Modeling_NN_Transfer_Learning

July 27, 2022

1 Importing Libraries

[ ]:
```
import numpy as np
import pandas as pd
import string


import seaborn as sns
import matplotlib.pyplot as plt


from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report, plot_confusion_matrix
from sklearn.preprocessing import LabelEncoder


from sklearn.pipeline import Pipeline
from sklearn.preprocessing import FunctionTransformer
from sklearn.compose import ColumnTransformer
from gensim.models import word2vec

import tensorflow as tf
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.layers import Input, Dense, LSTM, Embedding, Flatten
from tensorflow.keras.layers import Dropout, Activation, Bidirectional,␣
 ↪GlobalMaxPool1D
from tensorflow.keras.models import Sequential
from tensorflow.keras import initializers, regularizers, constraints,␣
 ↪optimizers, layers
from tensorflow.keras.preprocessing import text, sequence
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.callbacks import EarlyStopping

import tensorflow_hub as hub
import tensorflow_datasets as tfds
```

```
from  IPython import display

import pathlib
import shutil
import tempfile

!pip install -q git+https://github.com/tensorflow/docs

import tensorflow_docs as tfdocs
import tensorflow_docs.modeling
import tensorflow_docs.plots

print("Version: ", tf.__version__)
print("Hub version: ", hub.__version__)
print("GPU is", "available" if tf.config.list_physical_devices('GPU') else "NOT␣
 ↪AVAILABLE")

logdir = pathlib.Path(tempfile.mkdtemp())/"tensorboard_logs"
shutil.rmtree(logdir, ignore_errors=True)


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

```
  Building wheel for tensorflow-docs (setup.py) … done
Version:  2.8.2
Hub version:  0.12.0
GPU is NOT AVAILABLE
```

2 Functions We Use

[ ]:
```
def transfer_model(module_url, embed_size, name, trainable=False):

    hub_layer = hub.KerasLayer(module_url,
                               output_shape=[embed_size],
                               input_shape=[],
                               dtype=tf.string,
                               trainable = trainable)

    model = tf.keras.models.Sequential([
           hub_layer,
           tf.keras.layers.Dense(256, activation = "relu"),
           tf.keras.layers.Dropout(0.3),
           tf.keras.layers.Dense(64, activation = "relu"),
           tf.keras.layers.Dropout(0.2),
           tf.keras.layers.Dense(1, activation  = "sigmoid")
```

```
                                        ])


    model.compile(optimizer = tf.keras.optimizers.Adam(learning_rate= 0.0001),
                  loss = tf.losses.BinaryCrossentropy(),
                  metrics = [tf.metrics.BinaryAccuracy(name = "accuracy")])

    model.summary()

    history = model.fit(X_train, y_train,
                        epochs = 100, batch_size = 32,
                        validation_data = (X_test, y_test),
                        callbacks = [tfdocs.modeling.EpochDots(),
                                     tf.keras.callbacks.EarlyStopping(monitor =␣
↪'val_loss', patience = 2, mode = "min"),
                                     tf.keras.callbacks.TensorBoard(logdir/
↪name)],
                        verbose = 0)


    return history
```

[ ]:
```
def new_cleaning(data):


    cleaned_data = data.replace("[", "").replace("]", "").replace("'", "")\
                                    .replace(" ", "").split(",")


    return cleaned_data
```

[ ]:
```
def text_from_token(data):

    cleaned_sentence = " ".join(data)

    return  cleaned_sentence
```

[ ]:
```
def acc_loss(model):


    train_loss = model.history["loss"]
    train_acc  = model.history["accuracy"]

    test_loss = model.history["val_loss"]
    test_acc  = model.history["val_accuracy"]
```

```
    train_test = [(train_loss, test_loss, "loss"), (train_acc,test_acc,␣
↪"accuracy")]

    figs, axes = plt.subplots(nrows = 1, ncols = 2, figsize = (25,7))
    sns.set(font_scale=2)


    for i, item in enumerate(train_test):
        ax = axes[i]
        g = sns.lineplot(x = range(1, 1 + len(item[0])), y = item[0], label =␣
↪"train_" + item[2], ax = ax);
        g = sns.lineplot(x = range(1, 1 + len(item[1])), y = item[1], label =␣
↪"test_" + item[2], ax = ax);
```

[ ]:
```
def print_results(model):

    cf_matrix_test  = confusion_matrix(y_test, np.rint(model.predict(X_test)))
    cf_matrix_train = confusion_matrix(y_train, np.rint(model.predict(X_train)))

    sns.set(font_scale= 1)
    fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(10,5))
    ax1 = axes[0]

    g = sns.heatmap(cf_matrix_test, annot=True, cmap='Blues', ax = ax1)

    g.xaxis.set_ticklabels(['Fake','True'])
    g.yaxis.set_ticklabels(['Fake','True'])


    ax1.set_title("Confusion Matrix for Test Set")

    ax2 = axes[1]
    g = sns.heatmap(cf_matrix_train, annot=True, cmap='Blues', ax = ax2)
    g.xaxis.set_ticklabels(['Fake','True'])
    g.yaxis.set_ticklabels(['Fake','True'])



    ax2.set_title("Confusion Matrix for Train Set")




    ### Presenting Classification Report as a DataFrame
    train_class = classification_report(y_train, np.rint(model.
↪predict(X_train)),
                                        output_dict = True)
```

```
    test_class  = classification_report(y_test, np.rint(model.predict(X_test)),
                                       output_dict = True)

    train_df = pd.DataFrame(train_class)
    test_df  = pd.DataFrame(test_class)

    train_df["data"] = "TRAIN"
    test_df["data"] = "TEST"


    report = pd.concat([test_df, train_df], axis = 0)
    report.rename(columns = {"1": f"{list(le.inverse_transform([1]))[0]}",
                             "0": f"{list(le.inverse_transform([0]))[0]}"},␣
 ↪inplace = True)
    report["index"] = list(report.index)

    report.set_index(["data", "index"], inplace = True)

    return report
```

[ ]:
```
model_urls = {}


model_urls[1] = {"model_name":"gnews-swivel-20dim",
                 "embed_size": 20,
                 "url": "https://tfhub.dev/google/tf2-preview/
 ↪gnews-swivel-20dim/1"}

model_urls[2] = {"model_name":"nnlm-en-dim50",
                 "embed_size": 50,
                 "url": "https://tfhub.dev/google/tf2-preview/nnlm-en-dim50/1"}

model_urls[3] = {"model_name":"nnlm-en-dim128",
                 "embed_size": 128,
                 "url": "https://tfhub.dev/google/tf2-preview/nnlm-en-dim128/1"}

model_urls[4] = {"model_name":"universal-sentence-encoder",
                 "embed_size": 512,
                 "url": "https://tfhub.dev/google/universal-sentence-encoder/4"}

model_urls[5] = {"model_name":"universal-sentence-encoder-large",
                 "embed_size": 512,
                 "url": "https://tfhub.dev/google/
 ↪universal-sentence-encoder-large/5"}
```

3 Importing Data

```
[ ]: test = pd.read_csv("/content/drive/MyDrive/Fake-Real-News-Classification/
      ↪Modeling/train_test/test.csv")
     train = pd.read_csv("/content/drive/MyDrive/Fake-Real-News-Classification/
      ↪Modeling/train_test/train.csv")


     data  = [train, test]

     for df in data:

         df.drop("Unnamed: 0", axis = 1, inplace = True)
         df["cleaned"] =  df["cleaned"].apply(lambda x: new_cleaning(x))
         df["cleaned_text"] =  df["cleaned"].apply(lambda x: text_from_token(x))
         df["for_glove"] =  df["for_glove"].apply(lambda x: new_cleaning(x))
         df["cleaned_glove"] =  df["for_glove"].apply(lambda x: text_from_token(x))

     print("DONE!")
```

```
DONE!
```

```
[ ]: train.head()

     le = LabelEncoder()

     X_train = train["cleaned_glove"].values
     y_train = le.fit_transform(train["label"])

     X_test = test["cleaned_glove"].values
     y_test = le.transform(test["label"])
```

4 Modeling

