PROJECT - (2nd April, 2021 - 18th April, 2021)

1. PART ONE

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
%tensorflow_version 2.x
import tensorflow
tensorflow.__version__
```

```
'2.4.1'
```

```
project_path = '/content/drive/MyDrive/My Files/AIML Workbooks'
```

```
import os                   # Importing os library
import pandas as pd         # To read the data set
import numpy as np          # Importing numpy library
import seaborn as sns       # For data visualization
import matplotlib.pyplot as plt      # Necessary library for plotting graphs
from glob import glob       # Importing necessary library
import tensorflow as tf     # Importing library
%matplotlib inline
sns.set(color_codes = True)

from sklearn import metrics          # Importing metrics
from sklearn.model_selection import train_test_split       # Splitting data into
from sklearn.metrics import classification_report, accuracy_score, recall_score,
from sklearn.preprocessing import StandardScaler           # Importing to standa
from sklearn.impute import SimpleImputer                   # Importing to fill i
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import PolynomialFeatures       # Importing polynomia
from sklearn.decomposition import PCA           # Importing to run pca analysis
from sklearn import svm              # Importing necessary library for model bui
from sklearn.ensemble import RandomForestClassifier        # Importing necessary
from sklearn.neighbors import KNeighborsClassifier         # Importing necessary
from sklearn import preprocessing               # Importing preprocessing librar
```

```
from sklearn.model_selection import KFold, cross_val_score          # Importing
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV          #
from sklearn.cluster import KMeans             # For KMeans cluster model build
from scipy.stats import zscore       # Import zscore library
from scipy.spatial.distance import cdist        # Importing cdist functionality
import tensorflow           # Importing tensorflow library
from tensorflow.keras.models import Sequential, Model              # Importing
from tensorflow.keras.utils import to_categorical         # Importing tensorflo
from tensorflow.keras import optimizers                   # Importing optimizer
from tensorflow.keras.layers import Dense, Dropout, Activation, BatchNormalizati
from tensorflow.keras.applications.mobilenet import preprocess_input          #
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLRO
from tensorflow.keras.applications.mobilenet import MobileNet       # Importing
from tensorflow.keras.losses import binary_crossentropy             # Importing
from tensorflow.keras.backend import log, epsilon          # Importing necessary
from keras.utils import np_utils     # Importing necessary library
from sklearn import svm              # Importing necessary library for model bui
from sklearn.svm import SVC          # Import svc library for model building

from skimage.color import rgb2gray             # Loading color library
from sklearn.preprocessing import OneHotEncoder            # Library for one hot
from sklearn.metrics import confusion_matrix               # Loading necessary l
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img, i
from keras.preprocessing import image          # Importing necessary image libr
from tensorflow import keras         # Loading keras libaray
from tensorflow.keras.optimizers import Adam, SGD          # Importing optimizer
import cv2                  # Importing necessary library
from PIL import ImageFile           # Importing image library
from tqdm import tqdm               # Importing necessary library
import time                 # Importing time library
from mpl_toolkits.axes_grid1 import ImageGrid              # Importing necessary
from PIL import Image       # Importing image library

import re                   # Importing regular expression library
import nltk                 # Import necessary library
from nltk.corpus import stopwords              # Importing necessary library
from sklearn.feature_extraction.text import CountVectorizer          # Importing
from sklearn.preprocessing import MultiLabelBinarizer      # Imorting necessary


nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
True
```

1. Import and analyse the data set.

```
df = pd.read_csv('/content/drive/MyDrive/My Files/AIML Workbooks/blogtext.csv')
```

```
df.shape
```

```
(681284, 7)
```

```
df.size
```

```
4768988
```

```
df.sample(10)         # Checking if the dataset is loaded properly
```

	id	gender	age	topic	sign	date	
613968	3568208	female	14	Student	Leo	08,July,2004	sigh s skool
61224	3881543	male	24	Military	Gemini	14,July,2004	I had dream y
6601	883178	male	36	Fashion	Aries	13,November,2002	As son know, my
486646	4164598	male	16	indUnk	Scorpio	12,August,2004	Today i time in c n
234953	1021779	female	25	indUnk	Scorpio	29,January,2004	Getting ba trip play

```
df.isna().any()          # Checking for any null values in the dataset
```

```
id        False
gender    False
age       False
topic     False
sign      False
date      False
text      False
dtype: bool
```

```
df.isna().sum()
```

```
id        0
gender    0
age       0
topic     0
sign      0
date      0
text      0
dtype: int64
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 681284 entries, 0 to 681283
Data columns (total 7 columns):
 #   Column  Non-Null Count   Dtype 
---  ------  --------------   ----- 
 0   id      681284 non-null  int64 
 1   gender  681284 non-null  object
 2   age     681284 non-null  int64 
 3   topic   681284 non-null  object
 4   sign    681284 non-null  object
 5   date    681284 non-null  object
 6   text    681284 non-null  object
dtypes: int64(2), object(5)
memory usage: 36.4+ MB
```

```
df.gender.value_counts()
```

```
male      345193
female    336091
Name: gender, dtype: int64
```

```
# As the dataset is large we are using fewer rows, inorder to run compatibly wit

df_new = pd.read_csv('/content/drive/MyDrive/My Files/AIML Workbooks/blogtext.cs
```

