Emotion Detection in Twitter Posts using Natural Language Processing (NLP)

AIML Project

Problem Statement: Implement Emotion Detection in Twitter Posts using NLP.

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Description: Natural Language Processing is a form of AI that gives machines the ability to not just read, but to understand and interpret human language. With NLP, machines can make sense of written or spoken text and perform tasks including speech recognition, sentiment analysis, and automatic text summarization. In this project we are detecting the emotions from the Posts of Twitter using Natural Language Processing.

Importing Libraries

In [6]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import neattext.functions as nfx
import matplotlib.pyplot as plt
import math
import string
from wordcloud import WordCloud
from sklearn.model_selection import GridSearchCV
import plotly.express as px

from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB
import sklearn.metrics as metrics
from nltk.corpus import stopwords
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.pipeline import Pipeline
import seaborn as sns
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import ConfusionMatrixDisplay
from sklearn.metrics.pairwise import cosine_similarity
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.metrics import accuracy_score,classification_report,confusion_matrix
import nltk
nltk.download('wordnet')
nltk.download('stopwords')
nltk.download('punkt')
from nltk.tokenize import word_tokenize
from nltk.tokenize import RegexpTokenizer

import warnings
warnings.filterwarnings('ignore')
```

```
[nltk_data] Downloading package wordnet to
[nltk_data]     C:\Users\Kshitija\AppData\Roaming\nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\Kshitija\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package punkt to
[nltk_data]     C:\Users\Kshitija\AppData\Roaming\nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Dataset

In [7]:
```
df = pd.read_csv(r"C:\Users\Kshitija\Downloads\df_emotions.csv")
df = df.drop('Unnamed: 0',axis=1)
df = df.rename(columns={'text':'Text','label':'Emotions'})
labels_dict = {0:'Sad', 1:'Happy', 2:'Love', 3:'Anger', 4:'Fear', 5:'Surprise'}
df['Emotions'] = df['Emotions'].map(labels_dict )
df
```

Out[7]:

	Text	Emotions
0	im feeling rather rotten so im not very ambiti...	Sad
1	im updating my blog because i feel shitty	Sad
2	i never make her separate from me because i do...	Sad
3	i left with my bouquet of red and yellow tulip...	Happy
4	i was feeling a little vain when i did this one	Sad
...	...	...
19995	im having ssa examination tomorrow in the morn...	Sad
19996	i constantly worry about their fight against n...	Happy
19997	i feel its important to share this info for th...	Happy
19998	i truly feel that if you are passionate enough...	Happy
19999	i feel like i just wanna buy any cute make up ...	Happy

Statistical summary or descriptive statistics of dataset

In [8]:
```
df.head(10) #returns the first 10 rows of the dataset
```

Out[8]:

	Text	Emotions
0	im feeling rather rotten so im not very ambiti...	Sad
1	im updating my blog because i feel shitty	Sad
2	i never make her separate from me because i do...	Sad
3	i left with my bouquet of red and yellow tulip...	Happy
4	i was feeling a little vain when i did this one	Sad
5	i cant walk into a shop anywhere where i do no...	Fear
6	i felt anger when at the end of a telephone call	Anger
7	i explain why i clung to a relationship with a...	Happy
8	i like to have the same breathless feeling as ...	Happy
9	i jest i feel grumpy tired and pre menstrual w...	Anger

In [9]:
```
df.tail(10) #returns the last 10 rows of the dataset
```

Out[9]:

	Text	Emotions
19990	i just feel too overwhelmed i can t see the fo...	Fear
19991	i cant help but feel sentimental about the fac...	Sad
19992	i feel i should make is how surprised but ente...	Surprise
19993	i feel so tortured by it	Anger
19994	i feel a bit rude leaving you hanging there fr...	Anger
19995	im having ssa examination tomorrow in the morn...	Sad
19996	i constantly worry about their fight against n...	Happy
19997	i feel its important to share this info for th...	Happy
19998	i truly feel that if you are passionate enough...	Happy
19999	i feel like i just wanna buy any cute make up ...	Happy

In [10]:
```
df.shape #returns the dimensions of the dataframe
```

Out[10]:
```
(20000, 2)
```

In [11]:
```
df.describe() #returns count, mean, std, etc for each column
```

Out[11]:

	Text	Emotions
count	20000	20000
unique	19948	6
top	i write these words i feel sweet baby kicks fr...	Happy
freq	2	6761

