In [1]:

```
# Importing Neccessary Libraries
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```
import re
import nltk
import string
import nlp_utils
import contractions
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize,sent_tokenize
from nltk.stem import PorterStemmer, LancasterStemmer, SnowballStemmer
```

In [3]:

```
df=pd.read_csv('train.csv')
# Reading train dataset.
```

In [4]:

```
df
# Loading dataset.
```

Out[4]:

| | id | comment_text | toxic | severe_toxic | obscene | threat | insult | identity_hate |
|---|---|---|---|---|---|---|---|---|
| **0** | 0000997932d777bf | Explanation\nWhy the edits made under my usern... | 0 | 0 | 0 | 0 | 0 | 0 |
| **1** | 000103f0d9cfb60f | D'aww! He matches this background colour I'm s... | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | 000113f07ec002fd | Hey man, I'm really not trying to edit war. It... | 0 | 0 | 0 | 0 | 0 | 0 |
| **3** | 0001b41b1c6bb37e | "\nMore\nI can't make any real suggestions on ... | 0 | 0 | 0 | 0 | 0 | 0 |
| **4** | 0001d958c54c6e35 | You, sir, are my hero. Any chance you remember... | 0 | 0 | 0 | 0 | 0 | 0 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... |
| **159566** | ffe987279560d7ff | ":::::And for the second time of asking, when ... | 0 | 0 | 0 | 0 | 0 | 0 |
| **159567** | ffea4adeee384e90 | You should be ashamed of yourself \n\nThat is ... | 0 | 0 | 0 | 0 | 0 | 0 |
| **159568** | ffee36eab5c267c9 | Spitzer \n\nUmm, theres no actual article for ... | 0 | 0 | 0 | 0 | 0 | 0 |
| **159569** | fff125370e4aaaf3 | And it looks like it was actually you who put ... | 0 | 0 | 0 | 0 | 0 | 0 |
| **159570** | fff46fc426af1f9a | "\nAnd ... I really don't think you understand... | 0 | 0 | 0 | 0 | 0 | 0 |

159571 rows × 8 columns

In [5]:

```
df.info()
# Information about the dataset
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 159571 entries, 0 to 159570
Data columns (total 8 columns):
 #   Column         Non-Null Count   Dtype 
---  ------         --------------   ----- 
 0   id             159571 non-null  object
 1   comment_text   159571 non-null  object
 2   toxic          159571 non-null  int64 
 3   severe_toxic   159571 non-null  int64 
 4   obscene        159571 non-null  int64 
 5   threat         159571 non-null  int64 
 6   insult         159571 non-null  int64 
 7   identity_hate  159571 non-null  int64 
dtypes: int64(6), object(2)
memory usage: 9.7+ MB
```

In [6]:

```
df.isnull().sum()
# There are no null values.
```

Out[6]:

```
id                 0
comment_text       0
toxic              0
severe_toxic       0
obscene            0
threat             0
insult             0
```

```
identity_hate    0
dtype: int64
```

In [7]:

```
df['toxic'].value_counts()
# Counts of toxic and non toxic sentences.
```

Out[7]:

```
0    144277
1     15294
Name: toxic, dtype: int64
```

In [8]:

```
df['severe_toxic'].value_counts()
# Counts of severe_toxic and non severe_toxic sentences.
```

Out[8]:

```
0    157976
1      1595
Name: severe_toxic, dtype: int64
```

In [9]:

```
df['obscene'].value_counts()
# Counts of obscene and non obscene sentences.
```

Out[9]:

```
0    151122
1      8449
Name: obscene, dtype: int64
```

In [10]:

```
df['threat'].value_counts()
# Counts of threat and non threatening sentences.
```

Out[10]:

```
0    159093
1       478
Name: threat, dtype: int64
```

In [11]:

```
df['insult'].value_counts()
# Counts of insult and non insulting sentences.
```

Out[11]:

```
0    151694
1      7877
Name: insult, dtype: int64
```

In [12]:

```
df['identity_hate'].value_counts()
# Counts of toxic and non identity_hate sentences.
```

Out[12]:

```
0    158166
1      1405
Name: identity_hate, dtype: int64
```

## Data Visualization

In [13]:

```
sentencetype_graph=df.iloc[:,2:].sum()
# Using only numeric columns.
```

In [14]:

```
sentencetype_graph
```

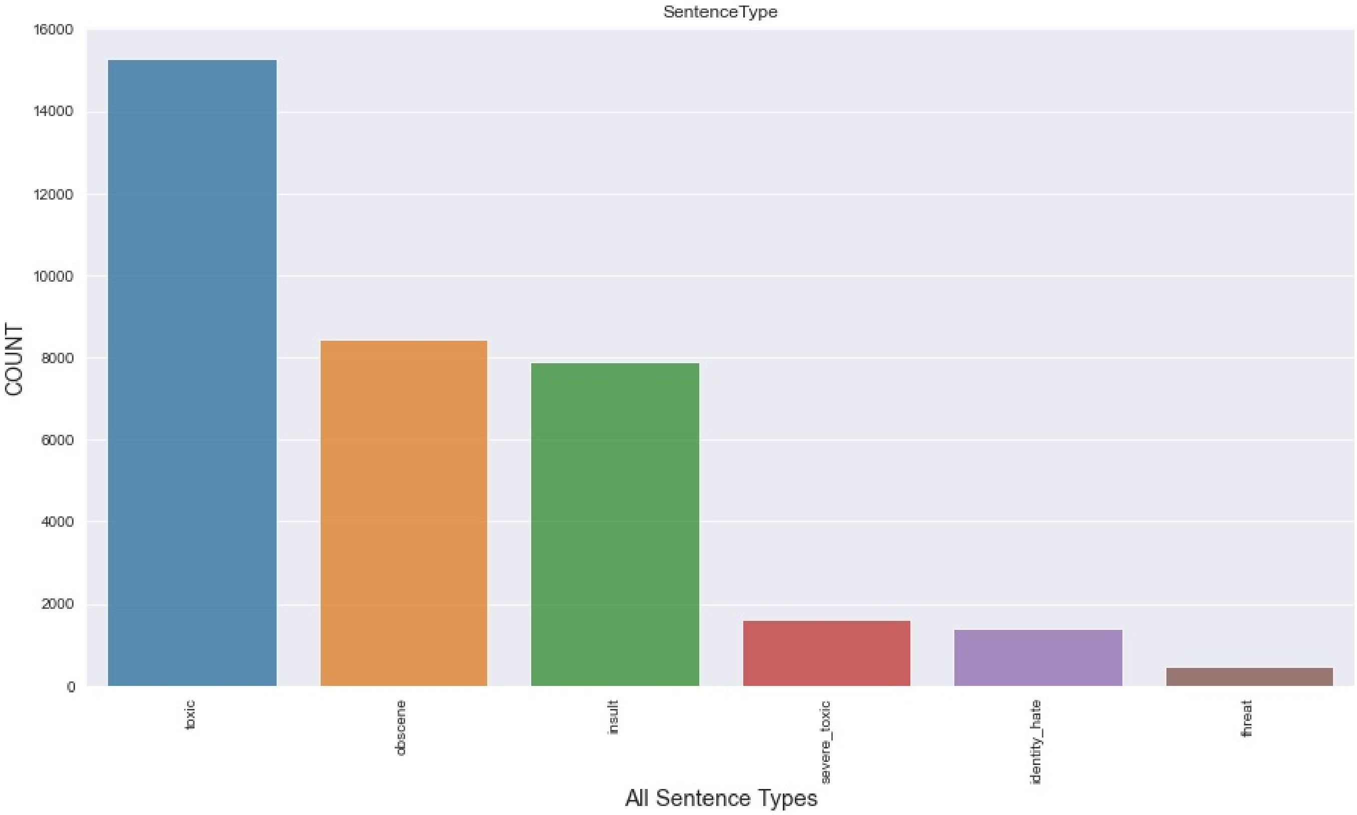
Out[14]:

```
toxic            15294
severe_toxic      1595
obscene           8449
threat             478
insult            7877
identity_hate     1405
dtype: int64
```

In [15]:

In [15]:

```python
sns.set_style("darkgrid")
ls=sentencetype_graph.sort_values(ascending=False)
plt.figure(figsize=(15,8))
temp =sns.barplot(ls.index, ls.values, alpha=0.8)
plt.title('SentenceType')
plt.ylabel('COUNT', fontsize=14)
plt.xlabel('All Sentence Types', fontsize=15)
temp.set_xticklabels(rotation=90,labels=ls.index,fontsize=10)
plt.show()
```



In [16]:

```python
# There are a many toxic sentences followed by obscene sentences and very few threatening sentences as seen above
```

## Text Pre-processing

In [17]:

```python
df['comment_text'][10]
```

Out[17]:

```
'"\nFair use rationale for Image:Wonju.jpg\n\nThanks for uploading Image:Wonju.jpg. I notice the image page speci
fies that the image is being used under fair use but there is no explanation or rationale as to why its use in Wi
kipedia articles constitutes fair use. In addition to the boilerplate fair use template, you must also write out
on the image description page a specific explanation or rationale for why using this image in each article is con
sistent with fair use.\n\nPlease go to the image description page and edit it to include a fair use rationale.\n\
nIf you have uploaded other fair use media, consider checking that you have specified the fair use rationale on t
hose pages too. You can find a list of \'image\' pages you have edited by clicking on the ""my contributions"" li
nk (it is located at the very top of any Wikipedia page when you are logged in), and then selecting ""Image"" fro
m the dropdown box. Note that any fair use images uploaded after 4 May, 2006, and lacking such an explanation wil
l be deleted one week after they have been uploaded, as described on criteria for speedy deletion. If you have an
y questions please ask them at the Media copyright questions page. Thank you. (talk • contribs • ) \nUnspecified
source for Image:Wonju.jpg\n\nThanks for uploading Image:Wonju.jpg. I noticed that the file\'s description page c
urrently doesn\'t specify who created the content, so the copyright status is unclear. If you did not create this
file yourself, then you will need to specify the owner of the copyright. If you obtained it from a website, then
a link to the website from which it was taken, together with a restatement of that website\'s terms of use of its
content, is usually sufficient information. However, if the copyright holder is different from the website\'s pub
lisher, then their copyright should also be acknowledged.\n\nAs well as adding the source, please add a proper co
pyright licensing tag if the file doesn\'t have one already. If you created/took the picture, audio, or video the
n the  tag can be used to release it under the GFDL. If you believe the media meets the criteria at Wikipedia:Fai
r use, use a tag such as  or one of the other tags listed at Wikipedia:Image copyright tags#Fair use. See Wikiped
ia:Image copyright tags for the full list of copyright tags that you can use.\n\nIf you have uploaded other files
, consider checking that you have specified their source and tagged them, too. You can find a list of files you h
ave uploaded by following [ this link]. Unsourced and untagged images may be deleted one week after they have bee
n tagged, as described on criteria for speedy deletion. If the image is copyrighted under a non-free license (per
Wikipedia:Fair use) then the image will be deleted 48 hours after . If you have any questions please ask them at
the Media copyright questions page. Thank you. (talk • contribs • ) "'
```

