Sentiment Analysis of Tweets: Beyond 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 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_beyond_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/libraryjogirl/status/14357...	2021-09-08 23:57:23	@AWCanada Hi A&W! I'm seeing commercials f...	1435754169965613057	1	0	0	en	0.000	0.912	0.088	0.4738	0
1	https://twitter.com/eliseelara/status/14357513...	2021-09-08 23:46:04	their supreme sauce?!? THEIR SEASONED FRIES?!?...	1435751320439361543	0	0	0	en	0.097	0.723	0.180	0.5615	0
2	https://twitter.com/t_kelly15/status/143574800...	2021-09-08 23:32:53	Someone accidentally sent their A&W dinner...	1435748002925326336	1	0	5	en	0.130	0.870	0.000	-0.5859	1
3	https://twitter.com/marlenemdiaz08/status/1435...	2021-09-08 23:24:47	Like beyond nasty for a fast food joint. No ke...	1435745963189014532	0	0	0	en	0.242	0.690	0.067	-0.9083	1
4	https://twitter.com/divinaxo/status/1425869375...	2021-08-12 17:18:45	Beyond burger 😊😊😊 https://t.co/eiqlclnsnQ	1425869375941267463	0	1	1	en	0.000	1.000	0.000	0.0000	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
29995	https://twitter.com/_HiZel_/status/13277190531...	2020-11-14 21:04:24	Tell me why I called a Beyond burger an Infini...	1327719053171933184	0	0	7	en	0.000	1.000	0.000	0.0000	0
29996	https://twitter.com/400lez/status/132771789520...	2020-11-14 20:59:48	feel like absolute garbage. just want a beyond...	1327717895208460288	0	0	5	en	0.000	0.648	0.352	0.4215	0
29997	https://twitter.com/njroute22/status/132771443...	2020-11-14 20:46:03	More Reasons to Avoid Beyond Meat Fake Food ht...	1327714432378695683	0	0	0	en	0.218	0.782	0.000	-0.8865	1
29998	https://twitter.com/aviosAdventurer/status/132...	2020-11-14 20:40:46	@GazRich88 I'm trying to get my hands on some ...	1327713105720336385	1	0	1	en	0.000	0.870	0.130	0.6369	0
29999	https://twitter.com/ReginaBanali/status/132771...	2020-11-14 20:30:14	Beyond Meat Reveals It Is Behind the McDonald'...	1327710455666790401	0	0	0	en	0.000	1.000	0.000	0.0000	0

30000 rows × 13 columns

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

Read in tweets for test set

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

In [6]:
```
test
```

Out[6]:

	url	date_and_time	tweet	tweet_id	reply_count	retweet_count	like_count	lang
0	https://twitter.com/PathanShekib/status/132770...	2020-11-14 20:01:34	@aneelfassa beyond meat burgers are diff	1327703240729796609	0	0	0	en
1	https://twitter.com/galwaybae/status/132770305...	2020-11-14 20:00:50	dennys plant based burgers a close second to b...	1327703053777199106	0	0	0	en
2	https://twitter.com/TheHeroes_HERO/status/1327...	2020-11-14 19:32:53	Who ever said Beyond Meat tastes like meat FUC...	1327696020923420673	0	0	2	en
3	https://twitter.com/cherrymorello/status/13276...	2020-11-14 19:09:58	@feebee79 I've just had a beyond burger with f...	1327690255366053888	0	0	2	en
4	https://twitter.com/downlowbambi/status/132768...	2020-11-14 19:05:29	@themetdtd Yeah it's great that all I have to ...	1327689125328158720	1	0	0	en
...	...	...	...	...	...	...	...	...
9994	https://twitter.com/Intofurler/status/12956694...	2020-08-18 10:30:42	@O0Rocker0O they started selling the beyond bu...	1295669444891615233	1	0	0	en
9995	https://twitter.com/TravelOceans/status/129566...	2020-08-18 10:24:45	Reduce your meat consumption, start by cutting...	1295667947550253056	0	0	0	en
9996	https://twitter.com/TNarinen/status/1295646808...	2020-08-18 09:00:45	@mattimolari Tässähän tämä homma kärjistettynä...	1295646808992096256	0	0	0	fi
9997	https://twitter.com/surf_panda/status/12956346...	2020-08-18 08:12:20	@niksy @NebojsaG @polojaci @josephbt @borisrad...	1295634621636509696	0	0	2	und
9998	https://twitter.com/UPlantATree/status/1295620...	2020-08-18 07:17:11	Just eat salads instead of burgers to save the...	1295620742806228996	0	0	0	en

9999 rows × 8 columns

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

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

In [8]:
```
test_original.to_csv('beyond_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/libraryjogirl/status/14357...	2021-09-08 23:57:23	@AWCanada Hi A&W! I'm seeing commercials f...	1435754169965613057	1	0	0	en	0.000	0.912	0.088	0.4738	0.0
1	https://twitter.com/eliseelara/status/14357513...	2021-09-08 23:46:04	their supreme sauce?!? THEIR SEASONED FRIES?!?...	1435751320439361543	0	0	0	en	0.097	0.723	0.180	0.5615	0.0
2	https://twitter.com/t_kelly15/status/143574800...	2021-09-08 23:32:53	Someone accidentally sent their A&W dinner...	1435748002925326336	1	0	5	en	0.130	0.870	0.000	-0.5859	1.0
3	https://twitter.com/marlenemdiaz08/status/1435...	2021-09-08 23:24:47	Like beyond nasty for a fast food joint. No ke...	1435745963189014532	0	0	0	en	0.242	0.690	0.067	-0.9083	1.0
4	https://twitter.com/divinaxo/status/1425869375...	2021-08-12 17:18:45	Beyond burger 😋😋😋 https://t.co/eiqlclnsnQ	1425869375941267463	0	1	1	en	0.000	1.000	0.000	0.0000	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
39994	https://twitter.com/Intofurler/status/12956694...	2020-08-18 10:30:42	@O0Rocker0O they started selling the beyond bu...	1295669444891615233	1	0	0	en	NaN	NaN	NaN	NaN	NaN
39995	https://twitter.com/TravelOceans/status/129566...	2020-08-18 10:24:45	Reduce your meat consumption, start by cutting...	1295667947550253056	0	0	0	en	NaN	NaN	NaN	NaN	NaN
39996	https://twitter.com/TNarinen/status/1295646808...	2020-08-18 09:00:45	@mattimolari Tässähän tämä homma kärjistettynä...	1295646808992096256	0	0	0	fi	NaN	NaN	NaN	NaN	NaN
39997	https://twitter.com/surf_panda/status/12956346...	2020-08-18 08:12:20	@niksy @NebojsaG @polojaci @josephbt @borisrad...	1295634621636509696	0	0	2	und	NaN	NaN	NaN	NaN	NaN
39998	https://twitter.com/UPlantATree/status/1295620...	2020-08-18 07:17:11	Just eat salads instead of burgers to save the...	1295620742806228996	0	0	0	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/libraryjogirl/status/14357...	2021-09-08 23:57:23	@AWCanada Hi A&W! I'm seeing commercials f...	1435754169965613057	1	0	0	en	0.000	0.912	0.088	0.4738	0.0	see commerci your beyond meat burger vegetaria...
1	https://twitter.com/eliseelara/status/14357513...	2021-09-08 23:46:04	their supreme sauce?!? THEIR SEASONED FRIES?!?...	1435751320439361543	0	0	0	en	0.097	0.723	0.180	0.5615	0.0	their suprem sauc their season fri their beyon...
2	https://twitter.com/t_kelly15/status/143574800...	2021-09-08 23:32:53	Someone accidentally sent their A&W dinner...	1435748002925326336	1	0	5	en	0.130	0.870	0.000	-0.5859	1.0	someon accident sent their dinner apart will u...
3	https://twitter.com/marlenemdiaz08/status/1435...	2021-09-08 23:24:47	Like beyond nasty for a fast food joint. No ke...	1435745963189014532	0	0	0	en	0.242	0.690	0.067	-0.9083	1.0	like beyond nasti fast food joint ketchup smas...
4	https://twitter.com/divinaxo/status/1425869375...	2021-08-12 17:18:45	Beyond burger 😁😁😁 https://t.co/eiqlclnsnQ	1425869375941267463	0	1	1	en	0.000	1.000	0.000	0.0000	0.0	beyond burger http eiqlclnsnq
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
39994	https://twitter.com/Intofurler/status/12956694...	2020-08-18 10:30:42	@O0Rocker0O they started selling the beyond bu...	1295669444891615233	1	0	0	en	NaN	NaN	NaN	NaN	NaN	they start sell beyond burger supermarket migh...
39995	https://twitter.com/TravelOceans/status/129566...	2020-08-18 10:24:45	Reduce your meat consumption, start by cutting...	1295667947550253056	0	0	0	en	NaN	NaN	NaN	NaN	NaN	reduc your meat consumpt start cut beef then s...
39996	https://twitter.com/TNarinen/status/1295646808...	2020-08-18 09:00:45	@mattimolari Tässähän tämä homma kärjistettynä...	1295646808992096256	0	0	0	fi	NaN	NaN	NaN	NaN	NaN	homma rjistettyn miksei siell esim beyond burg...
39997	https://twitter.com/surf_panda/status/12956346...	2020-08-18 08:12:20	@niksy @NebojsaG @polojaci @josephbt @borisrad...	1295634621636509696	0	0	2	und	NaN	NaN	NaN	NaN	NaN	beyond burger lar sven
39998	https://twitter.com/UPlantATree/status/1295620...	2020-08-18 07:17:11	Just eat salads instead of burgers to save the...	1295620742806228996	0	0	0	en	NaN	NaN	NaN	NaN	NaN	just salad instead burger save planet imposs b...

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('beyond_wc_positive.png')
```

