.xlabel('MODEL')
plt.ylabel('SCORE')

plt.show()
```



In [113]:
```
Algo_2 = ['LogisticRegression(TF-IDF)','XGBoost(TF-IDF)','DecisionTree(TF-IDF)']
```

In [114]:
```
score_2 = [log_tfidf,score,dct_score_tfidf]
```

In [115]:
```
compare_2 = pd.DataFrame({'Model':Algo_2,'F1_Score':score_2},index=[i for i in range(1,4)])
```

F1 score of different models using TF-IDF features

In [116]:
```
compare_2.T
```

Out[116]:

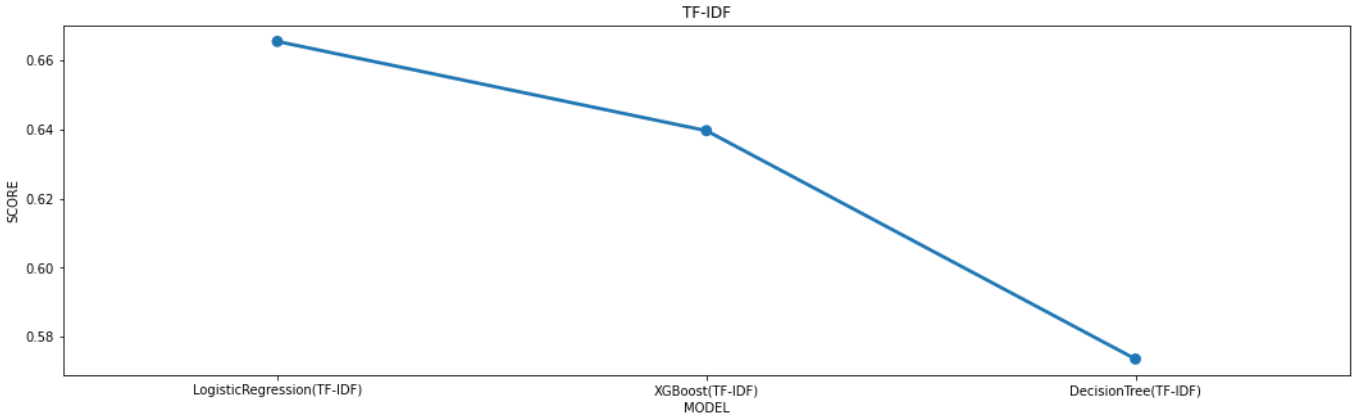
	1	2	3
Model	LogisticRegression(TF-IDF)	XGBoost(TF-IDF)	DecisionTree(TF-IDF)
F1_Score	0.665513	0.639668	0.573526

In [117]:
```
plt.figure(figsize=(18,5))

sns.pointplot(x='Model',y='F1_Score',data=compare_2)

plt.title('TF-IDF')
plt.xlabel('MODEL')
plt.ylabel('SCORE')

plt.show()
```



In [118]:
```
Algo_best = ['LogisticRegression(Bag-of-Words)','LogisticRegression(TF-IDF)']
```

In [119]:
```
score_best = [log_bow,log_tfidf]
```

In [120]:
```
compare_best = pd.DataFrame({'Model':Algo_best,'F1_Score':score_best},index=[i for i in range(1,3)])
```

Compare logistic regression F1 scores for bag-of-words and TF-IDF features

In [121]:
```
compare_best.T
```

Out[121]:

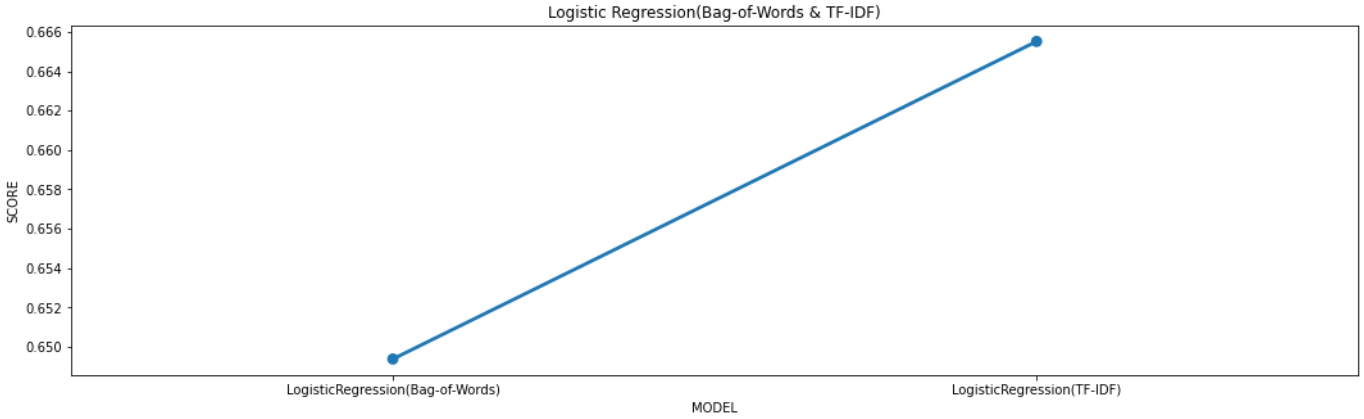
	1	2
Model	LogisticRegression(Bag-of-Words)	LogisticRegression(TF-IDF)
F1_Score	0.649389	0.665513

In [122]:
```
plt.figure(figsize=(18,5))

sns.pointplot(x='Model',y='F1_Score',data=compare_best)

plt.title('Logistic Regression(Bag-of-Words & TF-IDF)')
plt.xlabel('MODEL')
plt.ylabel('SCORE')

plt.show()
```



Part II: Predict results of test data via logisitic regression model using TF-IDF features

In [123]:
```
test_tfidf = tfidf_matrix[30000:]
```

In [124]:
```
test_pred = Log_Reg.predict_proba(test_tfidf)
```

In [125]:
```
test_pred_int = test_pred[:,1] >= 0.3
```

In [126]:
```
test_pred_int = test_pred_int.astype(np.int)
```

In [127]:
```
test['label'] = test_pred_int
```

In [129]:
```
submission = test[['tweet','label']]
```

In [130]:
```
submission.to_csv('result.csv', index=False)
```

In [131]:
```
res = pd.read_csv('result.csv')
res
```

Out[131]:

	tweet	label
0	@Stardogkilledme Thoughts on the impossible bu...	0
1	@jasminelydia17 the thing is one place can hav...	0
2	@syluwuv RIP WENDYS .. order an impossible bur...	0
3	@nymillenials What the hell? I ordered an impo...	1
4	the lady at burger king just asked me if i wan...	0
...	...	...
9994	@maulendemiri ihre Impossible Burger werden au...	0
9995	@thehauer Like an impossible burger?	0
9996	@cerebralsymphoy @AnimalJustice6 @AlanAlan5240...	0
9997	@TheAmberPicota Yeah, I was pretty impressed b...	0
9998	The main thing I love about eating vegan is th...	0

9999 rows × 2 columns