In [18]:

```python
import re
import string
```

In [19]:

```python
alphanumeric = lambda x: re.sub('\w*\d\w*', ' ', x)
punc_lower = lambda x: re.sub('[%s]' % re.escape(string.punctuation), ' ', x.lower())
remove_n = lambda x: re.sub("\n", " ", x)
remove_non_ascii = lambda x: re.sub(r'[^\x00-\x7f]',r' ', x)
df['comment_text'] = df['comment_text'].map(alphanumeric).map(punc_lower).map(remove_n).map(remove_non_ascii)
# Removing special characters
```

In [20]:

```python
Insulting_comment_df=df.loc[:,['id','comment_text','insult']]
# Creating insult dataframe
```

In [21]:

```python
IdentityHate_comment_df=df.loc[:,['id','comment_text','identity_hate']]
# Creating identityhate dataframe
```

In [22]:

```python
Obscene_comment_df=df.loc[:,['id','comment_text','obscene']]
# Creating obscene comment dataframe
```

In [23]:

```python
Threatening_comment_df=df.loc[:,['id','comment_text','threat']]
# Creating threatening dataframe
```

In [24]:

```python
Severetoxic_comment_df=df.loc[:,['id','comment_text','severe_toxic']]
# Creating severtoxic dataframe
```

In [25]:

```python
Toxic_comment_df=df.loc[:,['id','comment_text','toxic']]
# Creating toxic dataframe
```

In [26]:

```python
# Subset datasets.
```

In [27]:

```python
Severetoxic_comment_df
```

Out[27]:

| | id | comment_text | severe_toxic |
|---|---|---|---|
| **0** | 0000997932d777bf | explanation why the edits made under my userna... | 0 |
| **1** | 000103f0d9cfb60f | d aww he matches this background colour i m s... | 0 |
| **2** | 000113f07ec002fd | hey man i m really not trying to edit war it... | 0 |
| **3** | 0001b41b1c6bb37e | more i can t make any real suggestions on im... | 0 |
| **4** | 0001d958c54c6e35 | you sir are my hero any chance you remember... | 0 |
| **...** | ... | ... | ... |
| **159566** | ffe987279560d7ff | and for the second time of asking when ... | 0 |
| **159567** | ffea4adeee384e90 | you should be ashamed of yourself that is a ... | 0 |
| **159568** | ffee36eab5c267c9 | spitzer umm theres no actual article for pr... | 0 |
| **159569** | fff125370e4aaaf3 | and it looks like it was actually you who put ... | 0 |
| **159570** | fff46fc426af1f9a | and i really don t think you understand ... | 0 |

159571 rows × 3 columns

In [28]:

```python
Threatening_comment_df
```

Out[28]:

| | id | comment_text | threat |
|---|---|---|---|
| **0** | 0000997932d777bf | explanation why the edits made under my userna... | 0 |
| **1** | 000103f0d9cfb60f | d aww he matches this background colour i m s... | 0 |
| **2** | 000113f07ec002fd | hey man i m really not trying to edit war it... | 0 |
| **3** | 0001b41b1c6bb37e | more i can t make any real suggestions on im... | 0 |
| **4** | 0001d958c54c6e35 | you sir are my hero any chance you remember... | 0 |
| **...** | ... | ... | ... |
| **159566** | ffe987279560d7ff | and for the second time of asking when ... | 0 |
| **159567** | ffea4adeee384e90 | you should be ashamed of yourself that is a ... | 0 |
| **159568** | ffee36eab5c267c9 | spitzer umm theres no actual article for pr... | 0 |

| | | | |
|---|---|---|---|
| **159569** | fff125370e4aaaf3 | and it looks like it was actually you who put ... | 0 |
| **159570** | fff46fc426af1f9a | and i really don t think you understand ... | 0 |

159571 rows × 3 columns

In [29]:
```
Obscene_comment_df
```

Out[29]:

| | id | comment_text | obscene |
|---|---|---|---|
| **0** | 0000997932d777bf | explanation why the edits made under my userna... | 0 |
| **1** | 000103f0d9cfb60f | d aww he matches this background colour i m s... | 0 |
| **2** | 000113f07ec002fd | hey man i m really not trying to edit war it... | 0 |
| **3** | 0001b41b1c6bb37e | more i can t make any real suggestions on im... | 0 |
| **4** | 0001d958c54c6e35 | you sir are my hero any chance you remember... | 0 |
| **...** | ... | ... | ... |
| **159566** | ffe987279560d7ff | and for the second time of asking when ... | 0 |
| **159567** | ffea4adeee384e90 | you should be ashamed of yourself that is a ... | 0 |
| **159568** | ffee36eab5c267c9 | spitzer umm theres no actual article for pr... | 0 |
| **159569** | fff125370e4aaaf3 | and it looks like it was actually you who put ... | 0 |
| **159570** | fff46fc426af1f9a | and i really don t think you understand ... | 0 |

