Audio_Modelling

June 2, 2022

1 Modelling and Deployment using MLOps

Now that we have audio input data & corresponding labels in an array format, it is easier to consume and apply Natural language processing techniques. We can convert audio files labels into integers using label Encoding or One Hot Vector Encoding for machines to learn. The labeled dataset will help us in the neural network model output layer for predicting results. These help in training & validation datasets into nD array. At this stage, we apply other pre-processing techniques like dropping columns, normalization, etc. to conclude our final training data for building models. Moving to the next stage of splitting the dataset into train, test, and validation is what we have been doing for other models. We can leverage CNN, RNN, LSTM,CTC etc. deep neural algorithms to build and train the models for speech applications like speech recognition. The model trained with the standard size few seconds audio chunk transformed into an array of n dimensions with the respective labels will result in predicting output labels for test audio input. As output labels will vary beyond binary, we are talking about building a multi-class label classification method.

[4]:
```
import pandas as pd
import numpy as np
import os,sys
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder,StandardScaler
sys.path.append(os.path.abspath(os.path.join('../scripts')))
import tensorflow as tf
from clean import Clean
from utils import vocab
from deep_learner import DeepLearn
from modeling import Modeler
from validators import CallbackEval
```

```
---------------------------------------------------------------------------
ImportError                               Traceback (most recent call last)
Input In [4], in <cell line: 12>()
     10 from deep_learner import DeepLearn
     11 from modeling import Modeler
---> 12 from validators import CallbackEval

ImportError: cannot import name 'CallbackEval' from 'validators' (/home/martin/
 ↪Documents/swahili_nlp/env/lib/python3.10/site-packages/validators/__init__.py
```

[2]:
```
AM_ALPHABET='                    auiāeəo'
EN_ALPHABET='abcdefghijklmnopqrstuvwxyz'
```

[3]:
```
cleaner = Clean()
char_to_num,num_to_char=vocab(AM_ALPHABET)
```

```
2022-06-02 07:50:53,939:logger:Successfully initialized clean class
```

```
The vocabulary is: ['', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ',
' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ',
' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', 'a', 'u', 'i', 'ā', 'e', 'ə', 'o']
(size =44)
```

2 Deep Learning Model

objective: Build a Deep learning model that converts speech to text.

[4]:
```
swahili_df = pd.read_csv("../data/swahili.csv")
amharic_df = pd.read_csv("../data/amharic.csv")
```

[5]:
```
pre_model = Modeler()
```

[6]:
```
swahili_preprocessed = pre_model.preprocessing_learn(swahili_df,'key','file')
```

[7]:
```
amharic_preprocessed = pre_model.preprocessing_learn(amharic_df,'key','file')
```

[8]:
```
train_df,val_df,test_df = amharic_preprocessed
```

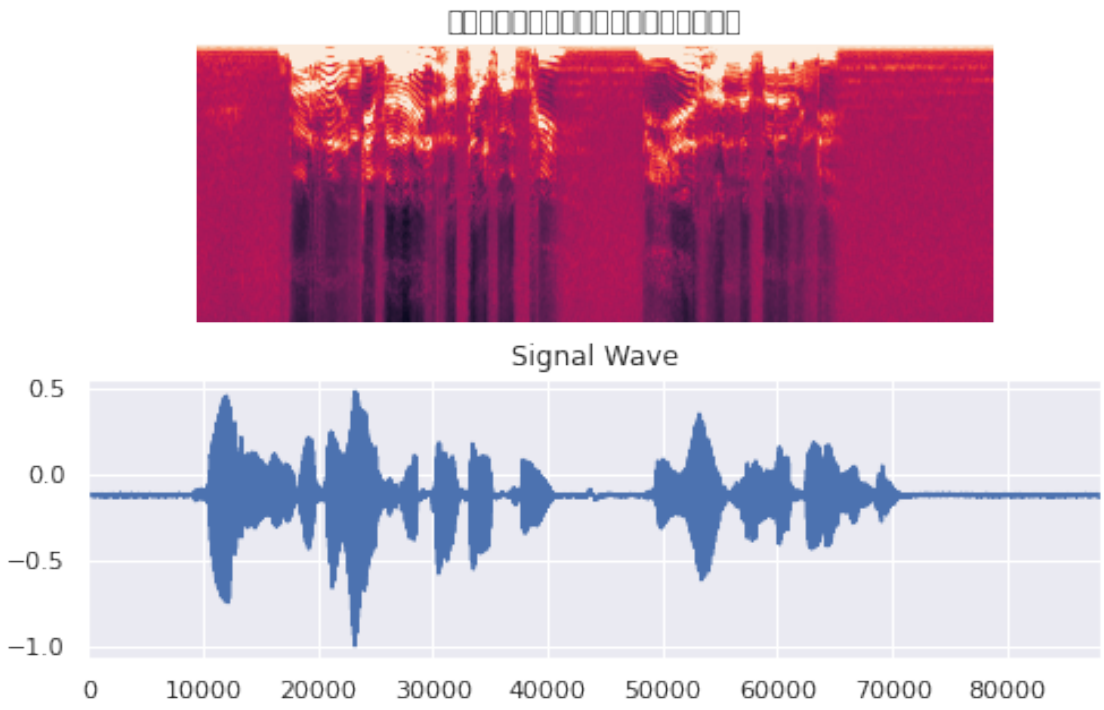
[9]:
```
batch_size = 32
# Define the trainig dataset
train_dataset = tf.data.Dataset.from_tensor_slices(
    (list(train_df["file"]), list(train_df["text"]))
)
train_dataset = (
    train_dataset.map(cleaner.encode_single_sample, num_parallel_calls=tf.data.
 ↪AUTOTUNE)
    .padded_batch(batch_size)
    .prefetch(buffer_size=tf.data.AUTOTUNE)
)

# Define the validation dataset
validation_dataset = tf.data.Dataset.from_tensor_slices(
    (list(val_df["file"]), list(val_df["text"]))
)
validation_dataset = (
    validation_dataset.map(cleaner.encode_single_sample, num_parallel_calls=tf.
 ↪data.AUTOTUNE)
```

```
    .padded_batch(batch_size)
    .prefetch(buffer_size=tf.data.AUTOTUNE)
)
```

[10]:
```
import matplotlib.pyplot as plt
from IPython import display
fig = plt.figure(figsize=(8, 5))
for batch in train_dataset.take(1):
    spectrogram = batch[0][0].numpy()
    spectrogram = np.array([np.trim_zeros(x) for x in np.
 ↪transpose(spectrogram)])
    label = batch[1][0]
    # Spectrogram
    label = tf.strings.reduce_join(num_to_char(label)).numpy().decode("utf-8")
    ax = plt.subplot(2, 1, 1)
    ax.imshow(spectrogram, vmax=1)
    ax.set_title(label)
    ax.axis("off")
    # Wav
    file = tf.io.read_file(list(train_df["file"])[0])
    audio, _ = tf.audio.decode_wav(file)
    audio = audio.numpy()
    ax = plt.subplot(2, 1, 2)
    plt.plot(audio)
    ax.set_title("Signal Wave")
    ax.set_xlim(0, len(audio))
    display.display(display.Audio(np.transpose(audio), rate=16000))
plt.show()
```

```
<IPython.lib.display.Audio object>
```



2.1 LSTM Deep Learning

[13]:
```
learn = DeepLearn(input_width=1, label_width=1, shift=1,epochs=5,
                  train_df=train_df, val_df=val_df, test_df=test_df,
                  label_columns=['mfcc-0'])
fft_length = 384
model = learn.build_asr_model(
    input_dim=fft_length // 2 + 1,
    output_dim=char_to_num.vocabulary_size(),
    rnn_units=512,
)
model.summary(line_length=110)
# predictions = learn.model(
#     model_=model
# )
```

```
Model: "DeepSpeech_2"
--------------------------------------------------------------------------------
 Layer (type)                                Output Shape
Param #
================================================================================
 input (InputLayer)                          [(None, None, 193)]
```

```
0

 expand_dim (Reshape)                        (None, None, 193, 1)
0

 conv_1 (Conv2D)                             (None, None, 97, 32)
14432

 conv_1_bn (BatchNormalization)              (None, None, 97, 32)
128

 conv_1_relu (ReLU)                          (None, None, 97, 32)
0

 conv_2 (Conv2D)                             (None, None, 49, 32)
236544

 conv_2_bn (BatchNormalization)              (None, None, 49, 32)
128

 conv_2_relu (ReLU)                          (None, None, 49, 32)
0

 reshape (Reshape)                           (None, None, 1568)
0

 bidirectional_1 (Bidirectional)             (None, None, 1024)
6395904

 dropout (Dropout)                           (None, None, 1024)
0

 bidirectional_2 (Bidirectional)             (None, None, 1024)
4724736

 dropout_1 (Dropout)                         (None, None, 1024)
0

 bidirectional_3 (Bidirectional)             (None, None, 1024)
4724736

 dropout_2 (Dropout)                         (None, None, 1024)
0

 bidirectional_4 (Bidirectional)             (None, None, 1024)
4724736

 dropout_3 (Dropout)                         (None, None, 1024)
```

```
0

 bidirectional_5 (Bidirectional)                (None, None, 1024)
4724736

 dense_1 (Dense)                                (None, None, 1024)
1049600

 dense_1_relu (ReLU)                            (None, None, 1024)
0

 dropout_4 (Dropout)                            (None, None, 1024)
0

 dense (Dense)                                  (None, None, 45)
46125

=================================================================================
==============================
Total params: 26,641,805
Trainable params: 26,641,677
Non-trainable params: 128
---------------------------------------------------------------------------------
------------------------------
```

3 Evaluation

objective: Evaluate your model.

[11]:
```
epochs = 1
# Callback function to check transcription on the val set.
validation_callback = CallbackEval(validation_dataset)
# Train the model
history = model.fit(
    train_dataset,
    validation_data=validation_dataset,
    epochs=epochs,
    callbacks=[validation_callback],
)
```

[11]:
```
[[[0.11674367636442184]],
 [[0.11674367636442184]],
 [[0.11674367636442184]],
 [[0.11674367636442184]],
 [[0.11674367636442184]],
 [[0.11674367636442184]]]
```

[ ]: