Objective:

To design a recommendation system that can suggest personalized news articles or blog posts to users based on their reading history and interests.The system should be able to learn and adapt to the user's preferences overtime and provide relevant and engaging content.

About Dataset:

The datasets consists of variables like category, headline, authors, link, short_description, date.

Variables Description:

- category: The category of the news.
- headline: The title of news.
- authors: Author of that particular news.
- link: The web address of that particular news.
- short_desceiption: In short about the news published.
- date: Day on which the news was published.

Tasks carried out:

- Data Extraction
- Data Exploration and EDA.
- Text Processing.
- Model Building
- Creating a pickle file for model deployment using web application :.

1) Importing The Required Libraries:

In [5]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import datetime
#import nltk
import string
#nltk.download('stopwords')
from nltk.corpus import stopwords, wordnet
from nltk.tokenize import word_tokenize
from nltk.stem import WordNetLemmatizer
#from gensim.models import Word2Vec
#from gensim.models import KeyedVectors
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics import pairwise_distances
from sklearn.metrics.pairwise import euclidean_distances
#from sklearn.metrics.pairwise import cosine_similarity
#from scipy.sparse import csr_matrix
import pickle
import warnings
warnings.filterwarnings("ignore")
```

2) Loading The Dataset:

In [6]:
```
news_articles = pd.read_csv(r"C:\Users\sksho\Desktop\ZenteiQ\Work\Data\News category dataset.csv")
news_articles.head()
```

Out[6]:

	category	headline	authors	link	short_description	date
0	CRIME	There Were 2 Mass Shootings In Texas Last Week...	Melissa Jeltsen	https://www.huffingtonpost.com/entry/texas-ama...	She left her husband. He killed their children...	2018-05-26
1	ENTERTAINMENT	Will Smith Joins Diplo And Nicky Jam For The 2...	Andy McDonald	https://www.huffingtonpost.com/entry/will-smit...	Of course it has a song.	2018-05-26
2	ENTERTAINMENT	Hugh Grant Marries For The First Time At Age 57	Ron Dicker	https://www.huffingtonpost.com/entry/hugh-gran...	The actor and his longtime girlfriend Anna Ebe...	2018-05-26
3	ENTERTAINMENT	Jim Carrey Blasts 'Castrato' Adam Schiff And D...	Ron Dicker	https://www.huffingtonpost.com/entry/jim-carre...	The actor gives Dems an ass-kicking for not fi...	2018-05-26
4	ENTERTAINMENT	Julianna Margulies Uses Donald Trump Poop Bags...	Ron Dicker	https://www.huffingtonpost.com/entry/julianna-...	The "Dietland" actress said using the bags is ...	2018-05-26

In [7]:
```
news_articles.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200853 entries, 0 to 200852
Data columns (total 6 columns):
 #   Column             Non-Null Count   Dtype
---  ------             --------------   -----
 0   category           200853 non-null  object
 1   headline           200847 non-null  object
 2   authors            164233 non-null  object
 3   link               200853 non-null  object
 4   short_description  181141 non-null  object
 5   date               200853 non-null  object
dtypes: object(6)
memory usage: 9.2+ MB
```

Note: From above we can observe that there are some missing values. Hence we will check the Number of missing values in the data and the contribution of missing values in the data.

In [8]:
```
missing_values_contribution = pd.DataFrame({'No.of Missing Values': news_articles.isna().sum(),
                                            '% of Missing Values': (news_articles.isna().sum() / len(news_articles)) * 100})
```

In [9]:
```
missing_values_contribution
```

Out[9]:

	No.of Missing Values	% of Missing Values
category	0	0.000000
headline	6	0.002987
authors	36620	18.232239
link	0	0.000000
short_description	19712	9.814143
date	0	0.000000

Note: There are total 200853 records in the data with 6 object type features. Also there are missing values in the data.