159571 rows × 3 columns

In [30]:
```
Toxic_comment_df
```

Out[30]:

| | id | comment_text | toxic |
|---|---|---|---|
| **0** | 0000997932d777bf | explanation why the edits made under my userna... | 0 |
| **1** | 000103f0d9cfb60f | d aww he matches this background colour i m s... | 0 |
| **2** | 000113f07ec002fd | hey man i m really not trying to edit war it... | 0 |
| **3** | 0001b41b1c6bb37e | more i can t make any real suggestions on im... | 0 |
| **4** | 0001d958c54c6e35 | you sir are my hero any chance you remember... | 0 |
| **...** | ... | ... | ... |
| **159566** | ffe987279560d7ff | and for the second time of asking when ... | 0 |
| **159567** | ffea4adeee384e90 | you should be ashamed of yourself that is a ... | 0 |
| **159568** | ffee36eab5c267c9 | spitzer umm theres no actual article for pr... | 0 |
| **159569** | fff125370e4aaaf3 | and it looks like it was actually you who put ... | 0 |
| **159570** | fff46fc426af1f9a | and i really don t think you understand ... | 0 |

159571 rows × 3 columns

In [31]:
```
IdentityHate_comment_df
```

Out[31]:

| | id | comment_text | identity_hate |
|---|---|---|---|
| **0** | 0000997932d777bf | explanation why the edits made under my userna... | 0 |
| **1** | 000103f0d9cfb60f | d aww he matches this background colour i m s... | 0 |
| **2** | 000113f07ec002fd | hey man i m really not trying to edit war it... | 0 |
| **3** | 0001b41b1c6bb37e | more i can t make any real suggestions on im... | 0 |
| **4** | 0001d958c54c6e35 | you sir are my hero any chance you remember... | 0 |
| **...** | ... | ... | ... |
| **159566** | ffe987279560d7ff | and for the second time of asking when ... | 0 |
| **159567** | ffea4adeee384e90 | you should be ashamed of yourself that is a ... | 0 |
| **159568** | ffee36eab5c267c9 | spitzer umm theres no actual article for pr... | 0 |
| **159569** | fff125370e4aaaf3 | and it looks like it was actually you who put ... | 0 |
| **159570** | fff46fc426af1f9a | and i really don t think you understand ... | 0 |

159571 rows × 3 columns

In [32]:

```
Insulting_comment_df
```

Out[32]:

|  | id | comment_text | insult |
|---|---|---|---|
| **0** | 0000997932d777bf | explanation why the edits made under my userna... | 0 |
| **1** | 000103f0d9cfb60f | d aww he matches this background colour i m s... | 0 |
| **2** | 000113f07ec002fd | hey man i m really not trying to edit war it... | 0 |
| **3** | 0001b41b1c6bb37e | more i can t make any real suggestions on im... | 0 |
| **4** | 0001d958c54c6e35 | you sir are my hero any chance you remember... | 0 |
| **...** | ... | ... | ... |
| **159566** | ffe987279560d7ff | and for the second time of asking when ... | 0 |
| **159567** | ffea4adeee384e90 | you should be ashamed of yourself that is a ... | 0 |
| **159568** | ffee36eab5c267c9 | spitzer umm theres no actual article for pr... | 0 |
| **159569** | fff125370e4aaaf3 | and it looks like it was actually you who put ... | 0 |
| **159570** | fff46fc426af1f9a | and i really don t think you understand ... | 0 |

159571 rows × 3 columns

In [33]:

```
import wordcloud
from PIL import Image
from wordcloud import WordCloud, STOPWORDS, ImageColorGenerator
from nltk.corpus import stopwords
```

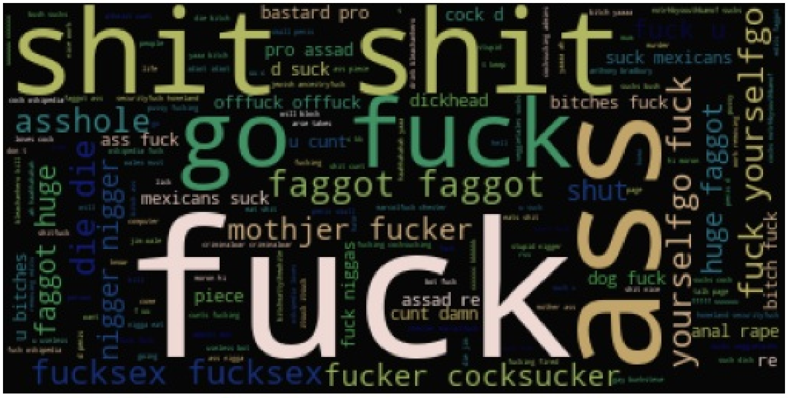
In [34]:

```
def wordcloud(df, label):

    subset=df[df[label]==1]
    text=subset.comment_text.values
    wc= WordCloud(background_color="black",max_words=2000)

    wc.generate(" ".join(text))

    plt.figure(figsize=(20,20))
    plt.subplot(221)
    plt.axis("off")
    plt.title("Words frequented in {}".format(label), fontsize=20)
    plt.imshow(wc.recolor(colormap= 'gist_earth' , random_state=244), alpha=0.98)
# Visualising the subset datasets using wordcloud
```

In [35]:

```
wordcloud(Severetoxic_comment_df,'severe_toxic')
```

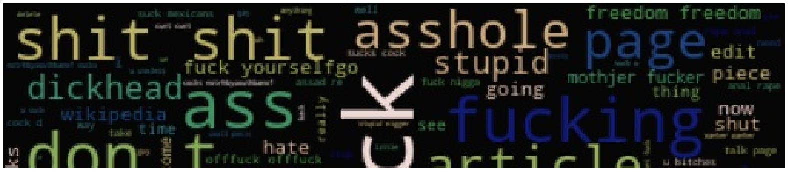
Words frequented in severe_toxic

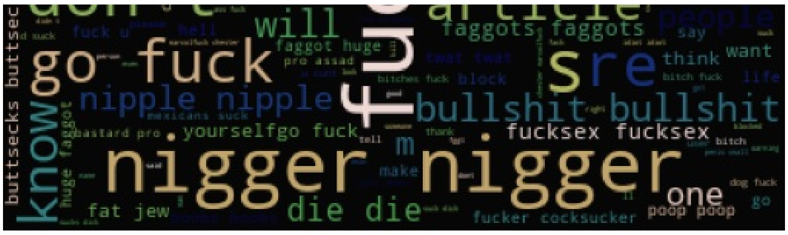


In [36]:

```
wordcloud(Obscene_comment_df,'obscene')
```

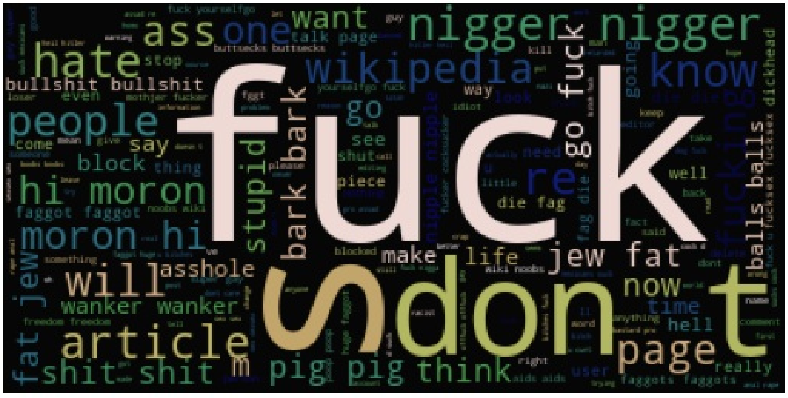
Words frequented in obscene





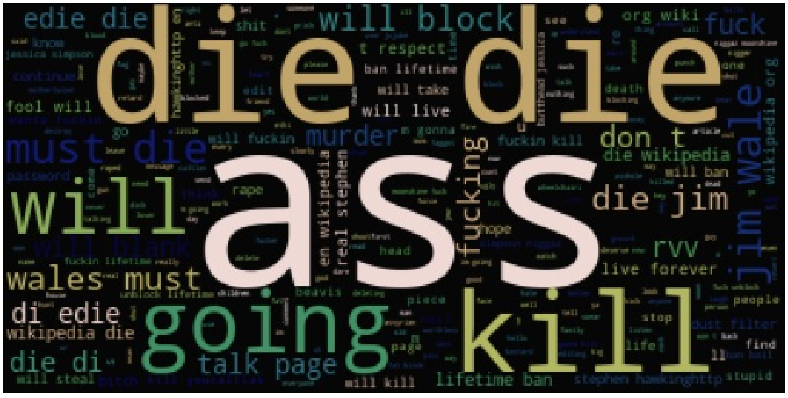
```
In [37]: wordcloud(Toxic_comment_df,'toxic')
```

Words frequented in toxic



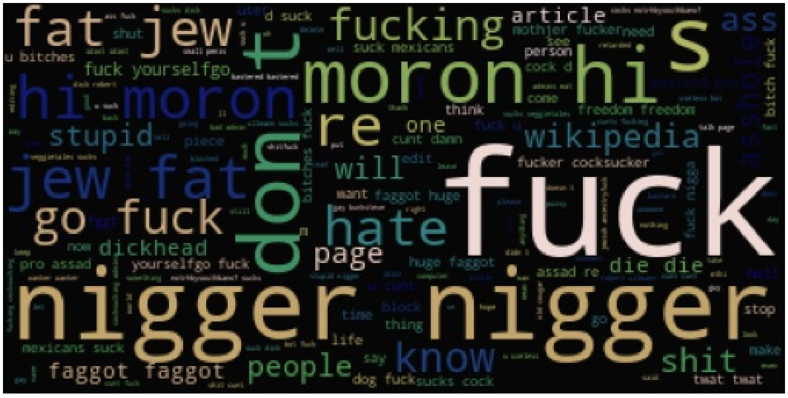
```
In [38]: wordcloud(Threatening_comment_df,'threat')
```

Words frequented in threat



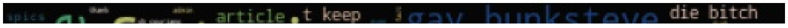
```
In [39]: wordcloud(Insulting_comment_df,'insult')
```

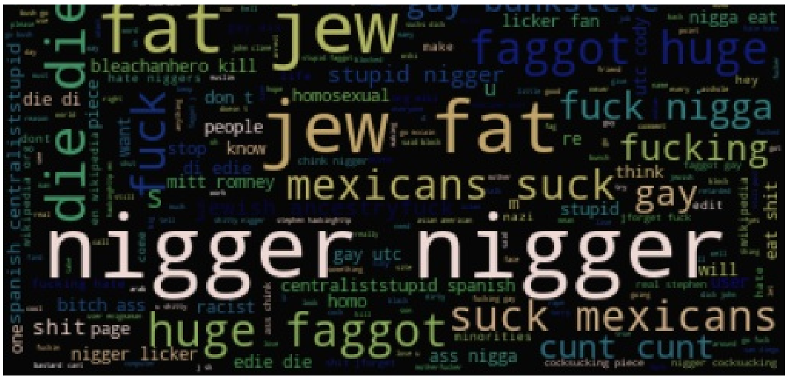
Words frequented in insult



```
In [40]: wordcloud(IdentityHate_comment_df,'identity_hate')
```