```
df_new.sample(10)         # Checking if the dataset is loaded properly
```

	id	gender	age	topic	sign	date	te
67380	2134154	male	16	Arts	Taurus	19,April,2004	If you are alrea watching Al
23519	299143	female	23	Engineering	Cancer	07,June,2002	Hmm...archiv are workin
61108	3423289	female	23	Arts	Leo	28,May,2004	Here is par a nice ema
73668	1570719	male	26	Education	Libra	01,August,2004	God I hope t doesn't co ou
54874	3712172	male	17	Student	Pisces	23,June,2004	H everybody! (to bec

```
df_new.size
```

```
700000
```

```
df_new.shape
```

```
(100000, 7)
```

```
df_new.info()
```

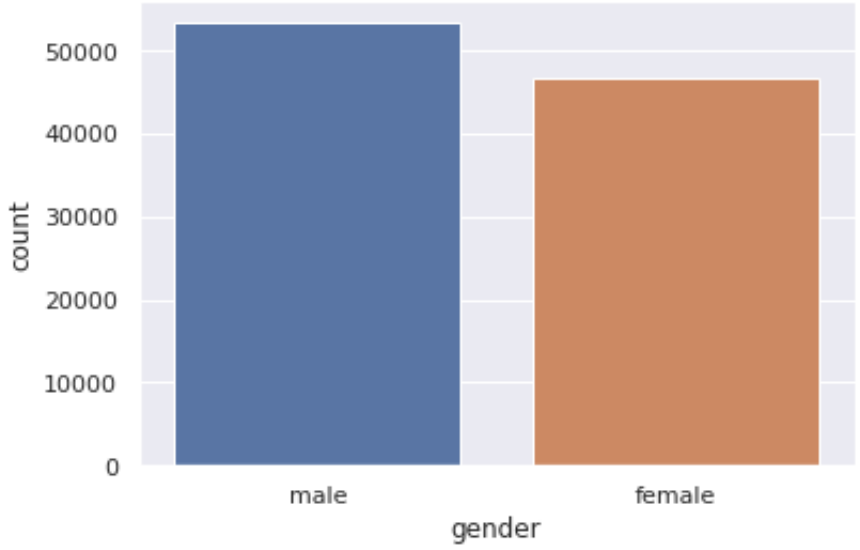
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 7 columns):
 #   Column  Non-Null Count   Dtype 
---  ------  --------------   ----- 
 0   id      100000 non-null  int64 
 1   gender  100000 non-null  object
 2   age     100000 non-null  int64 
 3   topic   100000 non-null  object
 4   sign    100000 non-null  object
 5   date    100000 non-null  object
 6   text    100000 non-null  object
dtypes: int64(2), object(5)
memory usage: 5.3+ MB
```

```
df_new.gender.value_counts()
```

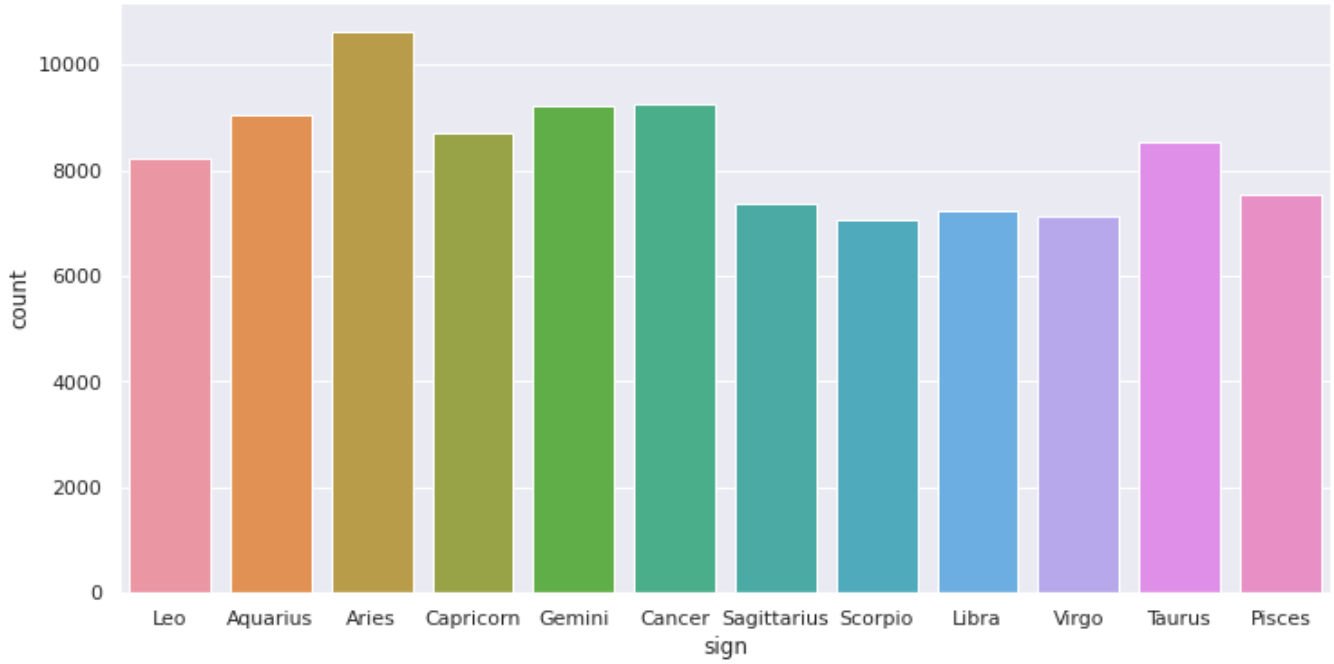
```
male      53358
female    46642
Name: gender, dtype: int64
```

```
sns.countplot(x = 'gender', data = df_new)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fb1e47b0210>
```



```
plt.figure(figsize = (12,6))
sns.countplot(x = 'sign', data = df_new);
```