```
[ ]: histories = {}
```

4.1 1st Model: `gnews-swivel-20dim`

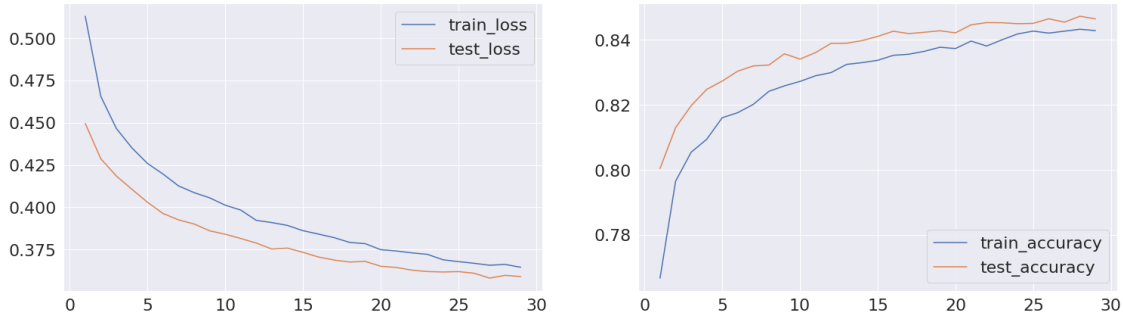
For this model, we use the embedding layer provided from TensorFlow Hub. The model we use is `gnews-swivel-20dim` and the embedding file can be find here. Thi model is token based text embedding trained on English Google News 130GB corpus and it is published by Google.

```
[ ]: i = 1

     url = model_urls[i]["url"]
     model_name = model_urls[i]["model_name"]
```

```
embed_size = model_urls[i]["embed_size"]

histories[model_name] = transfer_model(module_url = url, embed_size =␣
 ↪embed_size,
                                       name = model_name, trainable = False)
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 keras_layer (KerasLayer)     (None, 20)                400020

 dense (Dense)                (None, 256)               5376

 dropout (Dropout)            (None, 256)               0

 dense_1 (Dense)              (None, 64)                16448

 dropout_1 (Dropout)          (None, 64)                0

 dense_2 (Dense)              (None, 1)                 65

=================================================================
Total params: 421,909
Trainable params: 21,889
Non-trainable params: 400,020
_________________________________________________________________

Epoch: 0, accuracy:0.7667,  loss:0.5130,  val_accuracy:0.8004,  val_loss:0.4496,
…
```

[ ]:
```
acc_loss(histories[model_urls[1]["model_name"]])
```



[ ]:
```

```

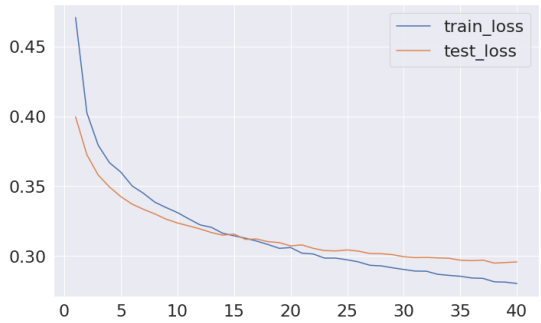
4.2 2nd Model: `nnlm-en-dim50`

The second model we use is `nnlm-en-dim50` that we found on the TensorFlow Hub webpage.

[ ]:
```
i = 2

url = model_urls[i]["url"]
model_name = model_urls[i]["model_name"]
embed_size = model_urls[i]["embed_size"]

histories[model_name] = transfer_model(module_url = url, embed_size =␣
 ↪embed_size,
                                       name = model_name, trainable = False)
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 keras_layer_1 (KerasLayer)  (None, 50)                48190600

 dense_3 (Dense)             (None, 256)               13056

 dropout_2 (Dropout)         (None, 256)               0

 dense_4 (Dense)             (None, 64)                16448

 dropout_3 (Dropout)         (None, 64)                0

 dense_5 (Dense)             (None, 1)                 65

=================================================================
Total params: 48,220,169
Trainable params: 29,569
Non-trainable params: 48,190,600
_________________________________________________________________

Epoch: 0, accuracy:0.8000,  loss:0.4708,  val_accuracy:0.8338,  val_loss:0.3997,
…
```

[ ]:
```
acc_loss(histories[model_urls[2]["model_name"]])
```



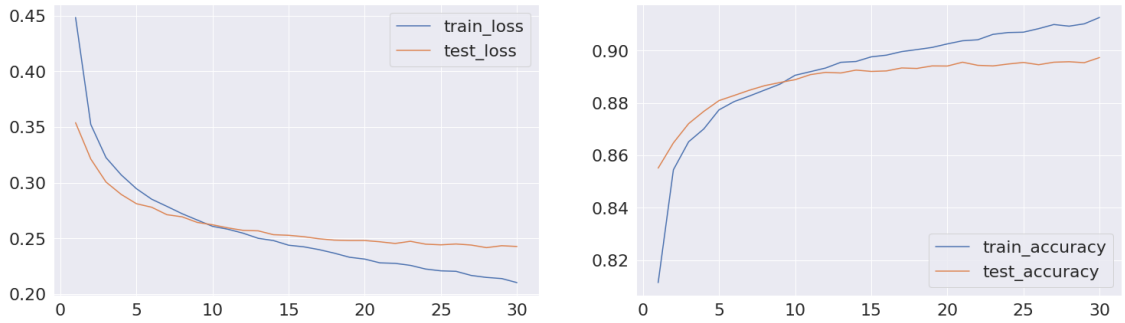
4.3 3rd Model

[ ]:
```
i = 3