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20000 entries, 0 to 19999
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   Text      20000 non-null  object
 1   Emotions  20000 non-null  object
dtypes: object(2)
memory usage: 312.6+ KB
```

In [13]:
```
df.isnull().sum()
```

Out[13]:
```
Text        0
Emotions    0
dtype: int64
```

In [14]:
```
df.Emotions.unique()
```

Out[14]:
```
array(['Sad', 'Happy', 'Fear', 'Anger', 'Love', 'Surprise'], dtype=object)
```

In [15]:
```
count_values = df['Emotions'].value_counts()
sns.set(style="whitegrid")
sns.barplot(count_values.index,count_values.values, palette='PuRd')
count_values
```

Out[15]:
```
Happy       6761
Sad         5797
Anger       2709
Fear        2373
Love        1641
Surprise     719
Name: Emotions, dtype: int64
```

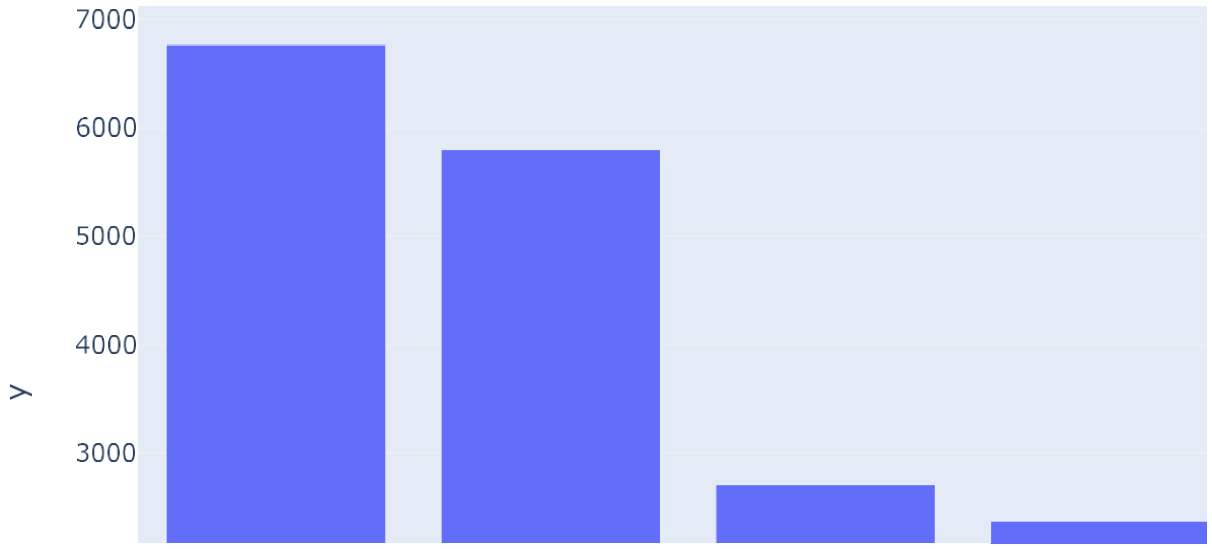
In [16]:
```
df = df.drop_duplicates(keep="first") # Drop duplicated data and reindex the data
df_reidx = df.reset_index(drop=True)
df.shape
```

Out[16]:
```
(19999, 2)
```

In [17]:
```
count_values = df['Emotions'].value_counts()
sns.set(style="whitegrid")
sns.barplot(count_values.index,count_values.values, palette='PuRd')
count_values
```

Out[17]:
```
Happy       6760
Sad         5797
Anger       2709
Fear        2373
Love        1641
Surprise     719
Name: Emotions, dtype: int64
```

In [18]:
```
fig = px.bar(x=count_values.index,y=count_values.values)
fig.show()
```



In [19]:
```
df_reidx['length'] = df_reidx['Text'].apply(len) # number of characters
df_reidx['length'].describe() # info()
```

Out[19]:
```
count    19999.000000
mean        96.671784
std         55.778779
min          7.000000
25%         53.000000
50%         86.000000
75%        129.000000
max        300.000000
Name: length, dtype: float64
```

In [20]:
```
df_reidx.head(10)
```

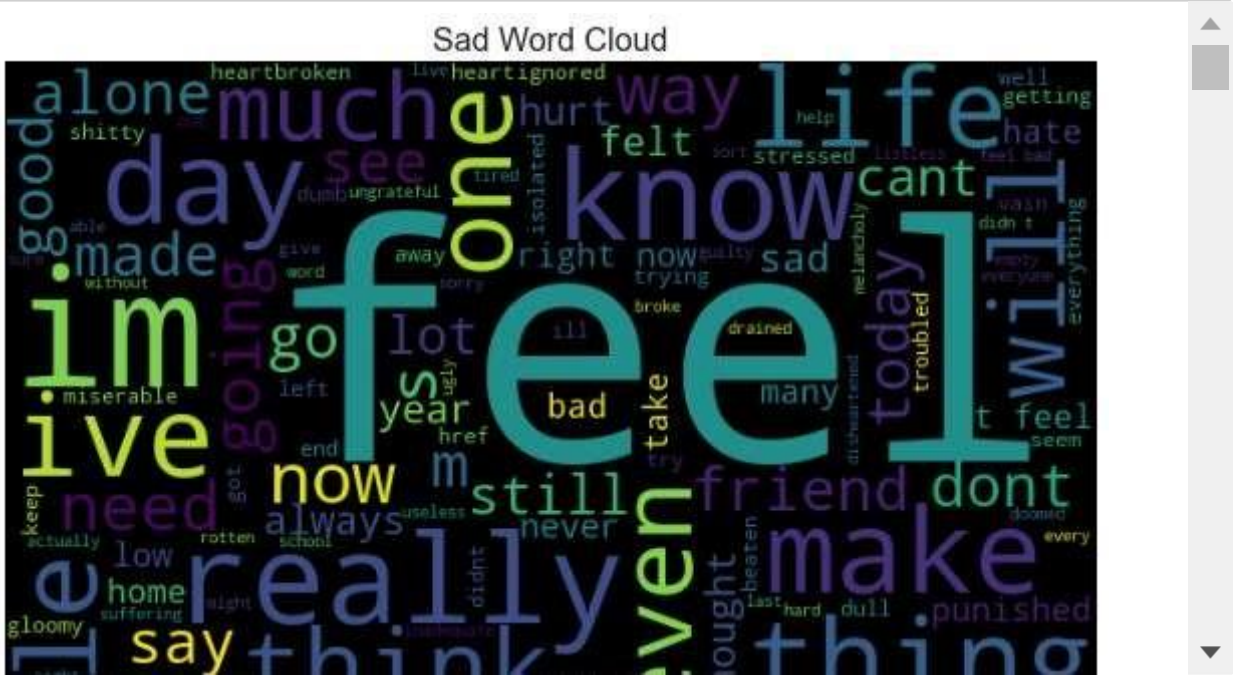
Out[20]:

	Text	Emotions	length
0	im feeling rather rotten so im not very ambiti...	Sad	59
1	im updating my blog because i feel shitty	Sad	41
2	i never make her separate from me because i do...	Sad	97
3	i left with my bouquet of red and yellow tulip...	Happy	113
4	i was feeling a little vain when i did this one	Sad	47
5	i cant walk into a shop anywhere where i do no...	Fear	66
6	i felt anger when at the end of a telephone call	Anger	48
7	i explain why i clung to a relationship with a...	Happy	222
8	i like to have the same breathless feeling as ...	Happy	89
9	i jest i feel grumpy tired and pre menstrual w...	Anger	159

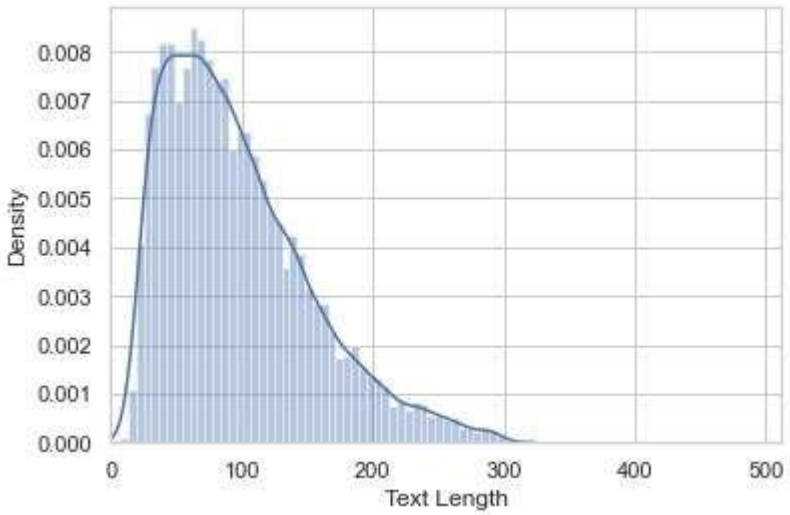
Data Exploration and Visualisation

In [21]:
```
def words_cloud(wordcloud, df):
    plt.figure(figsize=(10, 10))
    plt.title(df+' Word Cloud', size = 16)
    plt.imshow(wordcloud)
    plt.axis("off");
```

In [22]:
```
emotions_list = df['Emotions'].unique()

for emotion in emotions_list:
    text = ' '.join([sentence for sentence in df.loc[df['Emotions'] == emotion,'T
    wordcloud = WordCloud(width = 600, height = 600).generate(text)
    words_cloud(wordcloud, emotion)
```

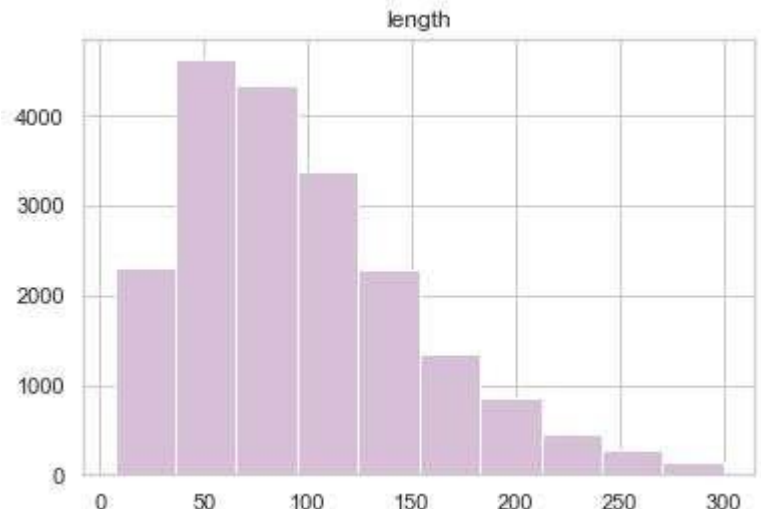


In [23]:
```
sns.distplot(df_reidx['length'])
plt.xlim([0, 512]);
plt.xlabel('Text Length');
```



In [24]:
```
colors = ['plum', 'pink', 'peachpuff','paleturquoise','thistle','lightsteelblue']
# explode = (0.05,0.05)
plt.figure(figsize=(5, 5))
plt.pie(df['Emotions'].value_counts(), colors=colors, labels=emotions_list, autop
plt.legend()
plt.title("Emotions")
plt.show()
```

In [25]:
```
df_reidx.hist(color='thistle') #to draw histogram
plt.show()
```



Text Proprocessing

1. Decontracted
2. Data cleaning
3. Spell check
4. Stop Words Removal
5. Tokenization
6. POS Tagging
7. Stemming
8. Lemmatization

Decontraction: Contractions are words or combinations of words that are shortened by dropping letters and replacing them by an apostrophe. Decontracting the contracted words.

DataCleaning: Removing html, xml tags, punctautions, urls, etc.

In [26]:

```
from tqdm import tqdm
import re
from bs4 import BeautifulSoup
from nltk.stem import PorterStemmer
from nltk.stem import WordNetLemmatizer

def decontracted(phrase):
    # specific
    phrase = re.sub(r"wont", "will not", phrase)
    phrase = re.sub(r"wouldnt", "would not", phrase)
    phrase = re.sub(r"shouldnt", "should not", phrase)
    phrase = re.sub(r"couldnt", "could not", phrase)
    phrase = re.sub(r"cudnt", "could not", phrase)
    phrase = re.sub(r"cant", "can not", phrase)
    phrase = re.sub(r"dont", "do not", phrase)
    phrase = re.sub(r"doesnt", "does not", phrase)
    phrase = re.sub(r"didnt", "did not", phrase)
    phrase = re.sub(r"wasnt", "was not", phrase)
    phrase = re.sub(r"werent", "were not", phrase)
    phrase = re.sub(r"havent", "have not", phrase)
    phrase = re.sub(r"hadnt", "had not", phrase)

    # general
    phrase = re.sub(r"n\ t", " not", phrase)
    phrase = re.sub(r"\re", " are", phrase)
    phrase = re.sub(r"\ s ", " is ", phrase)
    phrase = re.sub(r"\ d ", " would ", phrase)
    phrase = re.sub(r"\ ll ", " will ", phrase)
    phrase = re.sub(r"\dunno", "do not ", phrase)
    phrase = re.sub(r"ive ", "i have ", phrase)
    phrase = re.sub(r"im ", "i am ", phrase)
    phrase = re.sub(r"i m ", "i am ", phrase)
    phrase = re.sub(r" w ", " with ", phrase)

    return phrase


def clean_text(df):

    cleaned_review = []

    for review_text in tqdm(df['Text']):

        # expand the contracted words
        review_text = decontracted(review_text)
        #remove html tags
        review_text = BeautifulSoup(review_text, 'lxml').get_text().strip() # re.

        #remove non-alphabetic characters
        review_text = re.sub("[^a-zA-Z]"," ", review_text)

        #remove url
        review_text = re.sub(r'https?://\S+|www\.\S+', '', review_text)

        #Removing punctutation, string.punctuation in python consists of !"#$%&\
        review_text = review_text.translate(str.maketrans('', '', string.punctuat
```

```
        # ''.join([char for char in movie_text_data if char not in string.punctuc

        # remove emails
        review_text = re.sub(r"(^[a-zA-Z0-9_.+-]+@[a-zA-Z0-9-]+\.[a-zA-Z0-9-.]+$)

        cleaned_review.append(review_text)

    return cleaned_review

df_reidx['Cleaned_Text'] = clean_text(df_reidx)
df_reidx.head(10)
```

```
100%|
| 19999/19999 [00:07<00:00, 2759.31it/s]
```

Out[26]:

	Text	Emotions	length	Cleaned_Text
0	im feeling rather rotten so im not very ambiti...	Sad	59	i am feeling rather rotten so i am not very am...
1	im updating my blog because i feel shitty	Sad	41	i am updating my blog because i feel shitty
2	i never make her separate from me because i do...	Sad	97	i never make her separate from me because i do...
3	i left with my bouquet of red and yellow tulip...	Happy	113	i left with my bouquet of red and yellow tulip...
4	i was feeling a little vain when i did this one	Sad	47	i was feeling a little vain when i did this one
5	i cant walk into a shop anywhere where i do no...	Fear	66	i can not walk into a shop anywhere where i do...
6	i felt anger when at the end of a telephone call	Anger	48	i felt anger when at the end of a telephone call
7	i explain why i clung to a relationship with a...	Happy	222	i explain why i clung to a relationship with a...
8	i like to have the same breathless feeling as ...	Happy	89	i like to have the same breathless feeling as ...
9	i jest i feel grumpy tired and pre menstrual w...	Anger	159	i jest i feel grumpy tired and pre menstrual w...

Tokenization: Splitting sentences into words(tokens).

In [27]:
```
from nltk import word_tokenize, pos_tag
nltk.download('averaged_perceptron_tagger')

def tokenize(phrase):
    tokens_list = []
    tokenizer = RegexpTokenizer(r'[a-zA-Z0-9]+')

    for review_text in tqdm(phrase):
        tokens1 = word_tokenize(review_text)
        tokens1 = [word for word in tokens1]
        tokens_list.append(tokens1)
    return tokens_list

df_reidx2 = df.reset_index(drop=True)
df_reidx2['length'] = df_reidx['Text'].apply(len) # number of characters
df_reidx2['length'].describe() # info()
df_reidx2['Cleaned_Text'] = tokenize(df_reidx['Cleaned_Text'])
token_list = tokenize(df_reidx['Cleaned_Text'])
df_reidx2.head()
```

```
[nltk_data] Downloading package averaged_perceptron_tagger to
[nltk_data]     C:\Users\Kshitija\AppData\Roaming\nltk_data...
[nltk_data]   Package averaged_perceptron_tagger is already up-to-
[nltk_data]       date!
100%|
| 19999/19999 [00:03<00:00, 5744.03it/s]
100%|
| 19999/19999 [00:03<00:00, 6313.78it/s]
```

Out[27]:

	Text	Emotions	length	Cleaned_Text
0	im feeling rather rotten so im not very ambiti...	Sad	59	[i, am, feeling, rather, rotten, so, i, am, no...
1	im updating my blog because i feel shitty	Sad	41	[i, am, updating, my, blog, because, i, feel, ...
2	i never make her separate from me because i do...	Sad	97	[i, never, make, her, separate, from, me, beca...
3	i left with my bouquet of red and yellow tulip...	Happy	113	[i, left, with, my, bouquet, of, red, and, yel...
4	i was feeling a little vain when i did this one	Sad	47	[i, was, feeling, a, little, vain, when, i, di...

Remove Stopwords: Words like a,am,the,is,and,or, etc. will be removed.

In [28]:
```
def remove_stopwords(phrase):
    remove_sw = []
    tokenizer = RegexpTokenizer(r'[a-zA-Z0-9]+')
    stop_words = stopwords.words('english')

    for review_text in tqdm(phrase):
        tokens = word_tokenize(review_text)
        tokens = [word for word in tokens if not word in stop_words]
        remove_sw.append(tokens)
    return remove_sw

df_reidx['Cleaned_Text'] = remove_stopwords(df_reidx['Cleaned_Text'])
df_reidx.head()
```

```
100%|
| 19999/19999 [00:04<00:00, 4944.60it/s]
```

Out[28]:

	Text	Emotions	length	Cleaned_Text
0	im feeling rather rotten so im not very ambiti...	Sad	59	[feeling, rather, rotten, ambitious, right]
1	im updating my blog because i feel shitty	Sad	41	[updating, blog, feel, shitty]
2	i never make her separate from me because i do...	Sad	97	[never, make, separate, ever, want, feel, like...
3	i left with my bouquet of red and yellow tulip...	Happy	113	[left, bouquet, red, yellow, tulips, arm, feel...
4	i was feeling a little vain when i did this one	Sad	47	[feeling, little, vain, one]

POS Tagging: Identify the Part of Speech of each tokens

In [29]:
```
def Pos_tagging(phrase):
    postags = []
    for i in range(len(df_reidx['Cleaned_Text'])):
        pos_tagger = nltk.pos_tag(token_list[i])
        postags.append(pos_tagger)
        return postags

df_reidx3 = df.reset_index(drop=True)
df_reidx3['length'] = df_reidx['Text'].apply(len) # number of characters
df_reidx3['length'].describe() # info()
res = Pos_tagging(df_reidx['Cleaned_Text'])
res
```

Out[29]:
```
[[('i', 'NN'),
  ('am', 'VBP'),
  ('feeling', 'VBG'),
  ('rather', 'RB'),
  ('rotten', 'VBN'),
  ('so', 'RB'),
  ('i', 'JJ'),
  ('am', 'VBP'),
  ('not', 'RB'),
  ('very', 'RB'),
  ('ambitious', 'JJ'),
  ('right', 'NN'),
  ('now', 'RB')]]
```

Now we have the POS tags for every text. There are lots of categories. Here are the meanings:

NN: noun (there are other categories that can fit within this one for our purposes, such as NNS, NNP, NNPS, which all belong to nouns, containing plurals and proper names)

RB: adverb

VB: verb (and similar categories indicating tense: VBP, VBG, VBS..)

JJ: adjective or numeral

Stemming: Extrating root word by removing the suffixes and prefixes

In [30]:
```
from nltk.stem import PorterStemmer

def stemming(phrase):
    stemmer = PorterStemmer()
    stem_output=[]
    stemmed=[]
    for review_text in tqdm(phrase):
        stemmed = [stemmer.stem(word) for word in review_text]
        stem_output.append(stemmed)
    return stem_output

df_reidx1 = df.reset_index(drop=True)
df_reidx1['length'] = df_reidx['Text'].apply(len) # number of characters
df_reidx1['length'].describe() # info()
df_reidx1['Cleaned_Text'] = stemming(df_reidx['Cleaned_Text'])
df_reidx1.head()
```

```
100%|
| 19999/19999 [00:04<00:00, 4169.90it/s]
```

Out[30]:

	Text	Emotions	length	Cleaned_Text
0	im feeling rather rotten so im not very ambiti...	Sad	59	[feel, rather, rotten, ambiti, right]
1	im updating my blog because i feel shitty	Sad	41	[updat, blog, feel, shitti]
2	i never make her separate from me because i do...	Sad	97	[never, make, separ, ever, want, feel, like, a...
3	i left with my bouquet of red and yellow tulip...	Happy	113	[left, bouquet, red, yellow, tulip, arm, feel,...
4	i was feeling a little vain when i did this one	Sad	47	[feel, littl, vain, one]

Lemmatization: Extracting root word by refering the dictionary of words.

In [31]:
```
nltk.download('wordnet')
nltk.download('omw-1.4')
from nltk.stem import WordNetLemmatizer

def lemmatizing(phrase):
    lemmatizer = WordNetLemmatizer()
    lemmated_output=[]
    lemmated=[]
    for review_text in tqdm(phrase):
        lemmated = [lemmatizer.lemmatize(word) for word in review_text]
        lemmated_output.append(lemmated)
    return lemmated_output

df_reidx['Cleaned_Text'] = lemmatizing(df_reidx['Cleaned_Text'])
df_reidx.head()
```

```
[nltk_data] Downloading package wordnet to
[nltk_data]     C:\Users\Kshitija\AppData\Roaming\nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package omw-1.4 to
[nltk_data]     C:\Users\Kshitija\AppData\Roaming\nltk_data...
[nltk_data]   Package omw-1.4 is already up-to-date!
100%|
| 19999/19999 [00:02<00:00, 7270.25it/s]
```

Out[31]:

	Text	Emotions	length	Cleaned_Text
0	im feeling rather rotten so im not very ambiti...	Sad	59	[feeling, rather, rotten, ambitious, right]
1	im updating my blog because i feel shitty	Sad	41	[updating, blog, feel, shitty]
2	i never make her separate from me because i do...	Sad	97	[never, make, separate, ever, want, feel, like...
3	i left with my bouquet of red and yellow tulip...	Happy	113	[left, bouquet, red, yellow, tulip, arm, feeli...
4	i was feeling a little vain when i did this one	Sad	47	[feeling, little, vain, one]

In [32]:
```
def to_sentence(phrase):
    sentence=[]
    for words in tqdm(phrase):
        sentence.append((" ").join(words))
    return sentence
df_reidx['Cleaned_Text']=to_sentence(df_reidx['Cleaned_Text'])
df_reidx.head()
```

```
100%|██████████| 19999/19999 [00:00<00:00, 661200.55it/s]
```

Out[32]:

	Text	Emotions	length	Cleaned_Text
0	im feeling rather rotten so im not very ambiti...	Sad	59	feeling rather rotten ambitious right
1	im updating my blog because i feel shitty	Sad	41	updating blog feel shitty
2	i never make her separate from me because i do...	Sad	97	never make separate ever want feel like ashamed
3	i left with my bouquet of red and yellow tulip...	Happy	113	left bouquet red yellow tulip arm feeling slig...
4	i was feeling a little vain when i did this one	Sad	47	feeling little vain one

In [33]:
```
df_reidx
```

Out[33]:

	Text	Emotions	length	Cleaned_Text
0	im feeling rather rotten so im not very ambiti...	Sad	59	feeling rather rotten ambitious right
1	im updating my blog because i feel shitty	Sad	41	updating blog feel shitty
2	i never make her separate from me because i do...	Sad	97	never make separate ever want feel like ashamed
3	i left with my bouquet of red and yellow tulip...	Happy	113	left bouquet red yellow tulip arm feeling slig...
4	i was feeling a little vain when i did this one	Sad	47	feeling little vain one
...	...	...	...	...
19994	im having ssa examination tomorrow in the morn...	Sad	191	ssa examinatio notomorrow nothe morning quite ...
19995	i constantly worry about their fight against n...	Happy	173	constantly worry fight nature push limit inner...
19996	i feel its important to share this info for th...	Happy	80	feel important share info experience thing
19997	i truly feel that if you are passionate enough...	Happy	105	truly feel passionate enough something stay tr...
19998	i feel like i just wanna buy any cute make up ...	Happy	74	feel like wan na buy cute make see online eve ...

19999 rows × 4 columns

Vector Generation

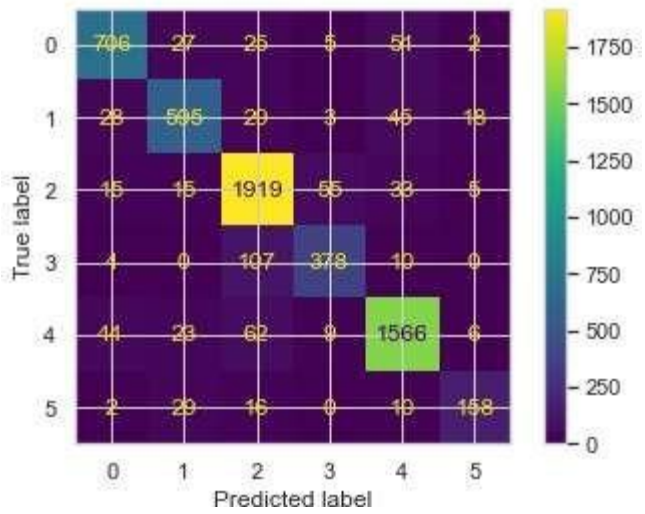
In [34]:
```
token = RegexpTokenizer(r'[a-zA-Z0-9]+')

vectorizer = CountVectorizer(stop_words='english', max_df=0.5, min_df=3, ngram_ra
x = vectorizer.fit_transform(df_reidx.Cleaned_Text)
y = df_reidx.Emotions.values

print("X.shape : ",x.shape)
print("y.shape : ",y.shape)

train_idx, test_idx = train_test_split(np.arange(df_reidx.shape[0]), test_size=0.

x_train = x[train_idx]
y_train = y[train_idx]

x_test = x[test_idx]
y_test = y[test_idx]
print("Number of training examples:{}".format(len(train_idx)))
print("Number of testing examples:{}\n".format(len(test_idx)))
print("Training data: X_train : {}, y_train : {}".format(x_train.shape, y_train.s
print("Testing data: X_test : {}, y_test : {}".format(x_test.shape, y_test.shape)
```

```
X.shape :  (19999, 5247)
y.shape :  (19999,)
Number of training examples:13999
Number of testing examples:6000

Training data: X_train : (13999, 5247), y_train : (13999,)
Testing data: X_test : (6000, 5247), y_test : (6000,)
```

Logistic Regression: Logistic regression is a process of modeling the probability of a discrete outcome given an input variable.

In [35]:
```
from sklearn import linear_model
lr_clf =  linear_model.LogisticRegression(multi_class='ovr', solver='liblinear')#

lr_clf.fit(x_train, y_train)

y_pred_test_lr = lr_clf.predict(x_test)
y_predprob_lr = lr_clf.predict_proba(x_test)
matrix_lr = confusion_matrix(y_test,y_pred_test_lr, )
print(classification_report(y_test, y_pred_test_lr))
print("\nAccuracy for Logistic Regression Model is:",metrics.accuracy_score(y_tes
print("\n")

y_predict = lr_clf.predict(x_test)
acc_lr = metrics.accuracy_score(y_test, y_pred_test_lr)
matrix_display = ConfusionMatrixDisplay(matrix_lr).plot()
```

```
              precision    recall  f1-score   support

       Anger       0.88      0.87      0.87       816
        Fear       0.86      0.83      0.85       718
       Happy       0.89      0.94      0.91      2042
        Love       0.84      0.76      0.80       499
         Sad       0.91      0.92      0.91      1710
    Surprise       0.84      0.73      0.78       215

    accuracy                           0.89      6000
   macro avg       0.87      0.84      0.85      6000
weighted avg       0.89      0.89      0.89      6000


Accuracy for Logistic Regression Model is: 0.887
```



In [36]:

```
def print_score(clf, X_train, y_train, X_test, y_test, train=True):
    if train:
        pred = clf.predict(X_train)
        clf_report = pd.DataFrame(classification_report(y_train, pred, output_dic
        print("Train Result:\n================================================")
        print(f"Accuracy Score: {accuracy_score(y_train, pred) * 100:.2f}%")
        print("_______________________________________________")
        print(f"CLASSIFICATION REPORT:\n{clf_report}")
        print("_______________________________________________")
        print(f"Confusion Matrix: \n {confusion_matrix(y_train, pred)}\n")

    elif train==False:
        pred = clf.predict(X_test)
        clf_report = pd.DataFrame(classification_report(y_test, pred, output_dict
        print("Test Result:\n================================================")
        print(f"Accuracy Score: {accuracy_score(y_test, pred) * 100:.2f}%")
        print("_______________________________________________")
        print(f"CLASSIFICATION REPORT:\n{clf_report}")
        print("_______________________________________________")
        print(f"Confusion Matrix: \n {confusion_matrix(y_test, pred)}\n")
```

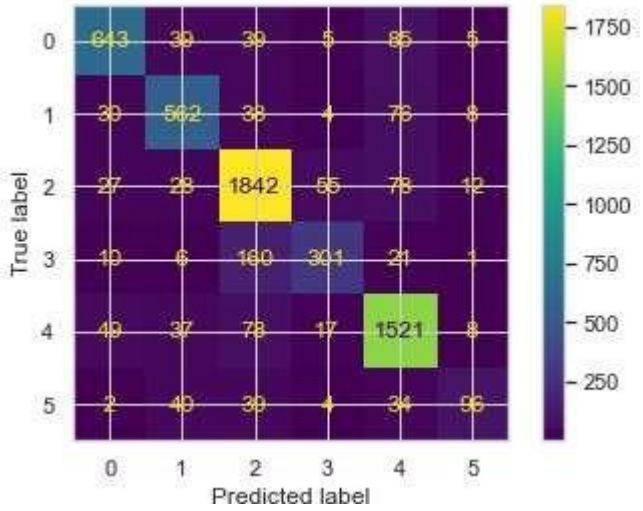
In [37]:
```
print_score(lr_clf, x_train, y_train, x_test, y_test, train=True)
print_score(lr_clf, x_train, y_train, x_test, y_test, train=False)
```

```
Train Result:
================================================
Accuracy Score: 96.89%

_______________________________________________

CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.972639     0.959246     0.967661     0.965766     0.974197
recall           0.957739     0.952870     0.983044     0.938704     0.979202
f1-score         0.965132     0.956047     0.975292     0.952043     0.976693
support       1893.000000  1655.000000  4718.000000  1142.000000  4087.000000

                 Surprise  accuracy     macro avg  weighted avg
precision        0.962500  0.968926      0.967001      0.968907
recall           0.916667  0.968926      0.954704      0.968926
f1-score         0.939024  0.968926      0.960705      0.968850
support        504.000000  0.968926  13999.000000  13999.000000

_______________________________________________
Confusion Matrix:
 [[1813   18   18    1   43    0]
 [  16 1577   23    0   27   12]
 [   8    7 4638   32   30    3]
 [   2    1   63 1072    3    1]
 [  25   13   40    5 4002    2]
 [   0   28   11    0    3  462]]

Test Result:
================================================
Accuracy Score: 88.70%

_______________________________________________
CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.883605     0.863570     0.889249     0.840000     0.913120
recall           0.865196     0.828691     0.939765     0.757515     0.915789
f1-score         0.874303     0.845771     0.913810     0.796628     0.914453
support        816.000000   718.000000  2042.000000   499.000000  1710.000000

                 Surprise  accuracy     macro avg  weighted avg
precision        0.835979     0.887      0.870920      0.886207
recall           0.782178     0.887      0.854521      0.887000
f1-score         0.754884     0.887      0.846527      0.886000
support        215.000000     0.887   6000.000000   6000.000000

_______________________________________________
Confusion Matrix:
 [[ 706   27   25    5   51
 [                       2]
 [  28  595   29    3   45   18]
 [  15   15 1919   55   33    5]
 [   4    0  107  378   10    0]
 [  44   23   62    9 1566    6]
    2   29   16    0   10  158]]
```

Multinomial Naive Bayes: The Multinomial Naive Bayes algorithm is a Bayesian learning approach popular in Natural Language Processing (NLP).

In [38]:
```
mnb = MultinomialNB()
mnb.fit(x_train, y_train)

y_pred_test_mnb = mnb.predict(x_test)
y_predprob_mnb = mnb.predict_proba(x_test)
matrix_mnb = confusion_matrix(y_test,y_pred_test_mnb)
print(classification_report(y_test, y_pred_test_mnb))
print("Accuracy for Multinominal Naive Bayes Model is:",metrics.accuracy_score(y_
print("\n")
acc_mnb = metrics.accuracy_score(y_test, y_pred_test_mnb)
matrix_display = ConfusionMatrixDisplay(matrix_mnb).plot()
```

```
              precision    recall  f1-score   support

       Anger       0.84      0.79      0.82       816
        Fear       0.79      0.78      0.79       718
       Happy       0.84      0.90      0.87      2042
        Love       0.78      0.60      0.68       499
         Sad       0.84      0.89      0.86      1710
    Surprise       0.74      0.45      0.56       215

    accuracy                           0.83      6000
   macro avg       0.80      0.74      0.76      6000
weighted avg       0.82      0.83      0.82      6000

Accuracy for Multinominal Naive Bayes Model is: 0.8275
```



In [39]:
```
print_score(mnb, x_train, y_train, x_test, y_test, train=True)
print_score(mnb, x_train, y_train, x_test, y_test, train=False)
```

```
Train Result:
================================================
Accuracy Score: 93.19%

_______________________________________________

CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.952980     0.918478     0.926770     0.940524     0.928004
recall           0.920761     0.919033     0.965663     0.816988     0.971373
f1-score         0.936593     0.918756     0.945817     0.874414     0.949193
support       1893.000000  1655.000000  4718.000000  1142.000000  4087.000000

                 Surprise     accuracy     macro avg  weighted avg
precision        0.981707     0.931852      0.941411      0.932794
recall           0.638889     0.931852      0.872118      0.931852
f1-score         0.774038     0.931852      0.899802      0.930347
support        504.000000     0.931852  13999.000000  13999.000000

_______________________________________________

Confusion Matrix:
 [[1743   30   33    2   85    0]
 [  29 1521   28    1   74    2]
 [  20   13 4556   47   78    4]
 [   5    3  171  933   30    0]
 [  28   14   66    9 3970    0]
 [   4   75   62    0   41  322]]

Test Result:
================================================
Accuracy Score: 82.75%

_______________________________________________

CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.844941     0.789326     0.838798     0.779793     0.838017
recall           0.787990     0.782730     0.902057     0.603206     0.889474
f1-score         0.815472     0.786014     0.869278     0.680226     0.862979
support        816.000000   718.000000  2042.000000   499.000000  1710.000000

                 Surprise     accuracy     macro avg  weighted avg
precision        0.738462       0.8275      0.804889      0.824988
recall           0.446512       0.8275      0.735328      0.827500
f1-score         0.556522       0.8275      0.761748      0.823271
support        215.000000       0.8275   6000.000000   6000.000000

_______________________________________________

Confusion Matrix:
 [[ 643   39   39    5   85
                          5]
 [  30  562   38    4   76    8]
 [  27   28 1842   55   78   12]
 [  10    6  160  301   21    1]
 [  49   37   78   17 1521    8]
 [   2   40   39    4   34   96]]
```

Support Vector Machine: Support Vector Machine or SVM is one of the most popular Supervised

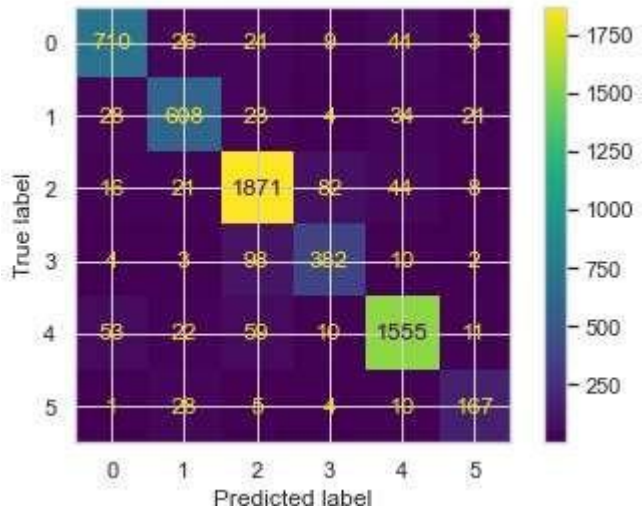
Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.

The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane.

In [40]:
```
from sklearn.svm import LinearSVC
model_svc = LinearSVC(loss='hinge', dual=True)

model_svc.fit(x_train, y_train)
y_pred_test_sv = model_svc.predict(x_test)
matrix_sv = confusion_matrix(y_test,y_pred_test_sv)
print(classification_report(y_test, y_pred_test_sv))
print("\nAccuracy for Support Vector Machine Model is:",metrics.accuracy_score(y_
print("\n")
acc_svm = metrics.accuracy_score(y_test, y_pred_test_sv)
matrix_display = ConfusionMatrixDisplay(matrix_sv).plot()
```

```
              precision    recall  f1-score   support

       Anger       0.87      0.87      0.87       816
        Fear       0.86      0.85      0.85       718
       Happy       0.90      0.92      0.91      2042
        Love       0.78      0.77      0.77       499
         Sad       0.92      0.91      0.91      1710
    Surprise       0.79      0.78      0.78       215

    accuracy                           0.88      6000
   macro avg       0.85      0.85      0.85      6000
weighted avg       0.88      0.88      0.88      6000
```

```
Accuracy for Support Vector Machine Model is: 0.8821666666666667
```



In [41]:
```
print_score(model_svc, x_train, y_train, x_test, y_test, train=True)
print_score(model_svc, x_train, y_train, x_test, y_test, train=False)
```

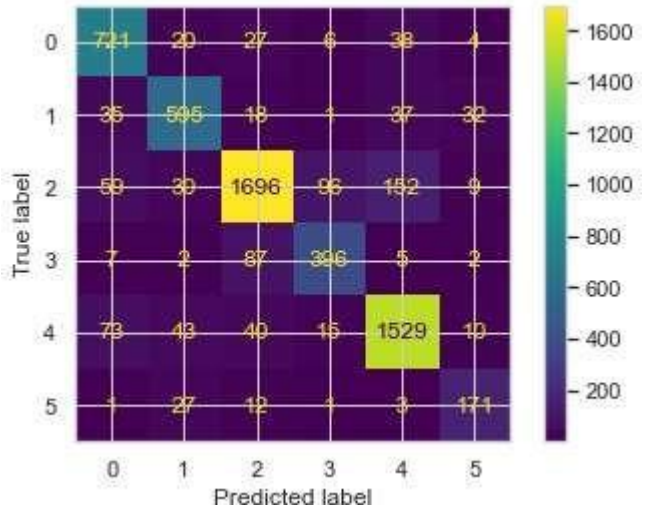
```
Train Result:
================================================
Accuracy Score: 97.93%

_______________________________________________

CLASSIFICATION REPORT:
                  Anger         Fear        Happy         Love          Sad  \
precision      0.979211     0.968825     0.981247     0.972591     0.983590
recall         0.970417     0.976435     0.987071     0.963222     0.982628
f1-score       0.974794     0.972615     0.984150     0.967884     0.983109
support     1893.000000  1655.000000  4718.000000  1142.000000  4087.000000

              Surprise  accuracy     macro avg  weighted avg
precision     0.975758  0.979284      0.976870      0.979284
recall        0.958333  0.979284      0.973018      0.979284
f1-score      0.966967  0.979284      0.974920      0.979272
support     504.000000  0.979284  13999.000000  13999.000000

_______________________________________________

Confusion Matrix:
 [[1837   15    7    1   33    0]
 [  11 1616    8    0   13    7]
 [   4    5 4657   28   19    5]
 [   1    1   39 1100    1    0]
 [  23   12   34    2 4016    0]
 [   0   19    1    0    1  483]]

Test Result:
================================================
Accuracy Score: 88.22%

_______________________________________________

CLASSIFICATION REPORT:
                  Anger        Fear        Happy        Love          Sad  \
precision      0.874384    0.858757     0.899519     0.778004     0.916323
recall         0.870098    0.846797     0.916259     0.765531     0.909357
f1-score       0.872236    0.852735     0.907812     0.771717     0.912827
support     816.000000  718.000000  2042.000000  499.000000  1710.000000

              Surprise  accuracy    macro avg  weighted avg
precision     0.787736  0.882167     0.852454      0.881900
recall        0.776744  0.882167     0.847464      0.882167
f1-score      0.782201  0.882167     0.849921      0.881992
support     215.000000  0.882167  6000.000000   6000.000000

_______________________________________________

Confusion Matrix:
 [[ 710   26   24    9   44
 [                       3]
 [  28  608   23    4   34   21]
 [  16   21 1871   82   44    8]
 [   4    3   98  382   10    2]
 [  53   22   59   10 1555   11]
     1   28    5    4   10  167]]
```

Decision Tree: Decision tree is the most powerful and popular tool for classification and

prediction. A Decision tree is a flowchart like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label.

In [42]:
```
from sklearn.tree import DecisionTreeClassifier

clf_DT = DecisionTreeClassifier()
clf_DT.fit(x_train, y_train)

y_pred_test_dt = clf_DT.predict(x_test)
matrix_dt = confusion_matrix(y_test,y_pred_test_dt)
print(classification_report(y_test, y_pred_test_dt))
print("\nAccuracy for Decision Tree Model is:",metrics.accuracy_score(y_test, y_p
print("\n")
acc_dt = metrics.accuracy_score(y_test, y_pred_test_dt)
matrix_display = ConfusionMatrixDisplay(matrix_dt).plot()
```

```
              precision    recall  f1-score   support

       Anger       0.80      0.88      0.84       816
        Fear       0.83      0.83      0.83       718
       Happy       0.90      0.83      0.86      2042
        Love       0.77      0.79      0.78       499
         Sad       0.87      0.89      0.88      1710
    Surprise       0.75      0.80      0.77       215

    accuracy                           0.85      6000
   macro avg       0.82      0.84      0.83      6000
weighted avg       0.85      0.85      0.85      6000


Accuracy for Decision Tree Model is: 0.8513333333333334
```



In [43]:
```
print_score(clf_DT, x_train, y_train, x_test, y_test, train=True)
print_score(clf_DT, x_train, y_train, x_test, y_test, train=False)
```

```
Train Result:
================================================
Accuracy Score: 99.71%

_______________________________________________

CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.995792     0.995773     0.995358     1.000000     0.999510
recall           1.000000     0.996375     0.999788     0.986865     0.997553
f1-score         0.997891     0.996074     0.997568     0.993389     0.998530
support       1893.000000  1655.000000  4718.000000  1142.000000  4087.000000

                 Surprise     accuracy     macro avg  weighted avg
precision        0.997988     0.997143      0.997403      0.997151
recall           0.984127     0.997143      0.994118      0.997143
f1-score         0.991009     0.997143      0.995744      0.997139
support        504.000000     0.997143  13999.000000  13999.000000

_______________________________________________
Confusion Matrix:
 [[1893    0    0    0    0    0]
 [   3 1649    1    0    1    1]
 [   0    0 4717    0    1    0]
 [   0    0   15 1127    0    0]
 [   5    1    4    0 4077    0]
 [   0    6    2    0    0  496]]

Test Result:
================================================
Accuracy Score: 85.13%

_______________________________________________
CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.804688     0.829847     0.902128     0.768932     0.866780
recall           0.883578     0.828691     0.830558     0.793587     0.894152
f1-score         0.842290     0.829268     0.864865     0.781065     0.880253
support        816.000000   718.000000  2042.000000   499.000000  1710.000000

                 Surprise     accuracy     macro avg  weighted avg
precision        0.750000     0.851333      0.820396      0.853623
recall           0.795349     0.851333      0.837653      0.851333
f1-score         0.772009     0.851333      0.828292      0.851624
support        215.000000     0.851333   6000.000000   6000.000000

_______________________________________________
Confusion Matrix:
 [[ 721   20   27    6   38
 [                      4]
 [  35  595   18    1   37   32]
 [  59   30 1696   96  152    9]
 [   7    2   87  396    5    2]
 [  73   43   40   15 1529   10]
 [   1   27   12    1    3  171]]
```

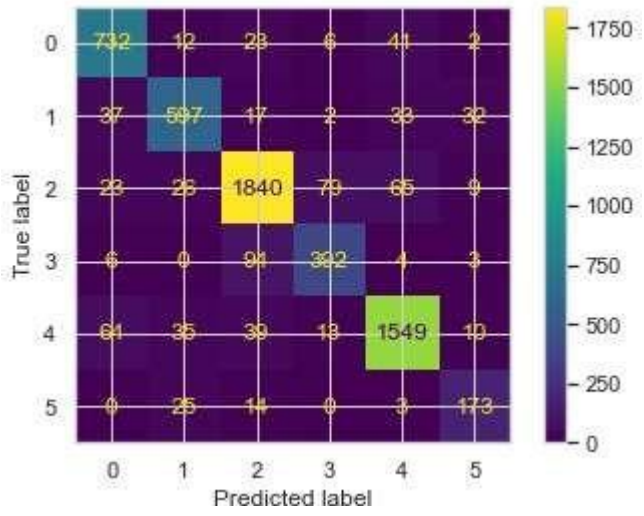
Randon Forest: Random forest is a Supervised Machine Learning Algorithm that is used widely in

Classification and Regression problems. It builds decision trees on different samples and takes their majority vote for classification and average in case of regression.

In [44]:
```
from sklearn.ensemble import RandomForestClassifier

clf_RF = RandomForestClassifier(n_estimators=200)
clf_RF.fit(x_train, y_train)

y_pred_test_re = clf_RF.predict(x_test)
matrix_re = confusion_matrix(y_test,y_pred_test_re)
print(classification_report(y_test, y_pred_test_re))
print("\nAccuracy for Random Forest Model is:",metrics.accuracy_score(y_test, y_p
print("\n")
acc_rf = metrics.accuracy_score(y_test, y_pred_test_re)
matrix_display = ConfusionMatrixDisplay(matrix_re).plot()
```

```
              precision    recall  f1-score   support

       Anger       0.85      0.90      0.87       816
        Fear       0.86      0.83      0.85       718
       Happy       0.91      0.90      0.90      2042
        Love       0.80      0.79      0.79       499
         Sad       0.91      0.91      0.91      1710
    Surprise       0.76      0.80      0.78       215

    accuracy                           0.88      6000
   macro avg       0.85      0.85      0.85      6000
weighted avg       0.88      0.88      0.88      6000
```

```
Accuracy for Random Forest Model is: 0.8513333333333334
```

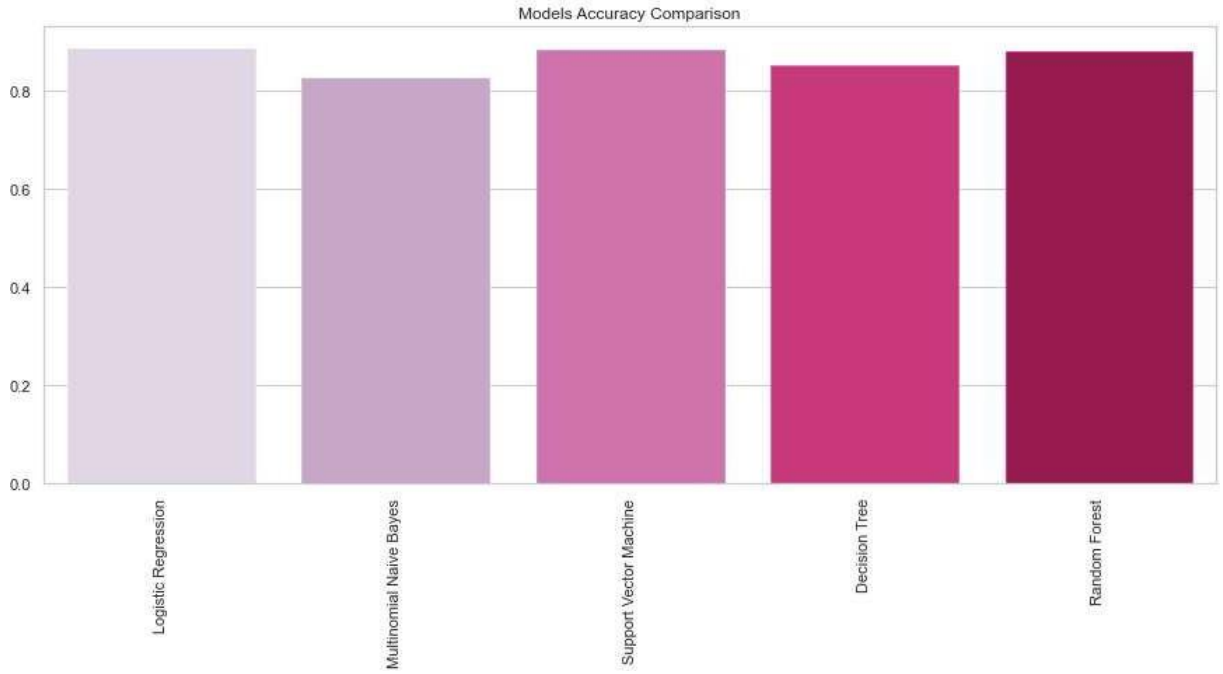


In [45]:
```
print_score(clf_RF, x_train, y_train, x_test, y_test, train=True)
print_score(clf_RF, x_train, y_train, x_test, y_test, train=False)
```

```
Train Result:
================================================
Accuracy Score: 99.71%

_______________________________________________

CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.997887     0.998180     0.995986     0.998232     0.998532
recall           0.997887     0.993958     0.999152     0.988616     0.998532
f1-score         0.997887     0.996064     0.997566     0.993401     0.998532
support       1893.000000  1655.000000  4718.000000  1142.000000  4087.000000

                 Surprise     accuracy     macro avg  weighted avg
precision        0.988166     0.997143      0.996164      0.997147
recall           0.994048     0.997143      0.995365      0.997143
f1-score         0.991098     0.997143      0.995758      0.997141
support        504.000000     0.997143  13999.000000  13999.000000

_______________________________________________
Confusion Matrix:
 [[1889    1    0    0    3    0]
 [   2 1645    1    0    2    5]
 [   0    0 4714    2    1    1]
 [   0    0   13 1129    0    0]
 [   2    0    4    0 4081    0]
 [   0    2    1    0    0  501]]

Test Result:
================================================
Accuracy Score: 88.05%

_______________________________________________
CLASSIFICATION REPORT:
                    Anger         Fear        Happy         Love          Sad  \
precision        0.849188     0.858993     0.907745     0.796748     0.913864
recall           0.897059     0.831476     0.901077     0.785571     0.905848
f1-score         0.872467     0.845011     0.904399     0.791120     0.909838
support        816.000000   718.000000  2042.000000   499.000000  1710.000000

                 Surprise     accuracy     macro avg  weighted avg
precision        0.755459     0.8805       0.846999      0.881003
recall           0.804651     0.8805       0.854280      0.880500
f1-score         0.779279     0.8805       0.850352      0.880595
support        215.000000     0.8805    6000.000000   6000.000000

_______________________________________________
Confusion Matrix:
 [[ 732   12   23    6   41
 [                      2]
 [  37  597   17    2   33   32]
 [  23   26 1840   79   65    9]
 [   6    0   94  392    4    3]
 [  64   35   39   13 1549   10]
 [   0   25   14    0    3  173]]
```

Model Evaluation

In [46]:
```
MLA_Name = ['Logistic Regression', 'Multinomial Naive Bayes', 'Support Vector Ma
MLA_Train_Accuracy = [acc_lr, acc_mnb, acc_svm, acc_dt, acc_rf]
plt.subplots(figsize=(15,6))
sns.barplot(x=MLA_Name, y=MLA_Train_Accuracy,palette='PuRd',edgecolor=sns.color_p
plt.xticks(rotation=90)
plt.title('Models Accuracy Comparison')
plt.show()
```



Model Accuracy Comparison

ML Model	Accuracy
Logistic Regression	88.7%
Multinomial Naive Bayes	82.75
Support Vector Machine	88.22
Decision Tree	84.9
Random Forest	87.92%

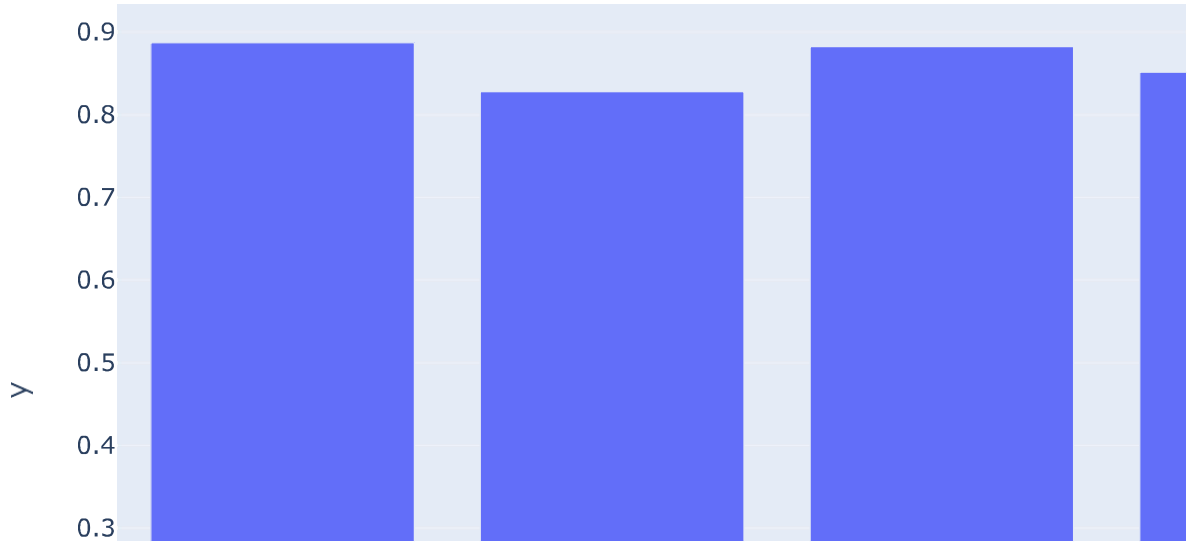
Logistic Regression is having the highest accuracy that is 88.7% hence it is the most optimal ML Algorithm for Emotion Detection in Test using NLP.

Hyperparameter Tuning using GridSearchCV for Logistic Regression

In [47]:
```
grid={"C":np.logspace(-3,3,7), "penalty":["l1","l2"]}# l1 lasso l2 ridge
logreg_cv = GridSearchCV(lr_clf,grid,cv=10)
logreg_cv.fit(x_train,y_train)

print('best paremeters for logistic regression: ', logreg_cv.best_params_)
print('best score for logistic regression after grid search cv:', logreg_cv.best_
acc_logreg = logreg_cv.best_score_
```

```
best paremeters for logistic regression:  {'C': 1.0, 'penalty': 'l1'}
best score for logistic regression after grid search cv: 0.8975637700398245
```

In [48]:
```
fig = px.bar(x=MLA_Name, y=MLA_Train_Accuracy)
fig.show()
```



Emotion Detection: String/Text is taken as input and the Emotion of the Text will be displayed.

In [49]:
```
inp = 'Y'
while(inp != 'N'):
    ip = input('\nEnter a Text: ')
    test_result = logreg_cv.predict(vectorizer.transform([ip]))
    if(test_result[0] == 'Happy'):
        print("\nEmotion: Happy\U0001F600")
    if(test_result[0] == 'Sad'):
        print("\nEmotion: Sad\N{loudly crying face}")
    if(test_result[0] == 'Anger'):
        print("\nEmotion: Anger\N{angry face}")
    if(test_result[0] == 'Fear'):
        print("\nEmotion: Fear\N{face screaming in fear}")
    if(test_result[0] == 'Surprise'):
        print("\nEmotion: Surprise\N{astonished face}")
    if(test_result[0] == 'Love'):
        print("\nEmotion: Love\U0001F970")
    inp = input("\nDo you want to continue? (Y/N): ")
```

```
Enter a Text: I feel good today

Emotion: Happy😀

Do you want to continue? (Y/N): Y

Enter a Text: I am irritated

Emotion: Anger😡

Do you want to continue? (Y/N): Y

Enter a Text: You are so caring

Emotion: Love😘

Do you want to continue? (Y/N): Y

Enter a Text: I am terrified of reptiles

Emotion: Fear😱

Do you want to continue? (Y/N): Y

Enter a Text: Your words hurt me

Emotion: Sad😭

Do you want to continue? (Y/N): Y

Enter a Text: Amazed!

Emotion: Surprise😲

Do you want to continue? (Y/N): N
```