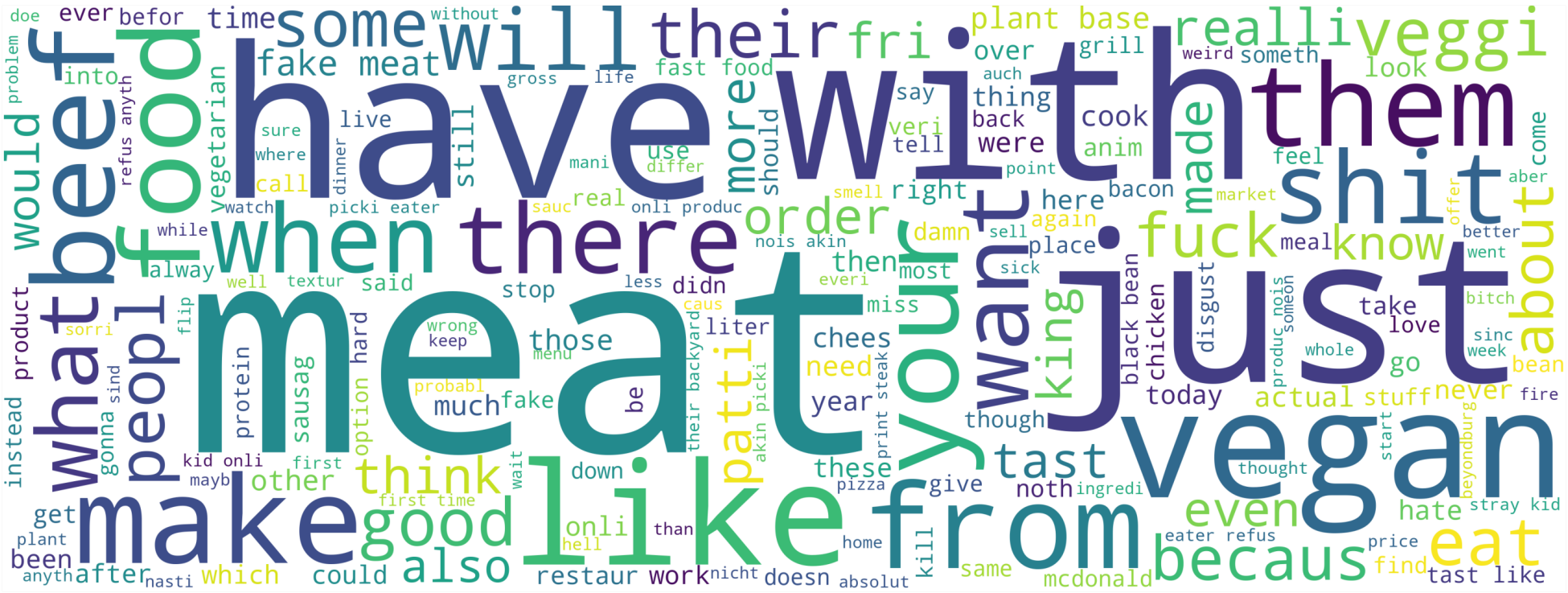
Out[26]:
```
<wordcloud.wordcloud.WordCloud at 0x7fdf97458940>
```

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('beyond_wc_negative.png')
```

Out[30]:
```
<wordcloud.wordcloud.WordCloud at 0x7fdf822a0220>
```

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
```

```
[],
[],
[],
[],
[],
['comfortfood'],
['fundrais', 'dine', 'nonprofit'],
[],
[],
['onthisdateinhiphop', 'odog', 'larenzt'],
[],
[],
[],
[],
[],
[],
[],
[],
[],
[],
```

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

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

```
'excit',
'hornsup',
'vegan',

'veganiseyourmenu',
'vegan',
'doinglunch',
'veganisthefutur',
'pragenc',
'getnot',
'stockmarket',
'trade',
'invest',
'themadsareback',
'themadsaversari',
'brioch',
'mymcdonaldsfancontest',
'frankenfood',
'nationalfrenchfryday',
'beyondburg',
```

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]:
```
[[],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
 [],
```

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

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

```
'deznat',
'climat',
'new',
'leonardo',
'beyond',
'climat',
'new',
'leonardo',
'beyond',
'climat',
'new',
'leonardo',
'beyond',
'beyondburg',
'lidl',
'aldi',
'coronatest',
'eatrealfood',
'raccosburg',
'climat',
```

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({'vegan': 315, 'beyondburg': 234, 'plantbas': 108, 'veganiseyourmenu': 107, 'beyondmeat': 82, 'burger': 75, 'vegetarian': 56, 'food': 37, 'beyond': 36, 'gobeyond': 26,
...})
```

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]:
```
1 sorted_df_positive
```

Out[44]:

	Hashtags	Count
12	vegan	315
46	beyondburg	234
14	plantbas	108
99	veganiseyourmenu	107
44	beyondmeat	82
...	...	...
648	makemoneyonlin	1
647	affiliatemarket	1
646	jasonabalo	1
645	dfwre	1
1636	ohiocraftb	1

1637 rows × 2 columns

Frequency of hashtags from tweets with negative compound sentiment

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

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

Out[46]:
```
FreqDist({'beyondburg': 53, 'vegan': 52, 'urbanfantasi': 32, 'scifi': 32, 'recip': 32, 'plantbas': 19, 'beyond': 19, 'food': 14, 'beyondmeat': 13, 'new': 12, ...})
```

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

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

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

Out[49]:

	Hashtags	Count
5	beyondburg	53
13	vegan	52
144	recip	32
143	scifi	32
142	urbanfantasi	32
...	...	...
178	rasselbocklb	1
177	meatabl	1
176	newproduct	1
175	canada	1
480	checker	1

481 rows × 2 columns

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

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

In [52]:
```
dfi.export(sorted_df_negative, 'beyond_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	1	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	1	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	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

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	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.394622	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.25122	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
39994	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39995	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39996	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39997	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39998	0.0	0.0	0.0	0.0	0.000000	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.00000	0.0	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([[0.8686603 , 0.1313397 ],
       [0.96595035, 0.03404965],
       [0.87991278, 0.12008722],
       ...,
       [0.74699931, 0.25300069],
       [0.07967073, 0.92032927],
       [0.90167298, 0.09832702]])
```

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]:
```
0.6236792197236521
```

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([[0.96178845, 0.03821155],
       [0.88435226, 0.11564774],
       [0.98177335, 0.01822665],
       ...,
       [0.74506747, 0.25493253],
       [0.90139261, 0.09860739],
       [0.3946238 , 0.6053762 ]])
```

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, 0, 1])
```

F1 score for TF-IDF features

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

Out[78]: 0.6012691697514543

Part II: XGBoost

In [79]:
```
from xgboost import XGBClassifier
```

Fit model with bag-of-words features

In [80]:
```
model_bow = XGBClassifier(random_state=22,learning_rate=0.9)
```

In [81]:
```
model_bow.fit(x_train_bow, y_train_bow)
```

...

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

In [82]:
```
xgb = model_bow.predict_proba(x_valid_bow)
xgb
```

Out[82]:
```
array([[0.580994  , 0.41900602],
       [0.9783035 , 0.02169648],
       [0.74625957, 0.2537404 ],
       ...,
       [0.8762531 , 0.12374689],
       [0.1645714 , 0.8354286 ],
       [0.87970245, 0.12029752]], dtype=float32)
```

In [83]:
```
xgb=xgb[:,1]>=0.3
```

In [84]:
```
xgb_int=xgb.astype(np.int)
```

F1 score for bag-of-words features

In [85]:
```
xgb_bow=f1_score(y_valid_bow,xgb_int)
xgb_bow
```

Out[85]: 0.610386151797603

Fit model with TF-IDF features

In [86]:
```
model_tfidf = XGBClassifier(random_state=29,learning_rate=0.7)
```

In [87]:
```
model_tfidf.fit(x_train_tfidf, y_train_tfidf)
```

...

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

In [88]:
```
xgb_tfidf=model_tfidf.predict_proba(x_valid_tfidf)
xgb_tfidf
```

Out[88]:
```
array([[0.99190533, 0.00809468],
       [0.89844334, 0.10155668],
       [0.99307865, 0.00692135],
       ...,
       [0.57925236, 0.42074767],
       [0.98387843, 0.01612156],
       [0.49028337, 0.50971663]], dtype=float32)
```

In [89]:
```
xgb_tfidf=xgb_tfidf[:,1]>=0.3
```

In [90]:
```
xgb_int_tfidf=xgb_tfidf.astype(np.int)
```

F1 score for TF-IDF features

In [91]:
```
score=f1_score(y_valid_tfidf,xgb_int_tfidf)
score
```

Out[91]:
```
0.5836260470143205
```

Part II: Decision Trees

In [92]:
```
from sklearn.tree import DecisionTreeClassifier
dct = DecisionTreeClassifier(criterion='entropy', random_state=1)
```

Fit model with bag-of-words features

In [93]:
```
dct.fit(x_train_bow,y_train_bow)
```

Out[93]:
```
DecisionTreeClassifier(criterion='entropy', random_state=1)
```

In [ ]:
```

```

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

In [94]:
```
dct_bow = dct.predict_proba(x_valid_bow)
dct_bow
```

Out[94]:
```
array([[0., 1.],
       [0., 1.],
       [1., 0.],
       ...,
       [0., 1.],
       [0., 1.],
       [1., 0.]])
```

In [95]:
```
dct_bow=dct_bow[:,1]>=0.3
```

In [96]:
```
dct_int_bow=dct_bow.astype(np.int)
```

F1 score for bag-of-words features

In [97]:
```
dct_score_bow=f1_score(y_valid_bow,dct_int_bow)
dct_score_bow
```

Out[97]:
```
0.503242542153048
```

Fit model with TF-IDF features

In [98]:
```
dct.fit(x_train_tfidf,y_train_tfidf)
```

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

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

In [99]:
```
dct_tfidf = dct.predict_proba(x_valid_tfidf)
dct_tfidf
```

Out[99]:
```
array([[1.        , 0.        ],
       [0.90566038, 0.09433962],
       [1.        , 0.        ],
       ...,
       [0.        , 1.        ],
       [1.        , 0.        ],
       [0.        , 1.        ]])
```

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

In [101]:
```
dct_int_tfidf=dct_tfidf.astype(np.int)
```

F1 score for TF-IDF features

In [102]:
```
dct_score_tfidf=f1_score(y_valid_tfidf,dct_int_tfidf)
dct_score_tfidf
```

Out[102]:
```
0.48990578734858686
```

Part II: Model Comparison

In [103]:
```
Algo_1 = ['LogisticRegression(Bag-of-Words)','XGBoost(Bag-of-Words)','DecisionTree(Bag-of-Words)']
```

In [104]:
```
score_1 = [log_bow,xgb_bow,dct_score_bow]
```

In [105]:
```
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 [106]:
```
compare_1.T
```

Out[106]:

	1	2	3
Model	LogisticRegression(Bag-of-Words)	XGBoost(Bag-of-Words)	DecisionTree(Bag-of-Words)
F1_Score	0.623679	0.610386	0.503243

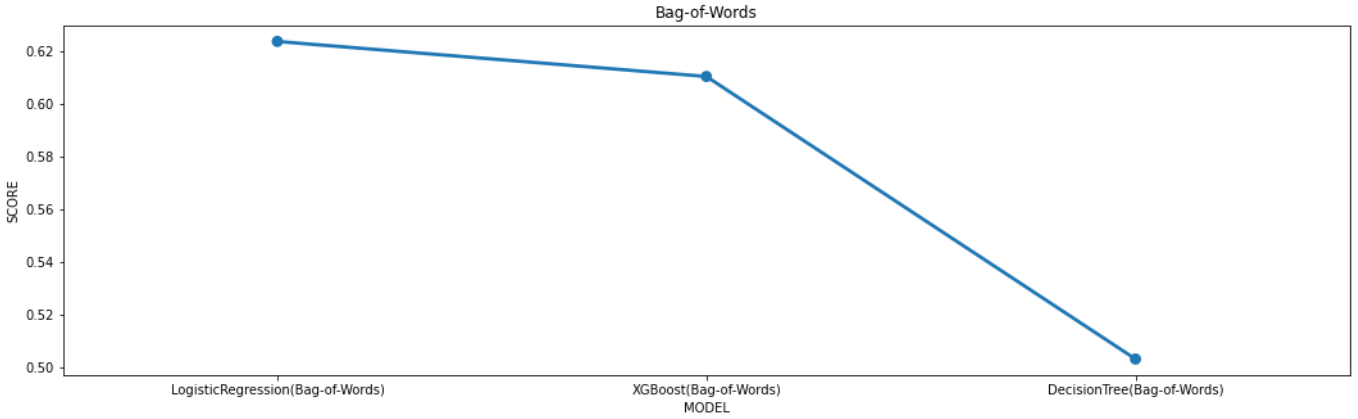
In [108]:
```
import seaborn as sns
```

In [109]:
```
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 [110]:
```
Algo_2 = ['LogisticRegression(TF-IDF)','XGBoost(TF-IDF)','DecisionTree(TF-IDF)']
```

In [111]:
```
score_2 = [log_tfidf,score,dct_score_tfidf]
```

In [112]:
```
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 [113]:
```
compare_2.T
```

Out[113]:

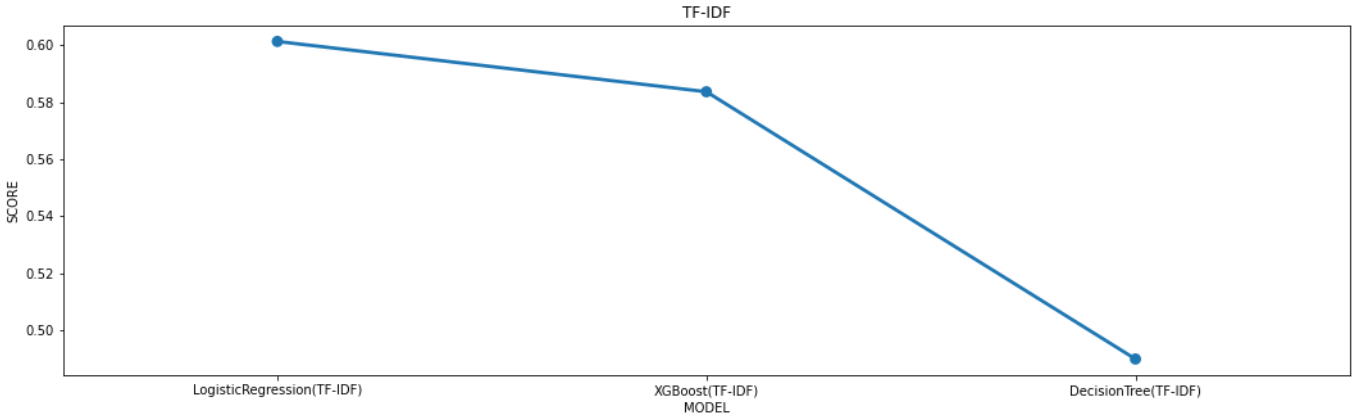
	1	2	3
Model	LogisticRegression(TF-IDF)	XGBoost(TF-IDF)	DecisionTree(TF-IDF)
F1_Score	0.601269	0.583626	0.489906

In [114]:
```
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 [115]:
```
Algo_best = ['LogisticRegression(Bag-of-Words)','LogisticRegression(TF-IDF)']
```

In [116]:
```
score_best = [log_bow,log_tfidf]
```

In [117]:
```
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 [118]:
```
compare_best.T
```

Out[118]:

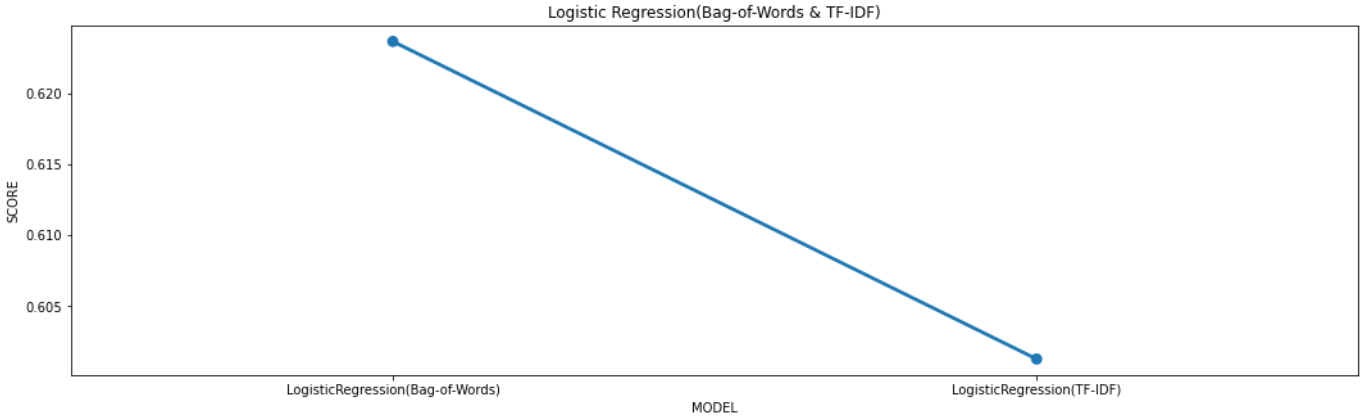
	1	2
Model	LogisticRegression(Bag-of-Words)	LogisticRegression(TF-IDF)
F1_Score	0.623679	0.601269

In [119]:
```
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 bag-of-words features

In [120]:
```
test_bow = bow[30000:]
```

In [121]:
```
test_pred = Log_Reg.predict_proba(test_bow)
```

In [122]:
```
test_pred_int = test_pred[:,1] >= 0.3
```

In [123]:
```
test_pred_int = test_pred_int.astype(np.int)
```

In [124]:
```
test['label'] = test_pred_int
```

In [125]:
```
submission = test[['tweet','label']]
```

In [126]:
```
submission.to_csv('result_beyond.csv', index=False)
```

In [127]:

```
res = pd.read_csv('result_beyond.csv')
res
```

Out[127]:

	tweet	label
0	@aneelfassa beyond meat burgers are diff	0
1	dennys plant based burgers a close second to b...	0
2	Who ever said Beyond Meat tastes like meat FUC...	1
3	@feebee79 I've just had a beyond burger with f...	0
4	@themetdtd Yeah it's great that all I have to ...	0
...	...	...
9994	@O0Rocker0O they started selling the beyond bu...	0
9995	Reduce your meat consumption, start by cutting...	1
9996	@mattimolari Tässähän tämä homma kärjistettynä...	0
9997	@niksy @NebojsaG @polojaci @josephbt @borisrad...	0
9998	Just eat salads instead of burgers to save the...	0

9999 rows × 2 columns