CNN+LSTM with Active Learning .ipynb

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Import and install all Required libraries

[63]
```
import pandas as pd

pd.set_option('max_colwidth', 50)

import numpy as np

# text preprocessing
from nltk.tokenize import word_tokenize
import re
!pip install contractions

# plots and metrics
import matplotlib.pyplot as plt
from sklearn.metrics import accuracy_score, f1_score, confusion_matrix

# preparing input to our model
from keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from keras.utils import to_categorical

# keras layers
from keras.models import Sequential
from keras.layers import Embedding, Conv1D, GlobalMaxPooling1D, Dense


# stopwords
import nltk
nltk.download("popular")

from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: contractions in /usr/local/lib/python3.10/dist-packages (0.1.73)
Requirement already satisfied: textsearch>=0.0.21 in /usr/local/lib/python3.10/dist-packages (from contractions) (0.0.24)
Requirement already satisfied: pyahocorasick in /usr/local/lib/python3.10/dist-packages (from textsearch>=0.0.21->contractions) (2.0.0)
Requirement already satisfied: anyascii in /usr/local/lib/python3.10/dist-packages (from textsearch>=0.0.21->contractions) (0.3.2)
[nltk_data] Downloading collection 'popular'
[nltk_data]    |
[nltk_data]    | Downloading package cmudict to /root/nltk_data...
[nltk_data]    |   Package cmudict is already up-to-date!
[nltk_data]    | Downloading package gazetteers to /root/nltk_data...
[nltk_data]    |   Package gazetteers is already up-to-date!
[nltk_data]    | Downloading package genesis to /root/nltk_data...
[nltk_data]    |   Package genesis is already up-to-date!
[nltk_data]    | Downloading package gutenberg to /root/nltk_data...
[nltk_data]    |   Package gutenberg is already up-to-date!
[nltk_data]    | Downloading package inaugural to /root/nltk_data...
[nltk_data]    |   Package inaugural is already up-to-date!
[nltk_data]    | Downloading package movie_reviews to
[nltk_data]    |     /root/nltk_data...
[nltk_data]    |   Package movie_reviews is already up-to-date!
[nltk_data]    | Downloading package names to /root/nltk_data...
[nltk_data]    |   Package names is already up-to-date!
[nltk_data]    | Downloading package shakespeare to /root/nltk_data...
[nltk_data]    |   Package shakespeare is already up-to-date!
[nltk_data]    | Downloading package stopwords to /root/nltk_data...
[nltk_data]    |   Package stopwords is already up-to-date!
[nltk_data]    | Downloading package treebank to /root/nltk_data...
[nltk_data]    |   Package treebank is already up-to-date!
[nltk_data]    | Downloading package twitter_samples to
[nltk_data]    |     /root/nltk_data...
[nltk_data]    |   Package twitter_samples is already up-to-date!
[nltk_data]    | Downloading package omw to /root/nltk_data...
[nltk_data]    |   Package omw is already up-to-date!
[nltk_data]    | Downloading package omw-1.4 to /root/nltk_data...
[nltk_data]    |   Package omw-1.4 is already up-to-date!
[nltk_data]    | Downloading package wordnet to /root/nltk_data...
[nltk_data]    |   Package wordnet is already up-to-date!
[nltk_data]    | Downloading package wordnet2021 to /root/nltk_data...
[nltk_data]    |   Package wordnet2021 is already up-to-date!
[nltk_data]    | Downloading package wordnet31 to /root/nltk_data...
[nltk_data]    |   Package wordnet31 is already up-to-date!
[nltk_data]    | Downloading package wordnet_ic to /root/nltk_data...
[nltk_data]    |   Package wordnet_ic is already up-to-date!
[nltk_data]    | Downloading package words to /root/nltk_data...
[nltk_data]    |   Package words is already up-to-date!
[nltk_data]    | Downloading package maxent_ne_chunker to
[nltk_data]    |     /root/nltk_data...
[nltk_data]    |   Package maxent_ne_chunker is already up-to-date!
[nltk_data]    | Downloading package punkt to /root/nltk_data...
[nltk_data]    |   Package punkt is already up-to-date!
[nltk_data]    | Downloading package snowball_data to
[nltk_data]    |     /root/nltk_data...
[nltk_data]    |   Package snowball_data is already up-to-date!
[nltk_data]    | Downloading package averaged_perceptron_tagger to
[nltk_data]    |     /root/nltk_data...
[nltk_data]    |   Package averaged_perceptron_tagger is already up-
[nltk_data]    |       to-date!
[nltk_data]    |
```

Variable Initialization

[64]
```
# Number of labels: joy, anger, fear, sadness, neutral
num_classes = 5

# Number of dimensions for word embedding
embed_num_dims = 300

# Max input length (max number of words)
max_seq_len = 500

class_names = ['joy', 'fear', 'anger', 'sadness', 'neutral']
```