Words frequented in identity_hate





## Balancing the target column in the dataset

In [41]:
```python
Toxic_comment_balanced_1 = Toxic_comment_df[Toxic_comment_df['toxic'] == 1].iloc[0:5000,:]
# Selecting only 5000 toxic comments
```

In [42]:
```python
Toxic_comment_balanced_0 = Toxic_comment_df[Toxic_comment_df['toxic'] == 0].iloc[0:5000,:]
# Selecting only 5000 non toxic comments
```

In [44]:
```python
Toxic_comment_balanced_1.shape
# Shape of Toxic_comment_balanced_1
```

Out[44]:
```
(5000, 3)
```

In [45]:
```python
Toxic_comment_balanced_0.shape
# Shape of Toxic_comment_balanced_0
```

Out[45]:
```
(5000, 3)
```

In [46]:
```python
Toxic_comment_balanced_1['toxic'].value_counts()
# Value_counts of Toxic_comment_balanced_1
```

Out[46]:
```
1    5000
Name: toxic, dtype: int64
```

In [47]:
```python
Toxic_comment_balanced_0['toxic'].value_counts()
# Value_counts of Toxic_comment_balanced_0
```

Out[47]:
```
0    5000
Name: toxic, dtype: int64
```

In [48]:
```python
Toxic_comment_balanced=pd.concat([Toxic_comment_balanced_1,Toxic_comment_balanced_0])
## concatenating toxic and non toxic comments
```

In [49]:
```python
Toxic_comment_balanced['toxic'].value_counts()
# Balanced column
```

Out[49]:
```
1    5000
0    5000
Name: toxic, dtype: int64
```

## Repeating the steps for other subset datasets

In [50]:
```python
Severetoxic_comment_df['severe_toxic'].value_counts()
# value counts of Severetoxic_comment_df
```

Out[50]:
```
0    157976
```

```
1      1595
Name: severe_toxic, dtype: int64
```

In [51]:

```
Severetoxic_comment_df_1 = Severetoxic_comment_df[Severetoxic_comment_df['severe_toxic'] == 1].iloc[0:1595,:]
# selecting 1595 values of Severetoxic_comment_df_1
```

In [52]:

```
Severetoxic_comment_df_0 = Severetoxic_comment_df[Severetoxic_comment_df['severe_toxic'] == 0].iloc[0:1595,:]
# selecting 1595 values of Severetoxic_comment_df_0
```

In [53]:

```
Severe_toxic_comment_balanced=pd.concat([Severetoxic_comment_df_1,Severetoxic_comment_df_0])
# Concatenating Severetoxic_comment_df_1 and Severetoxic_comment_df_0
```

In [54]:

```
Severe_toxic_comment_balanced['severe_toxic'].value_counts()
# Final value counts of the Severetoxic_comment_balanced
```

Out[54]:

```
1    1595
0    1595
Name: severe_toxic, dtype: int64
```

## Repeating the same for obscene comment data frame

In [55]:

```
Obscene_comment_df['obscene'].value_counts()
# Value counts of the obscene_comment_df
```

Out[55]:

```
0    151122
1      8449
Name: obscene, dtype: int64
```

In [56]:

```
Obscene_comment_df_1 = Obscene_comment_df[Obscene_comment_df['obscene'] == 1].iloc[0:5000,:]
```

In [57]:

```
Obscene_comment_df_0 = Obscene_comment_df[Obscene_comment_df['obscene'] == 0].iloc[0:5000,:]
```

In [58]:

```
Obscene_comment_balanced = pd.concat([Obscene_comment_df_1,Obscene_comment_df_0])
```

In [59]:

```
Obscene_comment_balanced['obscene'].value_counts()
```

Out[59]:

```
1    5000
0    5000
Name: obscene, dtype: int64
```

In [60]:

```
### Repeating the same for Threatening comment data frame
```

In [61]:

```
Threatening_comment_df
```

Out[61]:

| | id | comment_text | threat |
|---|---|---|---|
| **0** | 0000997932d777bf | explanation why the edits made under my userna... | 0 |
| **1** | 000103f0d9cfb60f | d aww he matches this background colour i m s... | 0 |
| **2** | 000113f07ec002fd | hey man i m really not trying to edit war it... | 0 |
| **3** | 0001b41b1c6bb37e | more i can t make any real suggestions on im... | 0 |
| **4** | 0001d958c54c6e35 | you sir are my hero any chance you remember... | 0 |
| **...** | ... | ... | ... |
| **159566** | ffe987279560d7ff | and for the second time of asking when ... | 0 |
| **159567** | ffea4adeee384e90 | you should be ashamed of yourself that is a ... | 0 |
| **159568** | ffee36eab5c267c9 | spitzer umm theres no actual article for pr... | 0 |
| **159569** | fff125370e4aaaf3 | and it looks like it was actually you who put ... | 0 |
| **159570** | fff46fc426af1f9a | and i really don t think you understand ... | 0 |

159571 rows × 3 columns

In [62]:

```
Threatening_comment_df['threat'].value_counts()
```

Out[62]:

```
0    159093
1       478
Name: threat, dtype: int64
```

In [63]:

```
Threatening_comment_df_1 = Threatening_comment_df[Threatening_comment_df['threat'] == 1].iloc[0:478,:]
```

In [64]:

```
Threatening_comment_df_0 = Threatening_comment_df[Threatening_comment_df['threat'] == 0].iloc[0:478,:]
```

In [65]:

```
Threatening_comment_balanced = pd.concat([Threatening_comment_df_1,Threatening_comment_df_0])
```

In [66]:

```
Threatening_comment_balanced['threat'].value_counts()
```

Out[66]:

```
1    478
0    478
Name: threat, dtype: int64
```

In [67]:

```
Threatening_comment_balanced
```

Out[67]:

| | id | comment_text | threat |
|---|---|---|---|
| **79** | 003217c3eb469ba9 | hi i am back again last warning stop undoin... | 1 |
| **176** | 006b94add72ed61c | i think that your a fagget get a oife and burn... | 1 |
| **600** | 0199d6af27b715f3 | i m also a sock puppet of this account supri... | 1 |
| **802** | 02230885017a50c5 | fuck you smith please have me notified when ... | 1 |
| **1017** | 02c6e41e4b317ac3 | wouldn t be the first time bitch fuck you i l... | 1 |
| **...** | ... | ... | ... |
| **475** | 01389dc7e054bfe5 | hello if you re interested we could re... | 0 |
| **476** | 013ad5246f4b953b | f k all rides at worlds of fun i hate all ... | 0 |
| **477** | 013bd808a6d3d69b | as to job for you sure thing as soon as i ... | 0 |
| **478** | 013c1a43411c5f9a | oh ok i just wanted to see what people though... | 0 |
| **479** | 013d17a8b342f501 | wrong the capital is podgorica as it has alwa... | 0 |

956 rows × 3 columns

In [68]:

```
### Repeating the same for Insulting_comment_data frame
```

In [69]:

```
Insulting_comment_df['insult'].value_counts()
```

Out[69]:

```
0    151694
1      7877
Name: insult, dtype: int64
```

In [70]:

```
Insulting_comment_df_1 = Insulting_comment_df[Insulting_comment_df['insult'] == 1].iloc[0:5000,:]
```

In [71]:

```
Insulting_comment_df_0 = Insulting_comment_df[Insulting_comment_df['insult'] == 0].iloc[0:5000,:]
```

In [72]:

```
Insulting_comment_balanced = pd.concat([Insulting_comment_df_1,Insulting_comment_df_0])
```

In [73]:

```
Insulting_comment_balanced['insult'].value_counts()
```

Out[73]:

```
1    5000
```

```
0    5000
Name: insult, dtype: int64
```

In [74]:

```
### Repeating the same for IdentityHate_comment_df
```

In [75]:

```
IdentityHate_comment_df['identity_hate'].value_counts()
```

Out[75]:

```
0    158166
1      1405
Name: identity_hate, dtype: int64
```

In [76]:

```
IdentityHate_comment_df_1 = IdentityHate_comment_df[IdentityHate_comment_df['identity_hate'] == 1].iloc[0:1405,:]
```

In [77]:

```
IdentityHate_comment_df_0 = IdentityHate_comment_df[IdentityHate_comment_df['identity_hate'] == 0].iloc[0:1405,:]
```

In [78]:

```
IdentityHate_comment_balanced = pd.concat([IdentityHate_comment_df_1,IdentityHate_comment_df_0])
```

In [79]:

```
IdentityHate_comment_balanced['identity_hate'].value_counts()
```

Out[79]:

```
1    1405
0    1405
Name: identity_hate, dtype: int64
```

# Machine learning

In [80]:

```
from sklearn import preprocessing
from sklearn.feature_selection import SelectFromModel

from sklearn.model_selection import train_test_split, KFold, cross_val_score
from sklearn.metrics import f1_score, precision_score, recall_score, precision_recall_curve, fbeta_score, confusi
from sklearn.metrics import roc_auc_score, roc_curve

from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import MultinomialNB, BernoulliNB
from sklearn.svm import LinearSVC
from sklearn.ensemble import RandomForestClassifier

from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer
from nltk import ngrams,bigrams,trigrams
```

In [81]:

```
def cv_tf_train_test(dataframe,label,vectorizer,ngram):

    # Split the data into X and y data sets
    X = dataframe.comment_text
    y = dataframe[label]

    # Split our data into training and test data
    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=50)

    # Using vectorizer and removing stopwords
    cv1 = vectorizer(ngram_range=(ngram), stop_words='english')

    # Transforming x-train and x-test
    X_train_cv1 = cv1.fit_transform(X_train)
    X_test_cv1  = cv1.transform(X_test)

    ## Machine learning models

    ## Logistic regression
    lr = LogisticRegression()
    lr.fit(X_train_cv1, y_train)

    ## k-nearest neighbours
    knn = KNeighborsClassifier(n_neighbors=5)
    knn.fit(X_train_cv1, y_train)

    ## Naive Bayes
    bnb = BernoulliNB()
    bnb.fit(X_train_cv1, y_train)

    ## Multinomial naive bayes
    mnb = MultinomialNB()
    mnb.fit(X_train_cv1, y_train)

    ## Support vector machine
    svm_model = LinearSVC()
    svm_model.fit(X_train_cv1, y_train)

    ## Random Forest
    randomforest = RandomForestClassifier(n_estimators=100, random_state=50)
    randomforest.fit(X_train_cv1, y_train)

    f1_score_data = {'F1 Score':[f1_score(lr.predict(X_test_cv1), y_test), f1_score(knn.predict(X_test_cv1), y_te
                            f1_score(bnb.predict(X_test_cv1), y_test), f1_score(mnb.predict(X_test_cv1), y_te
                            f1_score(svm_model.predict(X_test_cv1), y_test), f1_score(randomforest.predict(X_
    ## Saving f1 score results into a dataframe
    df_f1 = pd.DataFrame(f1_score_data, index=['Log Regression','KNN', 'BernoulliNB', 'MultinomialNB', 'SVM', 'Ra

    return df_f1
```

## Evaluating model performance using evaluation metrics.

In [82]:

```
severe_toxic_comment_cv = cv_tf_train_test(Severe_toxic_comment_balanced, 'severe_toxic', TfidfVectorizer, (1,1))
severe_toxic_comment_cv.rename(columns={'F1 Score': 'F1 Score(severe_toxic)'}, inplace=True)
severe_toxic_comment_cv
# Multinomial NB has higher F1 score
```

Out[82]:

| | F1 Score(severe_toxic) |
|---|---|
| **Log Regression** | 0.940282 |
| **KNN** | 0.860192 |
| **BernoulliNB** | 0.790738 |
| **MultinomialNB** | 0.932377 |
| **SVM** | 0.937901 |
| **Random Forest** | 0.941176 |

In [83]:

```
obscene_comment_cv = cv_tf_train_test(Obscene_comment_balanced, 'obscene', TfidfVectorizer, (1,1))
obscene_comment_cv.rename(columns={'F1 Score': 'F1 Score(obscene)'}, inplace=True)
obscene_comment_cv
# Random Forest has higher F1 score
```

Out[83]:

| | F1 Score(obscene) |
|---|---|
| **Log Regression** | 0.901183 |
| **KNN** | 0.625341 |
| **BernoulliNB** | 0.766640 |
| **MultinomialNB** | 0.887496 |
| **SVM** | 0.915613 |
| **Random Forest** | 0.884261 |

In [84]:

```
threat_comment_cv = cv_tf_train_test(Threatening_comment_balanced, 'threat', TfidfVectorizer, (1,1))
threat_comment_cv.rename(columns={'F1 Score': 'F1 Score(threat)'}, inplace=True)
threat_comment_cv
# Random Forest has higher F1 score
```

Out[84]:

| | F1 Score(threat) |
|---|---|
| **Log Regression** | 0.897338 |
| **KNN** | 0.852459 |
| **BernoulliNB** | 0.745205 |
| **MultinomialNB** | 0.902098 |
| **SVM** | 0.894737 |
| **Random Forest** | 0.923077 |

In [85]:

```
insult_comment_cv = cv_tf_train_test(Insulting_comment_balanced, 'insult', TfidfVectorizer, (1,1))
insult_comment_cv = cv_tf_train_test(insulting_comment_balanced, 'insult', TfidfVectorizer, (1,1))
insult_comment_cv.rename(columns={'F1 Score': 'F1 Score(insult)'}, inplace=True)
insult_comment_cv
# SVM has higher F1 score
```

Out[85]:

| | F1 Score(insult) |
|---|---|
| Log Regression | 0.901851 |
| KNN | 0.320661 |
| BernoulliNB | 0.776986 |
| MultinomialNB | 0.896299 |
| SVM | 0.906218 |
| Random Forest | 0.890821 |

In [86]:

```
identity_hatecomment_cv = cv_tf_train_test(IdentityHate_comment_balanced, 'identity_hate', TfidfVectorizer, (1,1
identity_hatecomment_cv.rename(columns={'F1 Score': 'F1 Score(identity_hate)'}, inplace=True)
identity_hatecomment_cv
# MultinomialNB has higher F1 score
```

Out[86]:

| | F1 Score(identity_hate) |
|---|---|
| Log Regression | 0.905707 |
| KNN | 0.820046 |
| BernoulliNB | 0.776699 |
| MultinomialNB | 0.903302 |
| SVM | 0.896806 |
| Random Forest | 0.888087 |

In [87]:

```
X = Toxic_comment_balanced.comment_text
y = Toxic_comment_balanced['toxic']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

# Initiate a Tfidf vectorizer
tfv = TfidfVectorizer(ngram_range=(1,1), stop_words='english')

X_train_fit = tfv.fit_transform(X_train)
X_test_fit = tfv.transform(X_test)
randomforest = RandomForestClassifier(n_estimators=100, random_state=50)

randomforest.fit(X_train_fit, y_train)
randomforest.predict(X_test_fit)
```

Out[87]:

```
array([0, 1, 1, ..., 1, 1, 1], dtype=int64)
```

In [88]:

```
## Testing the model to check if the given text is toxic or not.
```

In [89]:

```
comment1 = ['i killed an insect and ate it']
comment1_vect = tfv.transform(comment1)
randomforest.predict_proba(comment1_vect)[:,1]
## As seen below the above comment is 73 percent toxic
```

Out[89]:

```
array([0.73519444])
```

In [90]:

```
comment2 = ['Is this sentence a good one']
comment2_vect = tfv.transform(comment2)
randomforest.predict_proba(comment2_vect)[:,1]
## As seen below the above comment is 0.08 percent toxic which says the comment is not toxic
```

Out[90]:

```
array([0.08770635])
```

In [91]:

```
comment2 = ['truth will prevail']
comment2_vect = tfv.transform(comment2)
randomforest.predict_proba(comment2_vect)[:,1]
```

```
## The above comment is 46 percent toxic.
```

Out[91]:

```
array([0.46238997])
```

In [ ]:

```

```

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