url = model_urls[i]["url"]
model_name = model_urls[i]["model_name"]
embed_size = model_urls[i]["embed_size"]

histories[model_name] = transfer_model(module_url = url, embed_size =␣
 ↪embed_size,
                                       name = model_name, trainable = False)

print("DONE!")
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 keras_layer_2 (KerasLayer)  (None, 128)               124642688

 dense_6 (Dense)             (None, 256)               33024

 dropout_4 (Dropout)         (None, 256)               0

 dense_7 (Dense)             (None, 64)                16448

 dropout_5 (Dropout)         (None, 64)                0

 dense_8 (Dense)             (None, 1)                 65

=================================================================
Total params: 124,692,225
Trainable params: 49,537
Non-trainable params: 124,642,688
_________________________________________________________________
```

```
Epoch: 0, accuracy:0.8114,  loss:0.4483,  val_accuracy:0.8551,  val_loss:0.3539,
…DONE!
```

[ ]:
```
acc_loss(histories[model_urls[3]["model_name"]])
```



[ ]:
```
# histories[model_urls[3]["model_name"]].history.keys()
```

[ ]:
```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

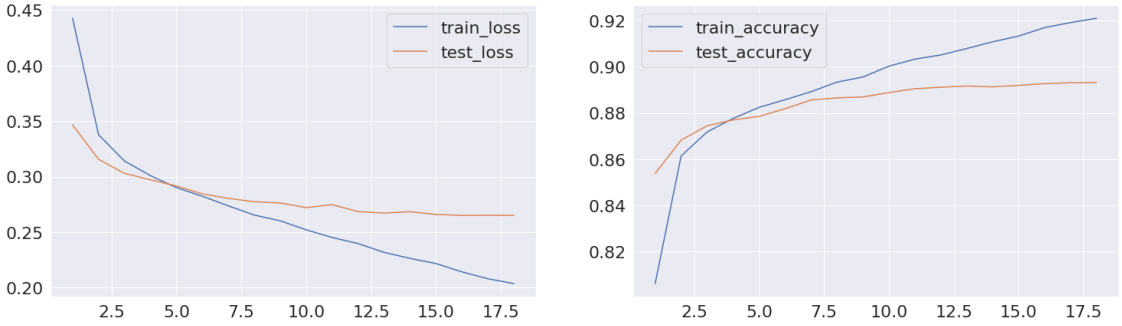
4.4 4th Model

[ ]:
```
i = 4

url = model_urls[i]["url"]
model_name = model_urls[i]["model_name"]
embed_size = model_urls[i]["embed_size"]

histories[model_name] = transfer_model(module_url = url, embed_size =␣
 ↪embed_size,
                                       name = model_name, trainable = False)

print("DONE!")
```

```
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 keras_layer_3 (KerasLayer)  (None, 512)               256797824

 dense_9 (Dense)             (None, 256)               131328

 dropout_6 (Dropout)         (None, 256)               0

 dense_10 (Dense)            (None, 64)                16448
```

```
 dropout_7 (Dropout)          (None, 64)                0

 dense_11 (Dense)             (None, 1)                 65

=================================================================
Total params: 256,945,665
Trainable params: 147,841
Non-trainable params: 256,797,824
_________________________________________________________________

Epoch: 0, accuracy:0.8061,  loss:0.4425,  val_accuracy:0.8538,  val_loss:0.3466,
…DONE!
```

[ ]:
```
acc_loss(histories[model_urls[4]["model_name"]])
```



[ ]:
```
print_results(histories[model_urls[4]["model_name"]])
```

4.5 5th Model: Wiki-words-250

This model can be found here. It is a "Token based text embedding trained on English Wikipedia corpus" and it is published by Google.

[ ]:
```
url = "https://tfhub.dev/google/Wiki-words-250/2"

histories["Wiki-words-250"] = transfer_model(module_url = url, embed_size = 250,
                                             name = "Wiki-words-250", trainable =␣
 ↪False)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-1-7290de0b2c16> in <module>()
      1 url = "https://tfhub.dev/google/Wiki-words-250/2"
      2
```

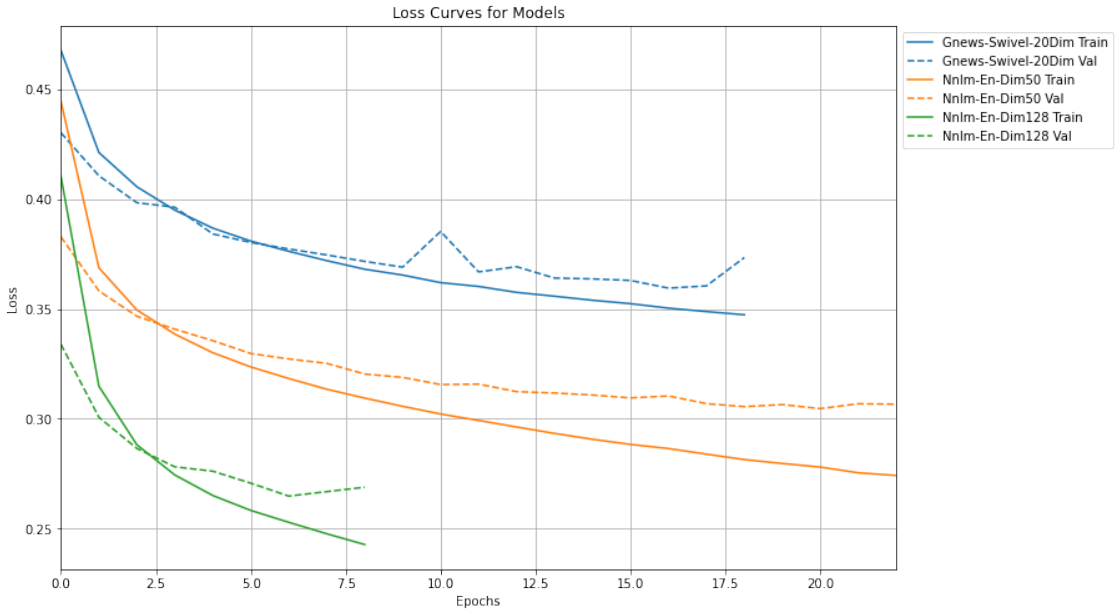
```
----> 3 histories["Wiki-words-250"] = transfer_model(module_url = url,␣
 ↪embed_size = 250,
      4                                              name = "Wiki-words-250",␣
 ↪trainable = False)

NameError: name 'transfer_model' is not defined
```

5 Comparison of Models

[ ]:
```
plt.rcParams['figure.figsize'] = (12, 8)
plotter = tfdocs.plots.HistoryPlotter(metric = 'accuracy')
plotter.plot(histories)
plt.xlabel("Epochs")
plt.legend(bbox_to_anchor=(1.0, 1.0), loc='upper left')
plt.title("Accuracy Curves for Models")
plt.show()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-2-6d7212da3a8b> in <module>()
----> 1 plt.rcParams['figure.figsize'] = (12, 8)
      2 plotter = tfdocs.plots.HistoryPlotter(metric = 'accuracy')
      3 plotter.plot(histories)
      4 plt.xlabel("Epochs")
      5 plt.legend(bbox_to_anchor=(1.0, 1.0), loc='upper left')

NameError: name 'plt' is not defined
```

[ ]:
```
plotter = tfdocs.plots.HistoryPlotter(metric = 'loss')
plotter.plot(histories)
plt.xlabel("Epochs")
plt.legend(bbox_to_anchor=(1.0, 1.0), loc='upper left')
plt.title("Loss Curves for Models")
plt.show()
```


Loss Curves for Models
Gnews-Swivel-20Dim Train
Gnews-Swivel-20Dim Val
NnIm-En-Dim50 Train
NnIm-En-Dim50 Val
NnIm-En-Dim128 Train
NnIm-En-Dim128 Val
Loss
Epochs
0.45
0.40
0.35
0.30
0.25
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0