Connect to google drive

To import all required data and stored our models values

[65]
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

Read Train and Test Data

```
[66] #Train Data

     print("Train Data")
     data_train = pd.read_csv('/content/drive/MyDrive/Final_Project/data_train.csv', encoding='utf-8')
     data_train = data_train.dropna()
     print(data_train)

     #Test Data

     print("Test Data")
     data_test = pd.read_csv('/content/drive/MyDrive/Final_Project/data_test.csv', encoding='utf-8')
     data_test = data_test.dropna()
     print(data_test)

     print("Complete Data")
     merged_data= data_train.append(data_test ,ignore_index=True)
     print(merged_data)
```

```
Train Data
      Emotion                                               Text
0        fear                                i didnt feel humiliated
1        fear  i can go from feeling so hopeless to so damned...
2       anger   im grabbing a minute to post i feel greedy wrong
3         joy  i am ever feeling nostalgic about the fireplac...
4       anger                                 i am feeling grouchy
...       ...                                                 ...
24030    fear                 When I felt alone and without love.
24031   anger                    Irina hung up in exasperation .
24032    fear  No wonder she was now inconsolable at the pros...
24033    fear  My friend had been telling me about a certain ...
24034   anger   I've created a monster ... you're a better ba...

[24034 rows x 2 columns]
Test Data
       Emotion                                               Text
0      sadness  I experienced this emotion when my grandfather...
1      neutral   when I first moved in , I walked everywhere ....
2        anger  ` Oh ! " she bleated , her voice high and rath...
3         fear  However , does the right hon. Gentleman recogn...
4      sadness  My boyfriend didn't turn up after promising th...
...        ...                                                 ...
11814  neutral  i had on my plate without the stress of feelin...
11815      joy  i was hoping i could rock a bikini with my bel...
11816     fear  im around my husband or home alone thinking ab...
11817     fear  i am working on one thing that i feel unsure o...
11818     fear                                i feel i cant stop aching

[11819 rows x 2 columns]
Complete Data
       Emotion                                               Text
0         fear                                i didnt feel humiliated
1         fear  i can go from feeling so hopeless to so damned...
2        anger   im grabbing a minute to post i feel greedy wrong
3          joy  i am ever feeling nostalgic about the fireplac...
4        anger                                 i am feeling grouchy
...        ...                                                 ...
35848  neutral  i had on my plate without the stress of feelin...
35849      joy  i was hoping i could rock a bikini with my bel...
35850     fear  im around my husband or home alone thinking ab...
35851     fear  i am working on one thing that i feel unsure o...
35852     fear                                i feel i cant stop aching

[35853 rows x 2 columns]
<ipython-input-66-8aea129f0ee5>:16: FutureWarning: The frame.append method is deprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  merged_data= data_train.append(data_test ,ignore_index=True)
```

Data Preprocessing

```
[67]
     # remove stopwords function
     def remove_stopwords(text):
         stop_words = set(stopwords.words("english"))
         word_tokens = word_tokenize(text)
         filtered_text = [word for word in word_tokens if word not in stop_words]
         return filtered_text
```

```
[68] def clean_text(data):

         # remove stopwords
         list1 = remove_stopwords(data)
         data = " ".join(list1)

         # remove punctuation
         data = re.sub(r'[^a-zA-Z0-9]', ' ', data)

         # remove extra spaces
         data = re.sub(r'^\s*|\s\s*', ' ', data).strip()

         # lowercase letter
         data = data.lower()

         # remove text less than length of 3
         shortword = re.compile(r'\W*\b\w{1,3}\b')
         data = shortword.sub('', data)

         # remove hashtags and @usernames
         data = re.sub(r"(#[\d\w\.]+)", '', data)
         data = re.sub(r"(@[\d\w\.]+)", '', data)

         # tekenization using nltk
         data = word_tokenize(data)

         return data
```

```
[69] data_train['Clean Text'] = [' '.join(clean_text(str(text))) for text in data_train['Text']]
     data_test['Clean Text'] = [' '.join(clean_text(str(text))) for text in data_test['Text']]

     print(data_train)
     print(data_test)

     merged_data['Clean Text'] = [' '.join(clean_text(text)) for text in merged_data.Text]
     print(merged_data)
```

```
24033  friend telling certain bird cries night sign s...
24034                       created monster better bayer

[24034 rows x 3 columns]
       Emotion                                               Text  \
0      sadness  I experienced this emotion when my grandfather...
1      neutral   when I first moved in , I walked everywhere ....
```

```
2        anger  ` Oh ! " she bleated , her voice high and rath...
3         fear  However , does the right hon. Gentleman recogn...
4      sadness  My boyfriend didn't turn up after promising th...
...        ...                                                ...
11814  neutral  i had on my plate without the stress of feelin...
11815      joy  i was hoping i could rock a bikini with my bel...
11816     fear  im around my husband or home alone thinking ab...
11817     fear  i am working on one thing that i feel unsure o...
11818     fear                          i feel i cant stop aching

                                                   Clean Text
0            experienced emotion grandfather passed away
1      first moved walked everywhere within week purs...
2                    bleated voice high rather indignant
3      however right gentleman recognise profound dis...
4                        boyfriend turn promising coming
...                                                    ...
11814  plate without stress feeling completely overwh...
11815  hoping could rock bikini belly summer feeling ...
11816   around husband home alone thinking feel hopeless
11817               working thing feel unsure completing
11818                               feel cant stop aching

[11819 rows x 3 columns]
       Emotion                                               Text  \
0         fear                                 i didnt feel humiliated
1         fear  i can go from feeling so hopeless to so damned...
2        anger   im grabbing a minute to post i feel greedy wrong
3          joy  i am ever feeling nostalgic about the fireplac...
4        anger                                   i am feeling grouchy
...        ...                                                ...
35848  neutral  i had on my plate without the stress of feelin...
35849      joy  i was hoping i could rock a bikini with my bel...
35850     fear  im around my husband or home alone thinking ab...
35851     fear  i am working on one thing that i feel unsure o...
35852     fear                          i feel i cant stop aching

                                                   Clean Text
0                                   didnt feel humiliated
1      feeling hopeless damned hopeful around someone...
2                grabbing minute post feel greedy wrong
3      ever feeling nostalgic fireplace know still pr...
4                                         feeling grouchy
...                                                    ...
35848  plate without stress feeling completely overwh...
35849  hoping could rock bikini belly summer feeling ...
35850   around husband home alone thinking feel hopeless
35851               working thing feel unsure completing
35852                               feel cant stop aching

[35853 rows x 3 columns]
```

[70]
```
# tokenization to break down raw text into smaller units (tokens) for analysis or processing

tokenizer = Tokenizer()
tokenizer.fit_on_texts(merged_data['Clean Text'])

data_train['Sequence Train'] = tokenizer.texts_to_sequences(data_train['Clean Text'])
data_test['Sequence Test'] = tokenizer.texts_to_sequences(data_test['Clean Text'])

index_of_words = tokenizer.word_index

# vacab size is number of unique words + reserved 0 index for padding
vocab_size = len(index_of_words) + 1

print('Number of unique words: {}'.format(len(index_of_words)))
```

```
Number of unique words: 19441
```

[71]
```
# Data padding to add extra space or characters at the beginning or end our data to ensure consistent length and formatting.

X_train_pad = pad_sequences(data_train['Sequence Train'], maxlen = max_seq_len )
X_test_pad = pad_sequences(data_test['Sequence Test'], maxlen = max_seq_len )

print(X_train_pad.size)
print(X_train_pad)

print(X_test_pad.size)
print(X_test_pad)
```

```
12017000
[[    0     0     0 ...    75     1   671]
 [    0     0     0 ...    45  1669  1180]
 [    0     0     0 ...     1   505   237]
 ...
 [    0     0     0 ...   168  1362  1185]
 [    0     0     0 ...   159  1724    82]
 [    0     0     0 ...  4777    85 18239]]
5909500
[[    0     0     0 ...   849   156    42]
 [    0     0     0 ...    65   807 11282]
 [    0     0     0 ...   302   107  1366]
 ...
 [    0     0     0 ...   144     1   455]
 [    0     0     0 ...     1   457  5497]
 [    0     0     0 ...    63   134   534]]
```

[72]
```
# Encode label data to simply fit the encoder on training data, transform both the training and test data

encoding = {
    'joy': 0,
    'fear': 1,
    'anger': 2,
    'sadness': 3,
    'neutral': 4
}

# Integer labels
y_train = [encoding[x] for x in data_train.Emotion]
y_test = [encoding[x] for x in data_test.Emotion]

print(y_train)

print(y_test)
```

```
[1, 1, 2, 0, 2, 1, 4, 1, 0, 0, 1, 0, 2, 1, 0, 0, 1, 1, 1, 1, 2, 1, 0, 0, 2, 1, 1, 1, 2, 0, 0, 1, 4, 2, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 2, 0, 1, 2, 1, 0, 1, 1, 4, 0, 0, 0, 0, 1, 1, 4, 2, 2,
[3, 4, 2, 1, 3, 4, 3, 2, 4, 3, 4, 4, 1, 2, 4, 3, 3, 4, 0, 1, 0, 1, 0, 2, 0, 1, 4, 0, 2, 2, 0, 0, 0, 3, 2, 1, 1, 3, 3, 4, 2, 0, 4, 2, 4, 0, 2, 3, 4, 2, 1, 1, 4, 1, 2, 3, 1, 0, 2, 4, 0, 2, 0, 2, 2, 1, 1,
```

[73]
```
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

print(y_train)
print(y_test)
```

```
[[0. 1. 0. 0. 0.]
 [0. 1. 0. 0. 0.]
 [0. 0. 1. 0. 0.]
 ...
 [0. 1. 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. 1. 0. 0.]
 ...
 [0. 1. 0. 0. 0.]
 [0. 1. 0. 0. 0.]
 [0. 1. 0. 0. 0.]]
```

Word Embetting Matrix

Helps us to incorporate a pre-trained word embedding matrix and train our machine learning models that involve training data

```
[48] def create_embedding_matrix(filepath, word_index, embedding_dim):
         vocab_size = len(word_index) + 1  # Adding again 1 because of reserved 0 index
         embedding_matrix = np.zeros((vocab_size, embedding_dim))
         with open(filepath) as f:
             for line in f:
                 word, *vector = line.split()
                 if word in word_index:
                     idx = word_index[word]
                     embedding_matrix[idx] = np.array(
                         vector, dtype=np.float32)[:embedding_dim]
         return embedding_matrix
```

```
[49] # We have used 'wiki-news-300d-1M.vec' which is 1 million word vectors trained on Wikipedia dataset

     import urllib.request
     import zipfile
     import os

     fname = 'embeddings/wiki-news-300d-1M.vec'

     if not os.path.isfile(fname):
         print('Downloading word vectors...')
         urllib.request.urlretrieve('https://dl.fbaipublicfiles.com/fasttext/vectors-english/wiki-news-300d-1M.vec.zip',
                                    'wiki-news-300d-1M.vec.zip')
         print('Unzipping...')
         with zipfile.ZipFile('wiki-news-300d-1M.vec.zip', 'r') as zip_ref:
             zip_ref.extractall('embeddings')
         print('done.')
```

```
[50] # embedd_matrix is dense representation of the above word embedding which will be used as input to our neural netowrk

     embedd_matrix = create_embedding_matrix(fname, index_of_words, embed_num_dims)
     embedd_matrix.shape

     (19442, 300)
```

```
     # Inspect unseen words which helps us to increae the accuracy of our model
     new_words = 0

     for word in index_of_words:
         entry = embedd_matrix[index_of_words[word]]
         if all(v == 0 for v in entry):
             new_words = new_words + 1

     print('Words found in wiki vocab: ' + str(len(index_of_words) - new_words))
     print('New words found: ' + str(new_words))

     Words found in wiki vocab: 17610
     New words found: 1831
```

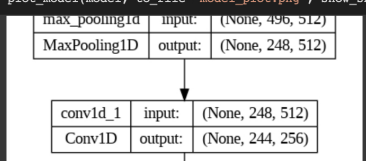
CNN+LSTM Model with the layer Embedding matrix

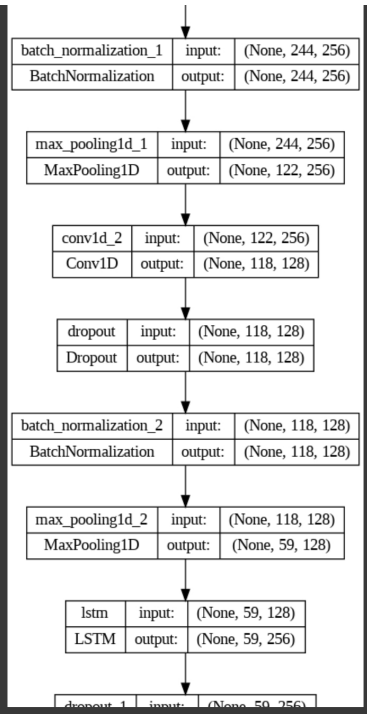
```
[52] # Embedding layer before the actaul BLSTM
     embedd_layer = Embedding(vocab_size,
                              embed_num_dims,
                              input_length = max_seq_len,
                              weights = [embedd_matrix],
                              trainable=False)
```

```
[53] # CNN-LSTM Model

     from keras.layers import MaxPooling1D, Conv1D, LSTM, BatchNormalization
     from keras.layers import Dropout
     from keras.models import Sequential

     kernel_size = 5
     filters = 512

     model = Sequential()
     model.add(embedd_layer)
     model.add(Conv1D(filters, kernel_size, activation='relu'))
     model.add(BatchNormalization())
     model.add(MaxPooling1D(pool_size=2))
     model.add(Conv1D(filters//2, kernel_size, activation='relu'))
     model.add(BatchNormalization())
     model.add(MaxPooling1D(pool_size=2))
     model.add(Conv1D(filters//4, kernel_size, activation='relu'))
     model.add(Dropout(0.25))
     model.add(BatchNormalization())
     model.add(MaxPooling1D(pool_size=2))
     model.add(LSTM(256, return_sequences=True))
     model.add(Dropout(0.25))
     model.add(LSTM(128))
     model.add(Dense(5, activation='softmax'))
```

```
[54] print(model)

     <keras.engine.sequential.Sequential object at 0x7f4561d07190>
```

```
[55] from keras.utils.vis_utils import plot_model

     plot_model(model, to_file='model_plot.png', show_shapes=True, show_layer_names=True)
```






```
[56] model.compile(loss = 'categorical_crossentropy', optimizer = 'RMSprop', metrics = ['accuracy'])
     model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 500, 300)          5832600

 conv1d (Conv1D)             (None, 496, 512)          768512

 batch_normalization (BatchN  (None, 496, 512)         2048
 ormalization)

 max_pooling1d (MaxPooling1D  (None, 248, 512)         0
 )

 conv1d_1 (Conv1D)           (None, 244, 256)          655616

 batch_normalization_1 (Batc  (None, 244, 256)         1024
 hNormalization)

 max_pooling1d_1 (MaxPooling  (None, 122, 256)         0
 1D)

 conv1d_2 (Conv1D)           (None, 118, 128)          163968

 dropout (Dropout)           (None, 118, 128)          0

 batch_normalization_2 (Batc  (None, 118, 128)         512
 hNormalization)

 max_pooling1d_2 (MaxPooling  (None, 59, 128)          0
 1D)

 lstm (LSTM)                 (None, 59, 256)           394240

 dropout_1 (Dropout)         (None, 59, 256)           0

 lstm_1 (LSTM)               (None, 128)               197120

 dense (Dense)               (None, 5)                 645

=================================================================
Total params: 8,016,285
Trainable params: 2,181,893
Non-trainable params: 5,834,392
_________________________________________________________________
```

```
[ ] batch_size = 256
    epochs = 10

    hist = model.fit(X_train_pad, y_train,
                     batch_size=batch_size,
                     epochs=epochs,
                     validation_data=(X_test_pad,y_test))
```

```
[ ] # Accuracy plot
    plt.plot(hist.history['accuracy'])
    plt.plot(hist.history['val_accuracy'])
    plt.title('model accuracy')
    plt.ylabel('accuracy')
    plt.xlabel('epoch')
    plt.legend(['train', 'validation'], loc='upper left')
    plt.show()

    # Loss plot
    plt.plot(hist.history['loss'])
    plt.plot(hist.history['val_loss'])
    plt.title('model loss')
    plt.ylabel('loss')
    plt.xlabel('epoch')
    plt.legend(['train', 'validation'], loc='upper left')
    plt.show()
```

```
[ ] predictions = model.predict(X_test_pad)
    predictions = np.argmax(predictions, axis=1)
    predictions = [class_names[pred] for pred in predictions]
```

```
[ ] print("Accuracy: {:.2f}%".format(accuracy_score(data_test.Emotion, predictions) * 100))
    print("\nF1 Score: {:.2f}".format(f1_score(data_test.Emotion, predictions, average='micro') * 100))
```

```
[ ] # save the model
    model.save('/content/drive/MyDrive/Final_Project/models/emotion_model_after_training.h5')
```

```
[76] # load the model
     from keras.models import load_model
     cnn_predictor = load_model('/content/drive/MyDrive/Final_Project/models/emotion_model_after_training.h5')
```

```
[77] # Example for Anger

     import time

     message = ['I am so angry at my neighbor for playing loud music late at night.']

     seq = tokenizer.texts_to_sequences(message)
     padded = pad_sequences(seq, maxlen=max_seq_len)

     start_time = time.time()
     pred = cnn_predictor.predict(padded)

     print('Message: ' + str(message))
     print('predicted: {} ({:.2f} seconds)'.format(class_names[np.argmax(pred)], (time.time() - start_time)))
```

```
1/1 [==============================] - 1s 1s/step
Message: ['I am so angry at my neighbor for playing loud music late at night.']
predicted: anger (1.11 seconds)
```

```
[78] # Example for Joy

     import time

     message = ['I feel over the moon about my promotion at work!']

     seq = tokenizer.texts_to_sequences(message)
     padded = pad_sequences(seq, maxlen=max_seq_len)

     start_time = time.time()
     pred = cnn_predictor.predict(padded)

     print('Message: ' + str(message))
     print('predicted: {} ({:.2f} seconds)'.format(class_names[np.argmax(pred)], (time.time() - start_time)))
```

```
1/1 [==============================] - 0s 92ms/step
Message: ['I feel over the moon about my promotion at work!']
predicted: joy (0.27 seconds)
```

```
[79] # Example for Fear

     import time

     message = ['I should go home, my parent might scold me.']

     seq = tokenizer.texts_to_sequences(message)
     padded = pad_sequences(seq, maxlen=max_seq_len)

     start_time = time.time()
     pred = cnn_predictor.predict(padded)

     print('Message: ' + str(message))
     print('predicted: {} ({:.2f} seconds)'.format(class_names[np.argmax(pred)], (time.time() - start_time)))
```

```
1/1 [==============================] - 0s 217ms/step
Message: ['I should go home, my parent might scold me.']
predicted: fear (0.41 seconds)
```

```
[83] !pip install modAL
     !pip install gradio
```

```
Requirement already satisfied: toolz in /usr/local/lib/python3.10/dist-packages (from altair>=4.2.0->gradio) (0.12.0)
Requirement already satisfied: entrypoints in /usr/local/lib/python3.10/dist-packages (from altair>=4.2.0->gradio) (0.4)
Requirement already satisfied: jsonschema>=3.0 in /usr/local/lib/python3.10/dist-packages (from altair>=4.2.0->gradio) (4.3.3)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from gradio-client>=0.1.3->gradio) (23.1)
Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages (from gradio-client>=0.1.3->gradio) (2023.4.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from huggingface-hub>=0.13.0->gradio) (3.12.0)
Requirement already satisfied: tqdm>=4.42.1 in /usr/local/lib/python3.10/dist-packages (from huggingface-hub>=0.13.0->gradio) (4.65.0)
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.10/dist-packages (from markdown-it-py[linkify]>=2.0.0->gradio) (0.1.2)
Collecting linkify-it-py<3,>=1
  Downloading linkify_it_py-2.0.2-py3-none-any.whl (19 kB)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas->gradio) (2022.7.1)
Requirement already satisfied: python-dateutil>=2.8.1 in /usr/local/lib/python3.10/dist-packages (from pandas->gradio) (2.8.2)
Collecting async-timeout<5.0,>=4.0.0a3
  Downloading async_timeout-4.0.2-py3-none-any.whl (5.8 kB)
Collecting frozenlist>=1.1.1
  Downloading frozenlist-1.3.3-cp310-cp310-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_64.whl (149 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 149.6/149.6 kB 17.0 MB/s eta 0:00:00
Collecting multidict<7.0,>=4.5
  Downloading multidict-6.0.4-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (114 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 114.5/114.5 kB 12.8 MB/s eta 0:00:00
Collecting yarl<2.0,>=1.0
  Downloading yarl-1.9.2-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (268 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 268.8/268.8 kB 17.5 MB/s eta 0:00:00
Collecting aiosignal>=1.1.2
  Downloading aiosignal-1.3.1-py3-none-any.whl (7.6 kB)
Requirement already satisfied: charset-normalizer<4.0,>=2.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->gradio) (2.0.12)
Requirement already satisfied: attrs>=17.3.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->gradio) (23.1.0)
Collecting starlette<0.27.0,>=0.26.1
  Downloading starlette-0.26.1-py3-none-any.whl (66 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 66.9/66.9 kB 7.3 MB/s eta 0:00:00
Requirement already satisfied: certifi in /usr/local/lib/python3.10/dist-packages (from httpx->gradio) (2022.12.7)
Requirement already satisfied: sniffio in /usr/local/lib/python3.10/dist-packages (from httpx->gradio) (1.3.0)
Collecting httpcore<0.18.0,>=0.15.0
  Downloading httpcore-0.17.0-py3-none-any.whl (70 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 70.6/70.6 kB 7.6 MB/s eta 0:00:00
Requirement already satisfied: idna in /usr/local/lib/python3.10/dist-packages (from httpx->gradio) (3.4)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->gradio) (1.4.4)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->gradio) (3.0.9)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->gradio) (1.0.7)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib->gradio) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->gradio) (4.39.3)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests->gradio) (1.26.15)
Collecting h11>=0.8
  Downloading h11-0.14.0-py3-none-any.whl (58 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 58.3/58.3 kB 6.6 MB/s eta 0:00:00
Requirement already satisfied: click>=7.0 in /usr/local/lib/python3.10/dist-packages (from uvicorn->gradio) (8.1.3)
Requirement already satisfied: anyio<5.0,>=3.0 in /usr/local/lib/python3.10/dist-packages (from httpcore<0.18.0,>=0.15.0->httpx->gradio) (3.6.2)
Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.14.0 in /usr/local/lib/python3.10/dist-packages (from jsonschema>=3.0->altair>=4.2.0->gradio) (0.19.3)
Collecting uc-micro-py
  Downloading uc_micro_py-1.0.2-py3-none-any.whl (6.2 kB)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.1->pandas->gradio) (1.16.0)
Building wheels for collected packages: ffmpy
  Building wheel for ffmpy (setup.py) ... done
  Created wheel for ffmpy: filename=ffmpy-0.3.0-py3-none-any.whl size=4707 sha256=50a99724034622b6961fa281f9f371ee8eaa27b2836b48a42ea95e85ae8f693a
  Stored in directory: /root/.cache/pip/wheels/0c/c2/0e/3b9c6845c6a4e35beb90910cc70d9ac9ab5d47402bd62af0df
Successfully built ffmpy
Installing collected packages: pydub, ffmpy, websockets, uc-micro-py, semantic-version, python-multipart, orjson, multidict, h11, frozenlist, async-timeout, aiofiles, yarl, uvicorn, starlette, mdit-py-
Successfully installed aiofiles-23.1.0 aiohttp-3.8.4 aiosignal-1.3.1 async-timeout-4.0.2 fastapi-0.95.1 ffmpy-0.3.0 frozenlist-1.3.3 gradio-3.28.3 gradio-client-0.2.0 h11-0.14.0 httpcore-0.17.0 httpx-0
```

Human-In-The-Loop Model using Active learning and without any Data Training

[84] 29m

```python
import gradio as gr
import numpy as np
import tensorflow as tf

# Load the saved model from .h5 file

from keras.models import load_model
from modAL.models import ActiveLearner
from modAL.uncertainty import uncertainty_sampling


model = load_model('/content/drive/MyDrive/Final_Project/models/emotion_model_after_training.h5')

# Initialize the active learner Model
learner = ActiveLearner(
    estimator=model,
    query_strategy=uncertainty_sampling,
    X_training=X_train_pad,
    y_training=y_train,
    bootstrap_init=False
)
```

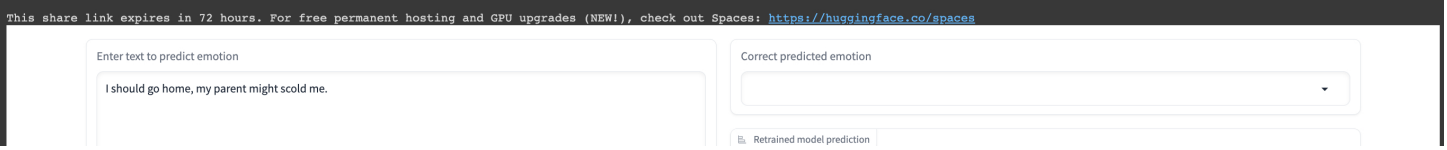
```
WARNING:tensorflow:6 out of the last 6 calls to <function Model.make_train_function.<locals>.train_function at 0x7f455b609090> triggered tf.function retracing. Tracing is expensive and the excessive nu
752/752 [==============================] - 1736s 2s/step - loss: 1.1137 - accuracy: 0.5051
```

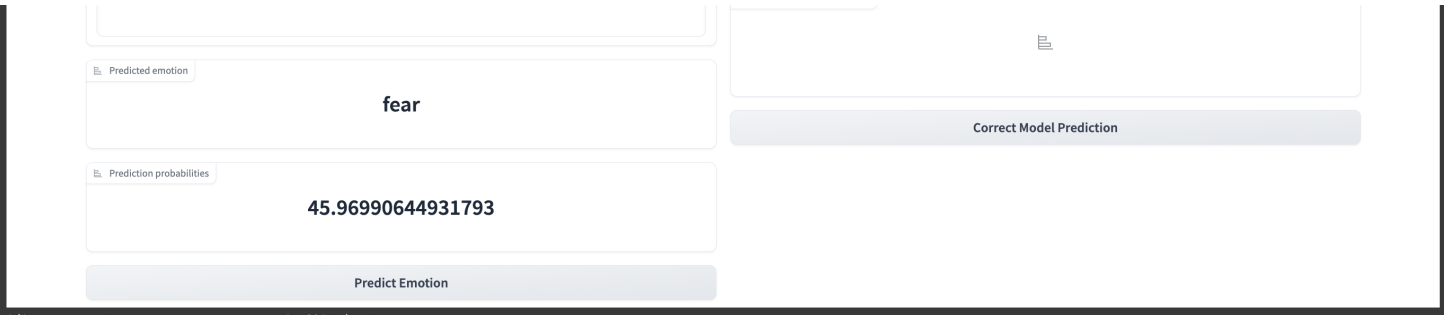
Design UI for User Interaction using Gradio API

[85] 3m

```python
# Define the prediction function
def predict_sentiment(text):

    # Preprocess the input text
    text_clean = [' '.join(clean_text(text))]
    text_seq = tokenizer.texts_to_sequences(text_clean)
    text_pad = pad_sequences(text_seq, maxlen=max_seq_len)

    # Make the prediction
    prediction = model.predict(text_pad)[0]

    # Map the predicted value to the corresponding emotion
    emotions = ['joy', 'fear', 'anger', 'sadness', 'neutral']
    predicted_emotion = emotions[np.argmax(prediction)]

    # Get the index of the maximum value in the prediction probabilities array
    max_index = np.argmax(prediction)

    # Calculate the percentage value of the max value
    max_percentage = prediction[max_index] * 100

    return predicted_emotion, max_percentage

# Define the retrain function
def retrain_model(text, emotion):

    # Preprocess the input text
    text_clean = [' '.join(clean_text(text))]
    text_seq = tokenizer.texts_to_sequences(text_clean)
    text_pad = pad_sequences(text_seq, maxlen=max_seq_len)

    encoding = {
            'joy': 0,
            'fear': 1,
            'anger': 2,
            'sadness': 3,
            'neutral': 4
    }
    y = encoding[emotion]
    X = text_pad

    human_label_onehot_categorical = to_categorical(y, 5)
    y = human_label_onehot_categorical.reshape(1, -1)
    learner.teach(X=X, y=y)

    # Save the model
    model.save("/content/drive/MyDrive/Final_Project/models/emotion_model_after_training.h5")

    # Make a prediction with the updated model
    predicted_emotion, prediction = predict_sentiment(text)

    # Get the index of the maximum value in the prediction probabilities array
    max_index = np.argmax(prediction)

    # Calculate the percentage value of the max value
    max_percentage = prediction[max_index] * 100

    return predicted_emotion, max_percentage

# Define the inputs and outputs for the UI using Gradio API
with gr.Blocks() as demo:
    with gr.Row():
        with gr.Column():
          input_text = gr.Textbox(lines=5, label="Enter text to predict emotion")
          predicted_emotion = gr.Label(label="Predicted emotion")
          prediction_probs = gr.Label(label="Prediction probabilities")
          btn1 = gr.Button("Predict Emotion")
          btn1.click(predict_sentiment, inputs=[input_text], outputs=[predicted_emotion, prediction_probs])
        with gr.Column():
          retrain_emotion = gr.Dropdown(["sadness", "anger", "joy", "neutral", "fear"], label="Correct predicted emotion")
          retrain_output = gr.Label(label="Retrained model prediction")
          btn2 = gr.Button("Correct Model Prediction")
          btn2.click(retrain_model, inputs=[input_text, retrain_emotion], outputs=[retrain_output])

demo.launch(share=True, debug=True)
```

```
Colab notebook detected. This cell will run indefinitely so that you can see errors and logs. To turn off, set debug=False in launch().
Running on public URL: https://db162f1fd4011f1734.gradio.live

This share link expires in 72 hours. For free permanent hosting and GPU upgrades (NEW!), check out Spaces: https://huggingface.co/spaces
```






```
1/1 [==============================] - 1s 891ms/step
Keyboard interruption in main thread... closing server.
Killing tunnel 127.0.0.1:7860 <> https://db162f1fd4011f1734.gradio.live
```

Using Model Retraining

We used 'train_on_batch' module which allow us retrain our model using new user data.

[35]
```python
# load the model
from keras.models import load_model
cnn_predictor = load_model('/content/drive/MyDrive/Final_Project/models/emotion_model_after_training.h5')

# Ask for human input
human_input = input("Please enter a text: ")

# Predict the emotion
human_input_seq = tokenizer.texts_to_sequences([human_input])
human_input_seq = pad_sequences(human_input_seq, maxlen=max_seq_len)
prediction = cnn_predictor.predict(human_input_seq)
emotion_labels = ['joy', 'fear', 'anger', 'sadness', 'neutral']
predicted_emotion = emotion_labels[np.argmax(prediction)]


# Print the predicted emotion
print("The predicted emotion is:", predicted_emotion)

# Retrain the model with human input
human_label = input("Please enter the correct emotion: ")

encoding = {
    'joy': 0,
    'fear': 1,
    'anger': 2,
    'sadness': 3,
    'neutral': 4
}

# Integer labels
print(human_input_seq)

human_label_onehot = encoding[human_label]
print(human_label_onehot)

human_label_onehot_categorical = to_categorical(human_label_onehot, 5)
new_arr = human_label_onehot_categorical.reshape(1, -1)
print(human_label_onehot_categorical)

cnn_predictor.train_on_batch(human_input_seq, new_arr)

# Predict again
predicted_again = cnn_predictor.predict(human_input_seq)
emotion_labels = ['joy', 'fear', 'anger', 'sadness', 'neutral']
predicted_emotion = emotion_labels[np.argmax(predicted_again)]

# Print the predicted emotion again
print("The predicted emotion is:", predicted_emotion)
```

[23]
```python
cnn_predictor.save('/content/drive/MyDrive/Final_Project/models/emotion_model_after_training.h5')
```

[81]
```python
# Example for Angry

import time

message = ["I am so angry at my neighbor for playing loud music late at night."]

seq = tokenizer.texts_to_sequences(message)
padded = pad_sequences(seq, maxlen=max_seq_len)

start_time = time.time()
pred = cnn_predictor.predict(padded)

print('Message: ' + str(message))
print('predicted: {} ({:.2f} seconds)'.format(class_names[np.argmax(pred)], (time.time() - start_time)))
```

```
1/1 [==============================] - 1s 986ms/step
Message: ['I am so angry at my neighbor for playing loud music late at night.']
predicted: anger (1.04 seconds)
```

Colab paid products - Cancel contracts here

3m 21s completed at 11:40 PM