2. Perform data pre-processing on the data

Data cleansing by removing unwanted characters, spaces, stop words etc.
Convert text to lowercase.

```
# Remove unwanted chars other than alphanumeric

pattern = "[^\w]"
df_new.text = df_new.text.apply(lambda s : re.sub(pattern,' ',s))
```

```
df_new.sample(5)
```

	id	gender	age	topic	sign	date	text
93407	324114	female	46	Consulting	Capricorn	19,May,2002	urlLink I don t know about...
52173	3718134	male	25	Arts	Scorpio	08,June,2003	Why is there such resistance out th...

```
# Coverting text to lowercase

df_new.text = df_new.text.apply(lambda s : s.lower())
```

```
df_new.sample(10)
```

	id	gender	age	topic	sign	date	text
3618	589736	male	35	Technology	Aries	05,August,2004	from ebert films like the ch...
39155	4002052	female	23	Education	Capricorn	08,August,2004	urllink alyson wong p...
6575	883178	male	36	Fashion	Aries	18,November,2002	that s a funny question because of...
1685	589736	male	35	Technology	Aries	05,August,2004	i know the feeling you are going th...
15039	4036173	female	24	Arts	Sagittarius	25,July,2004	this is my very first blog post ...

```
# Removing unwanted spaces

df_new.text = df_new.text.apply(lambda s : s.strip())
```

```
df_new.sample(10)
```

	id	gender	age	topic	sign	date	text
59157	2163386	male	26	Government	Taurus	18,April,2004	tomorrow i m going to make an appointment with...
36792	152151	female	23	Engineering	Libra	19,March,2001	i was talking to some friends yesterday and we...
56471	2217862	female	42	indUnk	Scorpio	16,June,2004	urllink this is one of my favourite places ...
38946	3955165	female	23	indUnk	Sagittarius	16,August,2004	whitey houston and vertical struts side trac...

```
# Removing stopwords

stopwords = set(stopwords.words('english'))

df_new.text  = df_new.text.apply(lambda t : ' '. join([words for words in t.spli
```

```
df_new.sample(10)
```

	id	gender	age	topic	sign	date	te
64515	1852920	female	25	indUnk	Sagittarius	18,May,2004	compu wa repr feeli poured h
39350	3672856	male	16	Student	Scorpio	26,July,2004	yup bra im free r look be though do
77159	2529236	male	24	indUnk	Cancer	08,July,2004	yester tom ri reminded osama lac
81913	1903669	female	14	Non-Profit	Aquarius	06,November,2003	

```
# Dropping id and date columns in the dataset

df_new.drop(labels = ['id', 'date'], axis = 1, inplace = True)

df_new.sample(10)
```

	gender	age	topic	sign	text
50089	male	27	Government	Sagittarius	urllink plane boeing 777 flew go england nice ...
11533	female	27	Publishing	Scorpio	hello dearest beautiful gal frens nbsp blog la...
82133	male	26	Technology	Scorpio	unsurprisingly berg execution made much impact...
11287	male	23	Engineering	Aquarius	urllink super prefix means upon superior size ...
22279	female	27	indUnk	Gemini	men desire virgin whore edward dahlberg died y...
9206	female	24	indUnk	Sagittarius	urllink las meninas velasquez el prado madrid
64417	female	23	Chemicals	Capricorn	dinner one arab street food stores tks treatin...
29085	female	33	Internet	Taurus	kind like answering silly quiz questions know

Target/label merger and transformation

```
df_new['labels'] = df_new.apply(lambda col : [col['gender'], col['age'], col['to

# Drop gender,age,topic & sign as they are already merged to labels column
df_new.drop(columns = ['gender','age','topic','sign'], axis = 1, inplace = True)

df_new.sample(10)
```

	text	labels
9134	came one house dance light feet kiss fingers l...	[female, 24, indUnk, Sagittarius]
95980	went last night sister drinks search man amazi...	[female, 25, Student, Taurus]
88660	idc reports pc shipments worldwide grew 1 5 20...	[male, 36, Technology, Pisces]
20112	okay month officially lost twice lost seoul am...	[female, 27, Education, Cancer]
35994	okay woke really late morning usually means ti...	[female, 16, Student, Sagittarius]
41996	happy 6th birthday andrew show great got odeon...	[female, 24, indUnk, Libra]
22418	well would seem everyone go ben lately well we...	[male, 17, Student, Cancer]
99894	jeevan ke har mod par mil jaate hain humsafar ...	[female, 27, Advertising, Aquarius]
29525	merciful lord blinded horror honestly think tr...	[female, 27, Government, Leo]
37615	safely contained illusive sactuary fragile wal...	[male, 36, Arts, Virgo]

Train and test split

```
x = df_new.text
y = df_new.labels

x_train, x_test, y_train, y_test = train_test_split(x,y, test_size = 0.2, random
```

```
print(x_train.shape)
print(y_train.shape)
print(x_test.shape)
print(y_test.shape)
```

```
(80000,)
(80000,)
(20000,)
(20000,)
```

```
x_train
```

```
78689    talking gal online chatted asked see pic showe...
76423    hey everybody started another painting yesterd...
86945    possibly need burn 2 ladders quote day power m...
57427    heart red urllink color heart brought urllink ...
34616    anything today woke 2pm hehehe made one ramen ...
                              ...
50057    method post urllink wild animal name username ...
98047    days rose bloom really like macro function nev...
5192     today dies cinerum lovely latin tells mean lit...
77708    awesome create blog keep posting choose templa...
98539    attention hamptons shoppers hottest talked wri...
Name: text, Length: 80000, dtype: object
```

```
x_test
```

```
43660    urllink information literacy wikipedia new art...
87278    sorry reading town day get practice make voice...
14317    happy birthday dad well huge news everyone goi...
81932    bothered wake 6 00 morning watch world idol re...
95321    artist beatles album let song let lennon mccar...
                              ...
73441    welcome course contrary title post means begin...
1341     weird feelings everything gonna talk 1 cuz one...
71987    birthday means drinking tonight dude pretty di...
26910    read lyle blog could say chance man desperate ...
24890    sin one ring hit today tolkien description one...
Name: text, Length: 20000, dtype: object
```

Vectorisation, etc.

```
convec = CountVectorizer(ngram_range=(1,2))
```

```
# Feed data into CountVectorizer
convec.fit(x_train)

# Check vocabulary size
len(convec.vocabulary_)
```

```
4262296
```

```
convec.get_feature_names()
```

```
['00',
 '00 00',
 '00 000',
 '00 00a',
 '00 00am',
 '00 01',
 '00 03',
 '00 04',
 '00 05',
 '00 07',
 '00 08',
 '00 0800',
 '00 09',
 '00 10',
 '00 11',
 '00 12',
 '00 120',
 '00 15',
 '00 17',
 '00 18',
 '00 20',
 '00 2004',
 '00 21',
 '00 23',
 '00 27',
 '00 28',
 '00 29',
 '00 2nd',
 '00 30',
 '00 300',
 '00 30am',
 '00 30ish',
 '00 30pm',
 '00 31st',
 '00 32',
 '00 34',
 '00 35',
 '00 36',
 '00 39',
 '00 40',
 '00 400',
 '00 41',
```

```
 '00 42',
 '00 44',
 '00 45',
 '00 47',
 '00 50',
 '00 500',
 '00 55',
 '00 56',
 '00 57',
 '00 59',
 '00 6lbs',
 '00 780',
 '00 81',
 '00 90',
 '00 96',
 '00 able',
 '00 according',
 '00 actually',
```

```
x_train_trans = convec.transform(x_train)
```

```
type(x_train_trans)
```

```
scipy.sparse.csr.csr_matrix
```

```
x_train_trans
```

```
<80000x4262296 sparse matrix of type '<class 'numpy.int64'>'
        with 13669695 stored elements in Compressed Sparse Row format>
```

```
x_train_trans[0]
```

```
<1x4262296 sparse matrix of type '<class 'numpy.int64'>'
        with 39 stored elements in Compressed Sparse Row format>
```

```
x_test_trans = convec.transform(x_test)
```

```
x_test_trans
```

```
<20000x4262296 sparse matrix of type '<class 'numpy.int64'>'
        with 2555765 stored elements in Compressed Sparse Row format>
```

```
convec.get_feature_names()[:10]
```

```
['00',
 '00 00',
 '00 000',
 '00 00a',
 '00 00am',
 '00 01',
 '00 03',
 '00 04',
 '00 05',
 '00 07']
```

```
print(x_train_trans)
```

```
(0, 280126)   1
(0, 281571)   1
(0, 656747)   1
(0, 656764)   1
(0, 767770)   1
(0, 769071)   1
(0, 1481476)  1
(0, 1481650)  1
(0, 1545997)  1
(0, 1550942)  1
(0, 1798724)  1
(0, 2097555)  1
(0, 2100025)  1
(0, 2512992)  1
(0, 2514598)  1
(0, 2627012)  1
(0, 2628742)  1
(0, 2638718)  1
(0, 2638926)  1
(0, 2781087)  1
(0, 2781417)  1
(0, 2927984)  1
(0, 2928046)  1
(0, 3199369)  1
(0, 3202000)  1
:     :
(79999, 3425683)      1
(79999, 3548988)      1
(79999, 3549426)      1
(79999, 3559880)      1
(79999, 3560675)      1
(79999, 3570390)      1
(79999, 3570430)      1
(79999, 3618805)      1
(79999, 3618823)      1
(79999, 3622576)      1
(79999, 3622581)      1
(79999, 3661457)      1
(79999, 3662790)      1
(79999, 3853798)      1
(79999, 3853811)      1
(79999, 3891594)      1
(79999, 3891611)      1
(79999, 3905006)      1
(79999, 3905007)      1
(79999, 4002832)      1
(79999, 4002834)      1
(79999, 4200082)      1
(79999, 4200688)      1
(79999, 4206128)      1
(79999, 4206297)      1
```

```
print(x_test_trans)
```

```
  (0, 27426)    1
  (0, 79796)    1
  (0, 80057)    1
  (0, 80555)    1
  (0, 81375)    1
  (0, 115114)   1
  (0, 142985)   1
  (0, 152758)   1
  (0, 152824)   1
  (0, 180482)   1
  (0, 181152)   1
  (0, 192557)   1
  (0, 193171)   1
  (0, 225481)   1
  (0, 226359)   1
  (0, 246204)   1
  (0, 271835)   3
  (0, 271883)   1
  (0, 272842)   1
  (0, 272879)   1
  (0, 290370)   1
  (0, 290382)   1
  (0, 355658)   1
  (0, 364270)   1
  (0, 646905)   2
  :     :
  (19999, 3733388)      1
  (19999, 3782530)      1
  (19999, 3787033)      1
  (19999, 3794952)      1
  (19999, 3808100)      1
  (19999, 3869260)      1
  (19999, 3873946)      1
  (19999, 3874156)      1
  (19999, 3910739)      1
  (19999, 3910831)      1
  (19999, 3914798)      1
  (19999, 3915766)      1
  (19999, 3938744)      2
  (19999, 3939435)      1
  (19999, 3957383)      1
  (19999, 3959374)      1
  (19999, 3969746)      1
  (19999, 3995987)      1
  (19999, 4035852)      2
  (19999, 4037932)      1
  (19999, 4037993)      1
  (19999, 4047826)      1
  (19999, 4115742)      1
  (19999, 4152425)      1
  (19999, 4153320)      1
```

```
label_counts=dict()

for labels in df_new.labels.values:
    for label in labels:
        if label in label_counts:
            label_counts[str(label)]+=1
        else:
            label_counts[str(label)]=1
```

Create a dictionary to get the count of every label i.e. the key will be label name and value will be the total count of the label.

```
label_counts
```

```
{'13': 1,
 '14': 1,
 '15': 1,
 '16': 1,
 '17': 1,
 '23': 1,
 '24': 1,
 '25': 1,
 '26': 1,
 '27': 1,
 '33': 1,
 '34': 1,
 '35': 1,
 '36': 1,
 '37': 1,
 '38': 1,
 '39': 1,
 '40': 1,
 '41': 1,
 '42': 1,
 '43': 1,
 '44': 1,
 '45': 1,
 '46': 1,
 '47': 1,
 '48': 1,
 'Accounting': 528,
 'Advertising': 766,
 'Agriculture': 168,
 'Aquarius': 9050,
 'Architecture': 83,
 'Aries': 10637,
 'Arts': 5031,
 'Automotive': 124,
 'Banking': 354,
 'Biotech': 324,
```

```
 'Biotech': 324,
 'BusinessServices': 626,
 'Cancer': 9253,
 'Capricorn': 8723,
 'Chemicals': 305,
 'Communications-Media': 2830,
 'Construction': 250,
 'Consulting': 905,
 'Education': 5553,
 'Engineering': 2332,
 'Environment': 6,
 'Fashion': 1898,
 'Gemini': 9225,
 'Government': 2055,
 'HumanResources': 209,
 'Internet': 2251,
 'InvestmentBanking': 244,
 'Law': 360,
 'LawEnforcement-Security': 368,
 'Leo': 8230,
 'Libra': 7250,
 'Manufacturing': 542,
 'Maritime': 59,
 'Marketing': 726,
 'Military': 708
```

Transform the labels

As we have noticed before, in this task each example can have multiple tags. To deal with such kind of prediction, we need to transform labels in a binary form and the prediction will be a mask of 0s and 1s.

```
binarizer = MultiLabelBinarizer(classes = sorted(label_counts.keys()))
```

```
y_train = binarizer.fit_transform(y_train)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/preprocessing/_label.py:987:
  .format(sorted(unknown, key=str)))
```

```
y_test = binarizer.transform(y_test)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/preprocessing/_label.py:987:
  .format(sorted(unknown, key=str)))
```

```
y_test
```

```
array([[0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 1, 1, 0],
       ...,
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 1, 0, 0],
       [0, 0, 0, ..., 0, 1, 1]])
```

```
y_train
```

```
array([[0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 1, 0, 0],
       [0, 0, 0, ..., 0, 0, 1],
       ...,
       [0, 0, 0, ..., 1, 1, 0],
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 0, 1, 1]])
```

3. Design, train, tune and test the best text classifier.

```
from sklearn.multiclass import OneVsRestClassifier
from sklearn.linear_model import LogisticRegression

model = LogisticRegression(solver = 'lbfgs', max_iter = 500000)
model = OneVsRestClassifier(model)
model.fit(x_train_trans, y_train)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/multiclass.py:75: UserWarnin
  str(classes[c]))
/usr/local/lib/python3.7/dist-packages/sklearn/multiclass.py:75: UserWarnin
  str(classes[c]))
/usr/local/lib/python3.7/dist-packages/sklearn/multiclass.py:75: UserWarnin
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```

```
  str(classes[c]))
/usr/local/lib/python3.7/dist-packages/sklearn/multiclass.py:75: UserWarnin
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/usr/local/lib/python3.7/dist-packages/sklearn/multiclass.py:75: UserWarnin
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  str(classes[c]))
/usr/local/lib/python3.7/dist-packages/sklearn/multiclass.py:75: UserWarnin
  str(classes[c]))
/usr/local/lib/python3.7/dist-packages/sklearn/multiclass.py:75: UserWarnin
  str(classes[c]))
OneVsRestClassifier(estimator=LogisticRegression(C=1.0, class_weight=None,
                                                 dual=False, fit_intercept=
                                                 intercept_scaling=1,
                                                 l1_ratio=None, max_iter=50
                                                 multi_class='auto',
                                                 n_jobs=None, penalty='l2',
                                                 random_state=None,
```

```
ypred = model.predict(x_test_trans)
```

```
ypred
```

```
array([[0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 0, 0, 1],
       ...,
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 1, 1, 0]])
```

```
y_test
```

```
array([[0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 1, 1, 0],
       ...,
       [0, 0, 0, ..., 0, 0, 1],
       [0, 0, 0, ..., 1, 0, 0],
       [0, 0, 0, ..., 0, 1, 1]])
```

Micro-average method :

you sum up the individual true positives, false positives, and false negatives of the system for different sets and the apply them to get the statistics.

Macro-average Method :

The method is straight forward. Just take the average of the precision and recall of the system on different sets

```
def display_metrics_micro(y_test, ypred):
    print('Accuracy score: ', accuracy_score(y_test, ypred))
    print('F1 score: Micro', f1_score(y_test, ypred, average='micro'))
    print('Average precision score: Micro', average_precision_score(y_test, ypre
    print('Average recall score: Micro', recall_score(y_test, ypred, average='mi


def display_metrics_macro(y_test, ypred):
    print('Accuracy score: ', accuracy_score(y_test, ypred))
    print('F1 score: Macro', f1_score(y_test, ypred, average='macro'))
    print('Average recall score: MAcro', recall_score(y_test, ypred, average='ma

def display_metrics_weighted(y_test, ypred):
    print('Accuracy score: ', accuracy_score(y_test, ypred))
    print('F1 score: weighted', f1_score(y_test, ypred, average='weighted'))
    print('Average precision score: weighted', average_precision_score(y_test, y
    print('Average recall score: weighted', recall_score(y_test, ypred, average=


display_metrics_micro(y_test, ypred)

    Accuracy score:  0.1164
    F1 score: Micro 0.4817371003751176
    Average precision score: Micro 0.2908289227811419
    Average recall score: Micro 0.35423333333333334


display_metrics_macro(y_test, ypred)

    Accuracy score:  0.1164
    F1 score: Macro 0.1678094304601543
    Average recall score: MAcro 0.1117599498017056
    /usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1
      average, "true nor predicted", 'F-score is', len(true_sum)
    /usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1
      _warn_prf(average, modifier, msg_start, len(result))
```

```
display_metrics_weighted(y_test, ypred)
```

```
Accuracy score:  0.1164
F1 score: weighted 0.4448969920386379
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1
  average, "true nor predicted", 'F-score is', len(true_sum)
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_ranking.py:677: Run
  recall = tps / tps[-1]
Average precision score: weighted 0.39193212328684823
Average recall score: weighted 0.35423333333333334
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1
  _warn_prf(average, modifier, msg_start, len(result))
```

5. Print the true vs predicted labels for any 5 entries from the dataset.

```
preds = ypred[:15]
actuals = y_test[:15]
```

```
five_actual = binarizer.inverse_transform(actuals)
five_actual
```

```
[('Aquarius', 'Education', 'male'),
 ('Pisces', 'Student', 'male'),
 ('Pisces', 'female', 'indUnk'),
 ('Aquarius', 'Non-Profit', 'female'),
 ('Arts', 'Cancer', 'male'),
 ('Scorpio', 'female', 'indUnk'),
 ('Cancer', 'Student', 'male'),
 ('Gemini', 'indUnk', 'male'),
 ('Scorpio', 'Technology', 'male'),
 ('Cancer', 'indUnk', 'male'),
 ('Pisces', 'Technology', 'male'),
 ('Gemini', 'Student', 'female'),
 ('Student', 'Virgo', 'male'),
 ('Cancer', 'indUnk', 'male'),
 ('Libra', 'female', 'indUnk')]
```

```
five_pred = binarizer.inverse_transform(preds)
five_pred
```

```
[('Aquarius', 'Education', 'male'),
 ('male',),
 ('male',),
 (),
 ('Non-Profit', 'male'),
 (),
 (),
 ('Internet', 'Leo', 'male'),
 ('male',),
 ('Scorpio', 'Student', 'male'),
 (),
 ('male',),
 ('Student', 'Virgo'),
 ('male',),
 ()]
```

```
print(binarizer.inverse_transform(ypred)[100])
print(binarizer.inverse_transform(y_test)[100])
```

```
('Student', 'female')
('Capricorn', 'Student', 'female')
```

```
print(binarizer.inverse_transform(ypred)[250])
print(binarizer.inverse_transform(y_test)[250])
```

```
('Pisces', 'female', 'indUnk')
('Pisces', 'female', 'indUnk')
```

```
print(binarizer.inverse_transform(ypred)[75])
print(binarizer.inverse_transform(y_test)[75])
```

```
('Scorpio', 'Technology', 'male')
('Sagittarius', 'Technology', 'male')
```

```
print(binarizer.inverse_transform(ypred)[299])
print(binarizer.inverse_transform(y_test)[299])
```

```
('Aquarius', 'indUnk', 'male')
('Aquarius', 'indUnk', 'male')
```

```
print(binarizer.inverse_transform(ypred)[699])
print(binarizer.inverse_transform(y_test)[699])
```

```
('Aquarius', 'Marketing', 'female')
('Aquarius', 'Marketing', 'female')
```

```
import random
j=[]
for i in range(5):
    j.append(random.randint(300,len(ypred)))

print(j)

for k in j:
    print(binarizer.inverse_transform(ypred)[k])
    print(binarizer.inverse_transform(y_test)[k])
```

```
[1606, 9886, 3194, 10883, 17913]
('indUnk', 'male')
('Gemini', 'Student', 'female')
('male',)
('Aries', 'Education', 'male')
('male',)
('Leo', 'female', 'indUnk')
('male',)
('Libra', 'Technology', 'male')
('male',)
('Scorpio', 'Student', 'male')
```

```
ypred_inversed = binarizer.inverse_transform(ypred)
y_test_inversed = binarizer.inverse_transform(y_test)
for i in range(5):
    print('Text:\t{}\nTrue labels:\t{}\nPredicted labels:\t{}\n\n'.format(
        x_test_trans[i],
        ','.join(y_test_inversed[i]),
        ','.join(ypred_inversed[i])
    ))
```

```
Text:     (0, 27426)    1
  (0, 79796)    1
  (0, 80057)    1
  (0, 80555)    1
  (0, 81375)    1
  (0, 115114)   1
  (0, 142985)   1
  (0, 152758)   1
  (0, 152824)   1
  (0, 180482)   1
  (0, 181152)   1
```

```
  (0, 192557)   1
  (0, 193171)   1
  (0, 225481)   1
  (0, 226359)   1
  (0, 246204)   1
  (0, 271835)   3
  (0, 271883)   1
  (0, 272842)   1
  (0, 272879)   1
  (0, 290370)   1
  (0, 290382)   1
  (0, 355658)   1
  (0, 364270)   1
  (0, 646905)   2
  :     :
  (0, 3463105)  1
  (0, 3528636)  1
  (0, 3702692)  1
  (0, 3703054)  1
  (0, 3734817)  1
  (0, 3737387)  1
  (0, 3771284)  1
  (0, 3771578)  1
  (0, 3822062)  1
  (0, 3822413)  1
  (0, 3944259)  2
  (0, 3949679)  1
  (0, 3949939)  1
  (0, 3963663)  1
  (0, 3964477)  1
  (0, 3970572)  1
  (0, 3982784)  1
  (0, 4009054)  1
  (0, 4009148)  1
  (0, 4035852)  1
  (0, 4038061)  1
  (0, 4126257)  1
  (0, 4126295)  4
  (0, 4126320)  1
  (0, 4159477)  1
True labels:    Aquarius,Education,male
Predicted labels:       Aquarius,Education,male


Text:     (0, 143874)   1
  (0, 175289)   1
  (0, 177204)   1
  (0, 339367)   1
  (0, 342183)   1
```

Use a linear classifier (LinearSVC is used in my file) wrap it up in OneVsRestClassifier to train it on every label.

```
from sklearn.linear_model import LogisticRegression
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
from sklearn.svm import LinearSVC
from sklearn.naive_bayes import MultinomialNB

def build_model_train(x_train, y_train, x_valid=None, y_valid=None, C=1.0, model
    if model=='lr':
        model = LogisticRegression(C=C, penalty='l1', dual=False, solver='liblin
        model = OneVsRestClassifier(model)
        model.fit(x_train, y_train)

    elif model=='svm':
        model = LinearSVC(C=C, penalty='l1', dual=False, loss='squared_hinge')
        model = OneVsRestClassifier(model)
        model.fit(x_train, y_train)

    elif model=='nbayes':
        model = MultinomialNB(alpha=1.0)
        model = OneVsRestClassifier(model)
        model.fit(x_train, y_train)

    elif model=='lda':
        model = LinearDiscriminantAnalysis(solver='svd')
        model = OneVsRestClassifier(model)
        model.fit(x_train, y_train)

    return model
```

```
models = ['lr','svm','nbayes']
for model in models:
    model = build_model_train(x_train_trans, y_train, model=model)
    model.fit(x_train_trans, y_train)
    ypred = model.predict(x_test_trans)
    print("\n")
    print(f"**displaying  metrics for the mode {model}\n")
    display_metrics_micro(y_test,ypred)
    print("\n")
    print("\n")
    display_metrics_macro(y_test,ypred)
    print("\n")
    print("\n")
    display_metrics_weighted(y_test,ypred)
    print("\n")
    print("\n")
```

2. PART TWO

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
%tensorflow_version 2.x
import tensorflow
tensorflow.__version__
```

```
'2.4.1'
```

```
project_path = '/content/drive/MyDrive/My Files/AIML Workbooks'
```

```
# Importing necessary libraries

import string
import random
import nltk
import numpy as np
from nltk.stem import WordNetLemmatizer
import tensorflow as tf
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Dense, Dropout
from nltk.chat.util import Chat, reflections
import tensorflow as tf

nltk.download("punkt")
nltk.download("wordnet")
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data]   Unzipping corpora/wordnet.zip.
True
```

```
# Loading corpus file

import json
with open('/content/drive/MyDrive/My Files/AIML Workbooks/GL Bot.json') as file:
  Corpus = json.load(file)
print(Corpus)
```

```
{'intents': [{'tag': 'Intro', 'patterns': ['hi', 'how are you', 'is anyone
```

```
# initializing lemmatizer to get stem of words
lem = WordNetLemmatizer()

# Each list to create
words = []
classes = []
doc_x = []
doc_y = []

# Loop through all the intents
# Tokenize each pattern and append tokens to words, the patterns and the associa

for intent in Corpus ['intents']:
  for pattern in intent['patterns']:
    tokens = nltk.word_tokenize(pattern)
    words.extend(tokens)
    doc_x.append(pattern)
    doc_y.append(intent['tag'])

    # Add tag to classes if it is not present already
    if intent['tag'] not in classes:
      classes.append(intent['tag'])

# lemmatize all the words in the vocab and convert them to lowercase if the word
words = [lem.lemmatize(word.lower()) for word in words if word not in string.pun

# sorting the vocab and classes in alphabetical order and taking the # set to en
words = sorted(set(words))
classes = sorted(set(classes))


print(words)
```

```
['a', 'able', 'access', 'activation', 'ada', 'adam', 'aifl', 'aiml', 'am',
```

```
print(classes)
```

```
['Bot', 'Exit', 'Intro', 'NN', 'Olympus', 'Profane', 'SL', 'Ticket']
```

```
print(doc_x)
```

```
['hi', 'how are you', 'is anyone there', 'hello', 'whats up', 'hey', 'yo',
```

```
print(doc_y)
```

```
['Intro', 'Intro', 'Intro', 'Intro', 'Intro', 'Intro', 'Intro', 'Intro', 'I
```

```
# list for training data
training = []
out_empty = [0] * len(classes)

# Creating the bag of words model
for idx, doc in enumerate(doc_x):
    bow = []
    text = lem.lemmatize(doc.lower())
    for word in words:
        bow.append(1) if word in text else bow.append(0)

    # Mark the index of class that the current pattern is associated to
    output_row = list(out_empty)
    output_row[classes.index(doc_y[idx])] = 1

    # Add the one hot encoded BoW and associated classes to training
    training.append([bow, output_row])

# Shuffle the data and convert it to an array
random.shuffle(training)
training = np.array(training, dtype=object)

# Split the features and target labels
train_x = np.array(list(training[:, 0]))
train_y = np.array(list(training[:, 1]))



# defining some parameters
input_shape = (len(train_x[0]),)
output_shape = len(train_y[0])
epochs = 200


model = Sequential()
model.add(Dense(128, input_shape=input_shape, activation="relu"))
model.add(Dropout(0.5))
model.add(Dense(64, activation="relu"))
model.add(Dropout(0.3))
model.add(Dense(output_shape, activation = "softmax"))

adam = tf.keras.optimizers.Adam(learning_rate=0.01, decay=1e-6)
```

```
model.compile(loss = 'categorical_crossentropy', optimizer = 'adam', metrics = [
model.summary()
model.fit(x = train_x, y = train_y, epochs = 200, verbose = 1)
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 128)               20352
_________________________________________________________________
dropout (Dropout)            (None, 128)               0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                8256
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 8)                 520
=================================================================
Total params: 29,128
Trainable params: 29,128
Non-trainable params: 0
_________________________________________________________________
Epoch 1/200
4/4 [==============================] - 2s 5ms/step - loss: 2.0786 - accurac
Epoch 2/200
4/4 [==============================] - 0s 4ms/step - loss: 2.0912 - accurac
Epoch 3/200
4/4 [==============================] - 0s 4ms/step - loss: 2.0417 - accurac
Epoch 4/200
4/4 [==============================] - 0s 4ms/step - loss: 2.0339 - accurac
Epoch 5/200
4/4 [==============================] - 0s 4ms/step - loss: 1.9836 - accurac
Epoch 6/200
4/4 [==============================] - 0s 4ms/step - loss: 1.9368 - accurac
Epoch 7/200
4/4 [==============================] - 0s 4ms/step - loss: 1.9167 - accurac
Epoch 8/200
4/4 [==============================] - 0s 4ms/step - loss: 1.8923 - accurac
Epoch 9/200
4/4 [==============================] - 0s 4ms/step - loss: 1.9036 - accurac
Epoch 10/200
4/4 [==============================] - 0s 4ms/step - loss: 1.8250 - accurac
Epoch 11/200
4/4 [==============================] - 0s 4ms/step - loss: 1.7985 - accurac
Epoch 12/200
4/4 [==============================] - 0s 4ms/step - loss: 1.7832 - accurac
Epoch 13/200
4/4 [==============================] - 0s 4ms/step - loss: 1.7065 - accurac
Epoch 14/200
4/4 [==============================] - 0s 5ms/step - loss: 1.7738 - accurac
Epoch 15/200
4/4 [==============================] - 0s 4ms/step - loss: 1.6676 - accurac
Epoch 16/200
4/4 [==============================] - 0s 4ms/step - loss: 1.6295 - accurac
```

```
4/4 [==============================] - 0s 4ms/step - loss: 1.6295 - accurac
Epoch 17/200
4/4 [==============================] - 0s 5ms/step - loss: 1.5756 - accurac
Epoch 18/200
4/4 [==============================] - 0s 5ms/step - loss: 1.6206 - accurac
Epoch 19/200
4/4 [==============================] - 0s 4ms/step - loss: 1.5197 - accurac
Epoch 20/200
4/4 [==============================] - 0s 4ms/step - loss: 1.5232 - accurac
Epoch 21/200
4/4 [==============================] - 0s 4ms/step - loss: 1.4025 - accurac
```

```
def clean_text(text):
  tokens = nltk.word_tokenize(text)
  tokens = [lem.lemmatize(word) for word in tokens]
  return tokens

def bag_of_words(text, vocab):
  tokens = clean_text(text)
  bow = [0] * len(vocab)
  for w in tokens:
    for idx, word in enumerate(vocab):
      if word == w:
        bow[idx] = 1
  return np.array(bow)

def pred_class(text, vocab, labels):
  bow = bag_of_words(text, vocab)
  result = model.predict(np.array([bow]))[0]
  thresh = 0.2
  y_pred = [[idx, res] for idx, res in enumerate(result) if res > thresh]

  y_pred.sort(key=lambda x: x[1], reverse=True)
  return_list = []
  for r in y_pred:
    return_list.append(labels[r[0]])
  return return_list

def get_response(intents_list, intents_json):
  tag = intents_list[0]
  list_of_intents = intents_json["intents"]
  for i in list_of_intents:
    if i["tag"] == tag:
      result = random.choice(i["responses"])
      break
  return result
```

```
# Running the chatbot

while True:
    message = input("")
    intents = pred_class(message, words, classes)
    result = get_response(intents, Corpus)
    print(result)
```