- We can observe that the feature authors have maximum number of missing values followed by shrot_description and headlines which contributes about 18.23%, 9.81%, and 0.0029% of data respectively.
- We will drop this null values as this will not contribute much in our analysis of dataset.

In [10]:
```
news_articles.dropna(inplace=True)
```

In [11]:
```
news_articles.isna().sum()
```

Out[11]:
```
category             0
headline             0
authors              0
link                 0
short_description    0
date                 0
dtype: int64
```

In [12]:
```
news_articles.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 148983 entries, 0 to 200848
Data columns (total 6 columns):
 #   Column             Non-Null Count   Dtype
---  ------             --------------   -----
 0   category           148983 non-null  object
 1   headline           148983 non-null  object
 2   authors            148983 non-null  object
 3   link               148983 non-null  object
 4   short_description  148983 non-null  object
 5   date               148983 non-null  object
dtypes: object(6)
memory usage: 8.0+ MB
```

Note: we can observe that all null values have be dropped and we are left with 148983 non null values.

In [13]:
```
news_articles.shape
```

Out[13]:
```
(148983, 6)
```

Note: From the dataset we can note that the columns category, authors, and short description can have same values. hence we have to note that if there are any duplicate values in the headlines column. and eliminate them.

In [14]:
```
news_articles['headline'].count()
```

Out[14]:
```
148983
```

In [15]:
```
news_articles
```

Out[15]:

	category	headline	authors	link	short_description	date
0	CRIME	There Were 2 Mass Shootings In Texas Last Week...	Melissa Jeltsen	https://www.huffingtonpost.com/entry/texas-ama...	She left her husband. He killed their children...	2018-05-26
1	ENTERTAINMENT	Will Smith Joins Diplo And Nicky Jam For The 2...	Andy McDonald	https://www.huffingtonpost.com/entry/will-smit...	Of course it has a song.	2018-05-26
2	ENTERTAINMENT	Hugh Grant Marries For The First Time At Age 57	Ron Dicker	https://www.huffingtonpost.com/entry/hugh-gran...	The actor and his longtime girlfriend Anna Ebe...	2018-05-26
3	ENTERTAINMENT	Jim Carrey Blasts 'Castrato' Adam Schiff And D...	Ron Dicker	https://www.huffingtonpost.com/entry/jim-carre...	The actor gives Dems an ass-kicking for not fi...	2018-05-26
4	ENTERTAINMENT	Julianna Margulies Uses Donald Trump Poop Bags...	Ron Dicker	https://www.huffingtonpost.com/entry/julianna-...	The "Dietland" actress said using the bags is ...	2018-05-26
...	...	...	...	...	...	...
200843	TECH	Good Games -- Is It possible?	Mateo Gutierrez, Contributor\nArtist	https://www.huffingtonpost.com/entry/games-for...	I don't think people who play Zynga games are ...	2012-01-28
200844	TECH	Google+ Now Open for Teens With Some Safeguards	Larry Magid, Contributor\nTechnology journalist	https://www.huffingtonpost.com/entry/google-pl...	For the most part, teens' experience on Google...	2012-01-28
200845	TECH	Web Wars	John Giacobbi, Contributor\nTales from the Int...	https://www.huffingtonpost.com/entry/congress-...	These "Web Wars" threaten to rage on for some ...	2012-01-28
200847	TECH	Watch The Top 9 YouTube Videos Of The Week	Catharine Smith	https://www.huffingtonpost.com/entry/watch-top...	If you're looking to see the most popular YouT...	2012-01-28
200848	TECH	RIM CEO Thorsten Heins' 'Significant' Plans Fo...	Reuters, Reuters	https://www.huffingtonpost.com/entry/rim-ceo-t...	Verizon Wireless and AT&T are already promotin...	2012-01-28

148983 rows × 6 columns

In [16]:
```
news_articles.sort_values('headline',inplace=True, ascending=False)
duplicated_articles_series = news_articles.duplicated('headline', keep = False)
news_articles = news_articles[~duplicated_articles_series]
print("Total number of articles after removing duplicates:", news_articles['headline'].nunique())
```

```
Total number of articles after removing duplicates: 147706
```

To see the total number of unique records.

In [17]:
```
news_articles.nunique()
```

Out[17]:
```
category                 41
headline             147706
authors               27055
link                 147706
short_description    146102
date                   2309
dtype: int64
```

3) Exploratory Data Analysis:

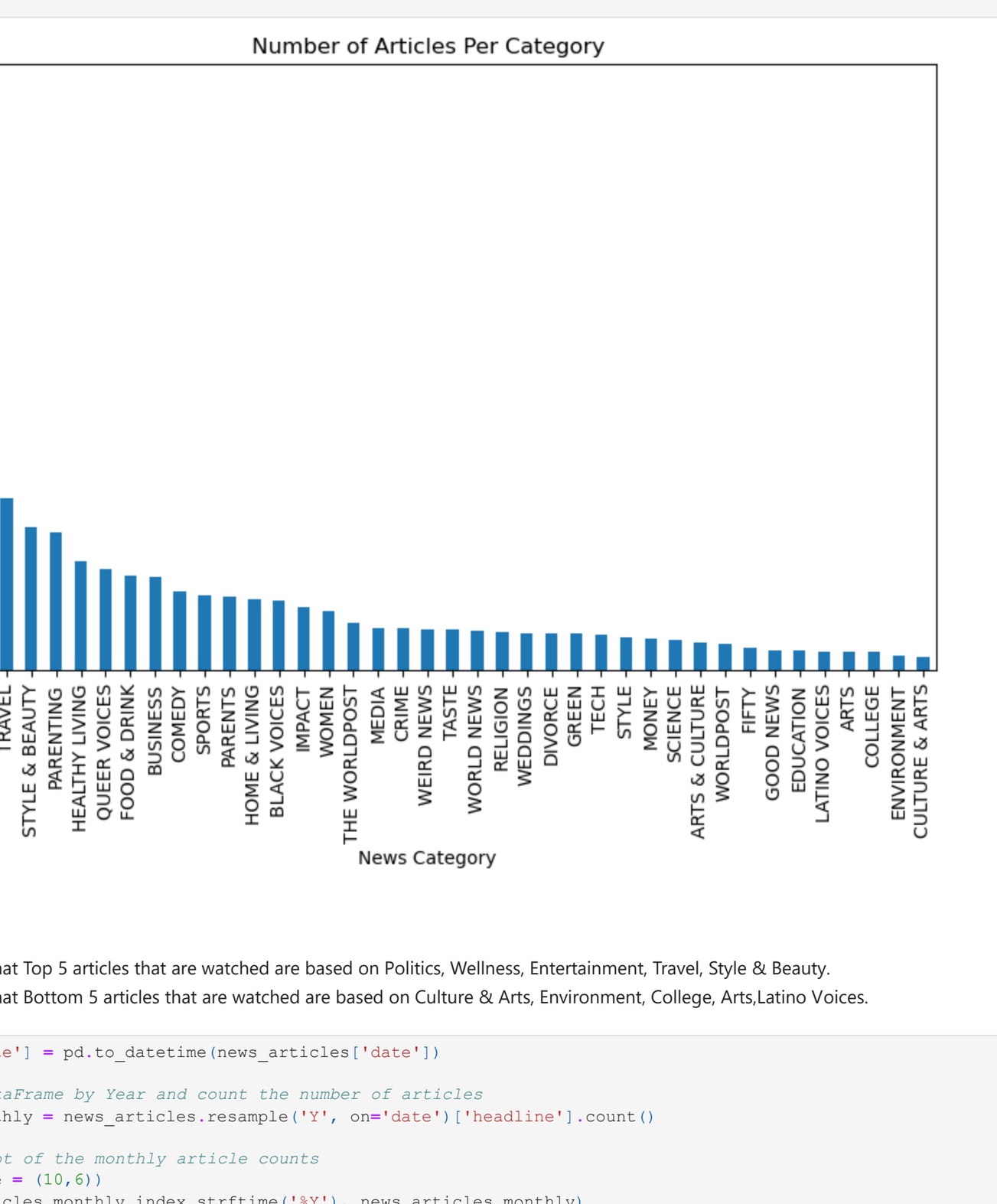
In [18]:
```
news_articles["category"].value_counts().head()
```

Out[18]:
```
POLITICS          26779
WELLNESS          12745
ENTERTAINMENT     12171
TRAVEL             7992
STYLE & BEAUTY     6635
Name: category, dtype: int64
```

In [19]:
```
news_articles["category"].value_counts().tail()
```

Out[19]:
```
LATINO VOICES     877
ARTS              861
COLLEGE           859
ENVIRONMENT       669
CULTURE & ARTS    611
Name: category, dtype: int64
```

In [20]:
```
plt.figure(figsize=(10,6))
news_articles["category"].value_counts().plot.bar(xlabel = 'News Category',
                                  ylabel = 'Number of Articles',
                                  title = 'Number of Articles Per Category')
plt.show()
```



Note:

- We can observe that Top 5 articles that are watched are based on Politics, Wellness, Entertainment, Travel, Style & Beauty.
- We can observe that Bottom 5 articles that are watched are based on Culture & Arts, Environment, College, Arts,Latino Voices.

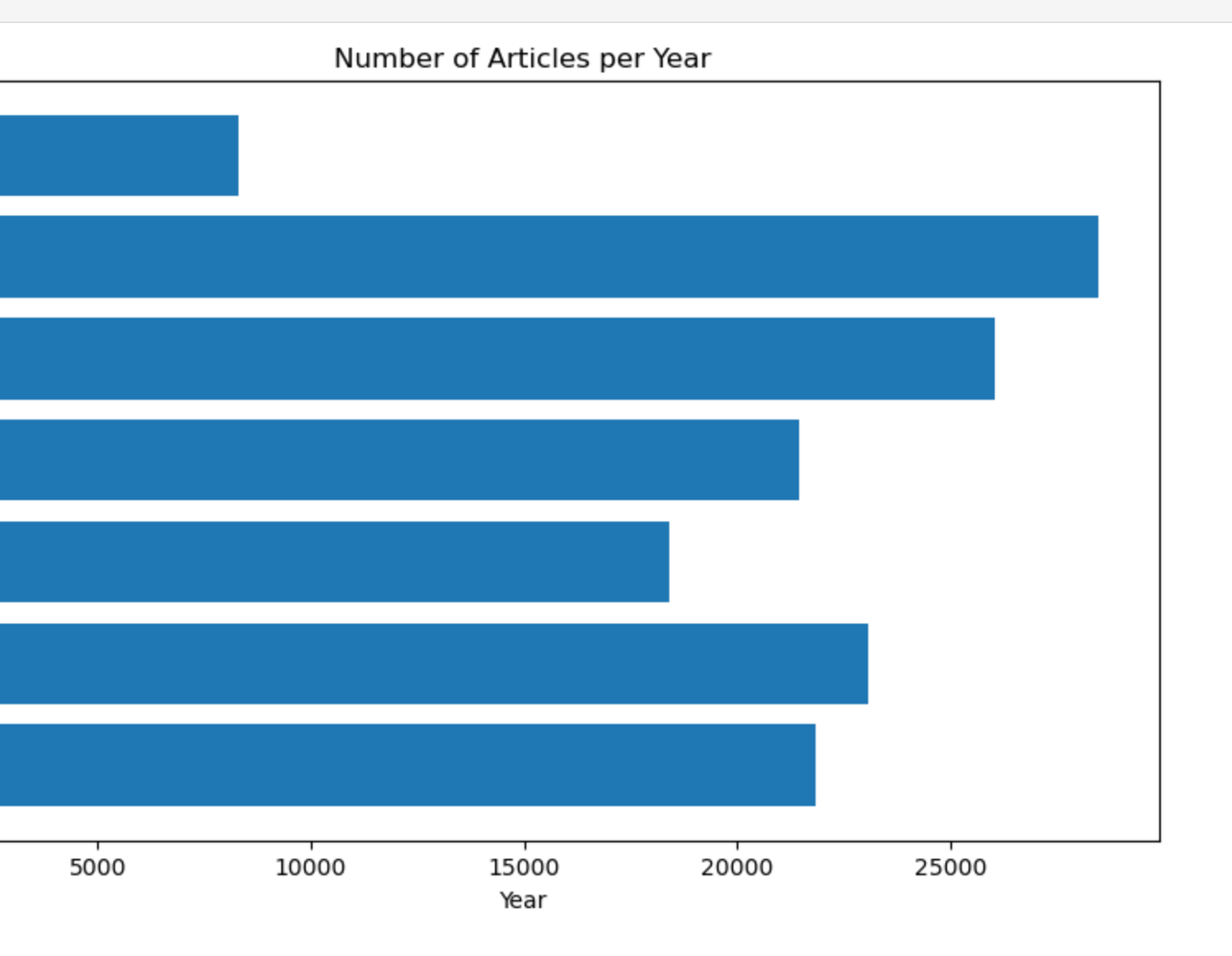
In [21]:
```
news_articles['date'] = pd.to_datetime(news_articles['date'])

# Resample the DataFrame by Year and count the number of articles
news_articles_monthly = news_articles.resample('Y', on='date')['headline'].count()

# Create a bar plot of the monthly article counts
plt.figure(figsize = (10,6))
plt.barh(news_articles_monthly.index.strftime('%Y'), news_articles_monthly)

# Set the plot title and axis labels
plt.title('Number of Articles per Year')
plt.xlabel('Year')
plt.ylabel('Number of Articles')

# Display the plot
plt.show()
```



Note: From above ditribution we can observe the total number of articles on yearly basis.

In [22]:
```
news_articles.index = range(news_articles.shape[0])
```

In [23]:
```
news_articles["day and month"] = news_articles["date"].dt.strftime("%a") + "_" + news_articles["date"].dt.strftime("%b")
```

In [24]:
```
news_articles["user_id"] = ["user_" + str(i) for i in range(1, 147707)]
```

In [25]:
```
news_articles = news_articles.reindex(columns=['user_id', 'category', 'headline','authors','link','short_description','date','day and month'])
```

In [26]:
```
news_articles
```

Out[26]:

	user_id	category	headline	authors	link	short_description	date	day and month
0	user_1	WOMEN	"We Shall Overcomb!" Say The 100,000 Marching ...	Darin Graham, ContributorJournalist	https://www.huffingtonpost.com/entry/we-shall-...	Thousands of activists descended on London to ...	2017-01-25	Wed_Jan
1	user_2	HEALTHY LIVING	"To The Bone" Didn't Teach Me Glamour. It Taug...	Mycah Hazel, Contributorblogger, equal opportu...	https://www.huffingtonpost.com/entry/to-the-bo...	Oftentimes, films or TV shows about eating dis...	2017-07-18	Tue_Jul
2	user_3	BUSINESS	"I'm Sorry"--The Two Tragically Forgotten Word...	Dana Brownlee, ContributorPresident of Profess...	https://www.huffingtonpost.com/entry/im-sorryt...	Unfortunately, I was one of those frustrated p...	2017-04-10	Mon_Apr
3	user_4	QUEER VOICES	'Will & Grace' Creator To Donate Gay Bunny Boo...	Elyse Wanshel	https://www.huffingtonpost.com/entry/will-grac...	It's about to be a lot easier for kids in Mike...	2018-04-02	Mon_Apr
4	user_5	WEIRD NEWS	'Wild Boar Curling' Rescues Stranded Wild Boar...	Nina Golgowski	https://www.huffingtonpost.com/entry/wild-boar...	Get this pig in a blanket!	2016-02-03	Wed_Feb
...	...	...	...	...	...	...	...	...
147701	user_147702	PARENTING	"A Doctor Prescribed My Son 140 Pain Pills in ...	Tessie Castillo, Contributor\nAdvocacy and Com...	https://www.huffingtonpost.com/entry/a-doctor-...	"I thought Riley was exempt from hard drugs," ...	2013-08-29	Thu_Aug
147702	user_147703	ARTS	"@Large" and Absent, Ai Weiwei on Alcatraz	MutualArt, ContributorWorld's largest online a...	https://www.huffingtonpost.com/entry/large-and...	The United States' most storied island prison,...	2014-10-06	Mon_Oct
147703	user_147704	MONEY	"4% Rule" Serves as Guideline for Today's Reti...	Cheryl Krueger, Contributor\nFounder, Growing ...	https://www.huffingtonpost.com/entry/retiremen...	An estimated 10,000 baby boomers turn age 65 e...	2012-04-04	Wed_Apr
147704	user_147705	ENTERTAINMENT	"3 Days to Kill" Proves Costner's Still Got It	Jackie K Cooper, Contributor\nFilm Critic	https://www.huffingtonpost.com/entry/3-days-to...	Kevin Costner is starring in the new action fl...	2014-02-22	Sat_Feb
147705	user_147706	ENTERTAINMENT	"2 Guns": Two Pros In Action	Jackie K Cooper, Contributor\nFilm Critic	https://www.huffingtonpost.com/entry/2-guns-tw...	It helps that the supporting cast is almost as...	2013-08-03	Sat_Aug

147706 rows × 8 columns

In [27]:
```
news_articles_temp = news_articles.copy()
```

In [28]:
```
news_articles_temp.head(1)
```

Out[28]:

	user_id	category	headline	authors	link	short_description	date	day and month
0	user_1	WOMEN	"We Shall Overcomb!" Say The 100,000 Marching ...	Darin Graham, ContributorJournalist	https://www.huffingtonpost.com/entry/we-shall-...	Thousands of activists descended on London to ...	2017-01-25	Wed_Jan

In [29]:
```
news_articles_temp.tail(1)
```

Out[29]:

	user_id	category	headline	authors	link	short_description	date	day and month
147705	user_147706	ENTERTAINMENT	"2 Guns": Two Pros In Action	Jackie K Cooper, Contributor\nFilm Critic	https://www.huffingtonpost.com/entry/2-guns-tw...	It helps that the supporting cast is almost as...	2013-08-03	Sat_Aug

Note: We can observe that all the changes has been done.

4) Text Processing:

In [30]:
```
stop_words = set(stopwords.words('english'))
```

In [31]:
```
for i, headline in enumerate(news_articles_temp["headline"]):
    cleaned_words = [word.lower() for word in headline.split() if word.isalnum() and word.lower() not in stop_words]
    cleaned_headline = ' '.join(cleaned_words)
    news_articles_temp.at[i, "clean_headline"] = cleaned_headline
    if(i%1000==0):
        print(i)           # To track number of records processed
```

```
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
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```

In [32]:
```
lemmatizer = WordNetLemmatizer()
```

In [33]:
```
for i, headline in enumerate(news_articles_temp["headline"]):
    if isinstance(headline, str):
        lemmatized_words = [lemmatizer.lemmatize(word, pos="v") for word in word_tokenize(headline)]
        lemmatized_headline = ' '.join(lemmatized_words)
        news_articles_temp.at[i, "lemmatized_headline"] = lemmatized_headline
    if i % 1000 ==0:
        print(i)
```

```
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147000
```

5) Model Building:

5.1 Using Bag of Words:

In [34]:
```
headline_vectorizer = CountVectorizer()
headline_features   = headline_vectorizer.fit_transform(news_articles_temp['headline'])
```

In [35]:
```
headline_features.get_shape()
```

Out[35]:
```
(147706, 48689)
```

In [44]:
```
from sklearn.metrics.pairwise import euclidean_distances

euclidean_sim = None  # Declare as global variable

def bag_of_words_based_model(user_id, num_similar_items):
    global euclidean_sim  # Declare as global to modify the variable

    # Calculate the Euclidean similarity
    euclidean_sim = euclidean_distances(headline_features,headline_features[user_id].reshape(1, -1))
    indices = np.argsort(euclidean_sim.ravel())[0:num_similar_items]

    df = pd.DataFrame({
        'publish_date': news_articles['date'][indices].values,
        'category': news_articles['category'][indices].values,
        'headline': news_articles['headline'][indices].values,
        'link': news_articles['link'][indices].values,
        'short_description': news_articles['short_description'][indices].values,
        'Euclidean similarity with the queried article': euclidean_sim[indices].ravel()
    })

    print("*" * 30, "Queried article details", "*" * 30)
    print('headline: ', news_articles['headline'][indices[0]])
    print("\n", "*" * 30, "Recommended articles: ", "*" * 30)

    return df.iloc[1:,]
```

Note: we have created a function with 2 input parameters i.e., user_id and number of recommendations needed for that particular user_id. Now we will enter the parameters and see the recommendations using Bag of words.

In [45]:
```
bag_of_words_based_model(1, 5)
```

```
****************************** Queried article details ******************************
headline:  “To The Bone” Didn’t Teach Me Glamour. It Taught Me Respect.

 ****************************** Recommended articles:  ******************************
```

Out[45]:

	publish_date	category	headline	link	short_description	Euclidean similarity with the queried article
1	2015-05-18	HEALTHY LIVING	It Didn't Happen to Me	https://www.huffingtonpost.com/entry/it-didnt-...	If it happened to a friend, a third cousin twi...	2.828427
2	2013-11-18	WELLNESS	The Real Me	https://www.huffingtonpost.com/entry/the-real-...	Several weeks ago I had that moment. With very...	3.162278
3	2015-04-06	SCIENCE	Fly Me to the Moon!	https://www.huffingtonpost.com/entry/fly-me-to...	Yes, I know the current push by our Federal Sp...	3.162278
4	2013-10-16	PARENTING	Listen to Me	https://www.huffingtonpost.com/entry/listen-to...	Kids don't listen. Not every time. Not now and...	3.162278

Note: Hence we can see that the following recommendations have been provided for the user_id we have chosen.

5.2 Using Tf-idf:

In [46]:
```
tfidf_headline_vectorizer = TfidfVectorizer(min_df = 0)
tfidf_headline_features = tfidf_headline_vectorizer.fit_transform(news_articles_temp['headline'])
```

In [47]:
```
euclidean_sim = None  # Declare as global variable

def tfidf_based_model(user_id, num_similar_items):
    global euclidean_sim  # Declare as global to modify the variable

    # Calculate the Euclidean similarity
    euclidean_sim = euclidean_distances(headline_features, headline_features[user_id].reshape(1, -1))
    indices = np.argsort(euclidean_sim.ravel())[0:num_similar_items]

    df = pd.DataFrame({
        'publish_date': news_articles['date'][indices].values,
        'category': news_articles['category'][indices].values,
        'headline': news_articles['headline'][indices].values,
        'link': news_articles['link'][indices].values,
        'short_description': news_articles['short_description'][indices].values,
        'Euclidean similarity with the queried article': euclidean_sim[indices].ravel()
    })

    print("*" * 30, "Queried article details", "*" * 30)
    print('headline: ', news_articles['headline'][indices[0]])
    print("\n", "*" * 30, "Recommended articles: ", "*" * 30)

    return df.iloc[1:,]
```

Note: we have created a function with 2 input parameters i.e., user_id and number of recommendations needed for that particular user_id. Now we will enter the parameters and see the recommendations using Tf-idf.

In [48]:
```
tfidf_based_model(1, 5)
```

```
****************************** Queried article details ******************************
headline:  “To The Bone” Didn’t Teach Me Glamour. It Taught Me Respect.

 ****************************** Recommended articles:  ******************************
```

Out[48]:

	publish_date	category	headline	link	short_description	Euclidean similarity with the queried article
1	2015-05-18	HEALTHY LIVING	It Didn't Happen to Me	https://www.huffingtonpost.com/entry/it-didnt-...	If it happened to a friend, a third cousin twi...	2.828427
2	2013-11-18	WELLNESS	The Real Me	https://www.huffingtonpost.com/entry/the-real-...	Several weeks ago I had that moment. With very...	3.162278
3	2015-04-06	SCIENCE	Fly Me to the Moon!	https://www.huffingtonpost.com/entry/fly-me-to...	Yes, I know the current push by our Federal Sp...	3.162278
4	2013-10-16	PARENTING	Listen to Me	https://www.huffingtonpost.com/entry/listen-to...	Kids don't listen. Not every time. Not now and...	3.162278

Note: Hence we can see that the following recommendations have been provided for the user_id we have chosen.

In [49]:
```
euclidean_sim
```

Out[49]:
```
array([[4.79583152],
       [0.        ],
       [4.47213595],
       ...,
       [4.89897949],
       [4.12310563],
       [4.24264069]])
```

6) Creating a pickle file for model deployment using web application :

Note: There are lots of features i am filtering the requrired features i.e., user_id, category, headline, link, short_description as this will be used to get the information related to news recommendation.

In [50]:
```
# Making a dictionary so that this can be consumed in the web application
data_for_web_app = news_articles_temp[['user_id','category','headline','link','short_description']]
```

In [ ]:
```
# Exporting the filtered data for Web App to csv file so that it can be consumed during development.
data_for_web_app.to_csv('user_data.csv')
```

In [ ]:
```
# Save the final Model as a pickle file for deployment.
pickle.dump(tfidf_headline_vectorizer,open('tf-idf Final Model File.pkl','wb'))
```

In [41]: