```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

from sklearn.feature_extraction.text import CountVectorizer
from keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from keras.models import Sequential
from keras.layers import Dense, Embedding, LSTM, SpatialDropout1D
from sklearn.model_selection import train_test_split
from keras.utils.np_utils import to_categorical
from sklearn.utils import resample
from sklearn.utils import shuffle
from sklearn.metrics import confusion_matrix,classification_report
import re
```

```
import tensorflow as tf
```

```
df_train = pd.read_csv("data (4).csv",names=["message","sentiment"],header=0)
```

```
data = df_train[["message","sentiment"]]
data.head()
```

| | message | sentiment |
|---|---|---|
| **676** | _xo they were so pretty and took like an hour ... | positive |
| **8570** | is suffering from hayfever, is drowsy from too... | negative |
| **5406** | addict? Me? Okay I admit I need help BUT... ... | positive |
| **1902** | Fighting a migraine Medication is almost wor... | positive |
| **6712** | the puppy shall loose his um... manly parts to... | negative |

To undo cell deletion use Ctrl+M Z or the Undo option in the Edit menu ✕

```
data['message'] = data['message'].apply(lambda x: x.lower())
# removing special chars
data['message'] = data['message'].apply((lambda x: re.sub('[^a-zA-z0-9\s]','',x)))
#
data.head()
```

| | message | sentiment |
|---|---|---|
| **0** | _xo they were so pretty and took like an hour ... | positive |
| **1** | is suffering from hayfever is drowsy from too ... | negative |
| **2** | addict me okay i admit i need help but i hav... | positive |
| **3** | fighting a migraine medication is almost wor... | positive |
| **4** | the puppy shall loose his um manly parts today... | negative |

```
data.sentiment.value_counts()
```

```
positive    3000
negative    3000
neutral     3000
Name: sentiment, dtype: int64
```

```
max_fatures = 1000
tokenizer = Tokenizer(num_words=max_fatures, split=' ')
tokenizer.fit_on_texts(data['message'].values)
X = tokenizer.texts_to_sequences(data['message'].values)
X = pad_sequences(X)
X[:2]
```

```
array([[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0,   0,   0,  76, 152,  18, 234,   7, 420,  38,  92,
        364,   2,  43,  32,   1,  43],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0,   0,   9,  51,   9,  51,  41,  77,   7,   9, 551,
          2, 146,  23,   3, 806,  17]], dtype=int32)
```

```
from keras.models import Sequential
from keras.layers import Embedding, Conv1D, MaxPooling1D, Bidirectional, LSTM, Dense, Dropout
```

```
embed_dim = 128
lstm_out = 196

model = Sequential()
model.add(Embedding(max_fatures, embed_dim,input_length = X.shape[1]))
model.add(Conv1D(filters=32, kernel_size=3, padding='same', activation='relu'))
model.add(MaxPooling1D(pool_size=2))
model.add(Bidirectional(LSTM(32)))
model.add(Dropout(0.4))
model.add(Dense(3, activation='softmax'))
model.compile(loss = 'categorical_crossentropy', optimizer='Nadam',metrics = ['accuracy'])
model.summary()
```

```
     Model: "sequential_1"
     _________________________________________________________________
      Layer (type)                Output Shape              Param #
     =================================================================
      embedding_1 (Embedding)     (None, 32, 128)           128000

      conv1d_1 (Conv1D)           (None, 32, 32)            12320

      max_pooling1d_1 (MaxPooling  (None, 16, 32)           0
      1D)

      bidirectional_1 (Bidirectio  (None, 64)               16640
      nal)

      dropout_1 (Dropout)         (None, 64)                0

      dense_1 (Dense)             (None, 3)                 195

     =================================================================
     Total params: 157,155
     Trainable params: 157,155
     Non-trainable params: 0
     _________________________________________________________________
```

```
Y = pd.get_dummies(data['sentiment']).values
```

To undo cell deletion use Ctrl+M Z or the Undo option in the Edit menu ×

```
ize = 0.20, random_state = 42)

print(X_test.shape,Y_test.shape)
```

```
     (7200, 32) (7200, 3)
     (1800, 32) (1800, 3)
```

```
batch_size = 128
model.fit(X_train, Y_train, epochs = 15, batch_size=batch_size, verbose = 1)
```

```
     Epoch 1/15
     57/57 [==============================] - 8s 44ms/step - loss: 1.0715 - accuracy: 0.4251
     Epoch 2/15
     57/57 [==============================] - 4s 70ms/step - loss: 0.8278 - accuracy: 0.6268
     Epoch 3/15
     57/57 [==============================] - 3s 44ms/step - loss: 0.7059 - accuracy: 0.6939
     Epoch 4/15
     57/57 [==============================] - 3s 47ms/step - loss: 0.6470 - accuracy: 0.7251
     Epoch 5/15
     57/57 [==============================] - 4s 66ms/step - loss: 0.5947 - accuracy: 0.7563
     Epoch 6/15
     57/57 [==============================] - 4s 65ms/step - loss: 0.5176 - accuracy: 0.7969
     Epoch 7/15
     57/57 [==============================] - 3s 48ms/step - loss: 0.4171 - accuracy: 0.8469
     Epoch 8/15
     57/57 [==============================] - 3s 44ms/step - loss: 0.3304 - accuracy: 0.8926
     Epoch 9/15
     57/57 [==============================] - 3s 44ms/step - loss: 0.2652 - accuracy: 0.9186
     Epoch 10/15
     57/57 [==============================] - 3s 44ms/step - loss: 0.2256 - accuracy: 0.9300
     Epoch 11/15
     57/57 [==============================] - 4s 69ms/step - loss: 0.1924 - accuracy: 0.9440
     Epoch 12/15
     57/57 [==============================] - 3s 45ms/step - loss: 0.1573 - accuracy: 0.9560
     Epoch 13/15
     57/57 [==============================] - 3s 45ms/step - loss: 0.1474 - accuracy: 0.9571
     Epoch 14/15
     57/57 [==============================] - 3s 44ms/step - loss: 0.1314 - accuracy: 0.9597
     Epoch 15/15
     57/57 [==============================] - 3s 54ms/step - loss: 0.1321 - accuracy: 0.9604
     <keras.callbacks.History at 0x7fc0039384c0>
```

```
Y_pred =np.argmax(model.predict(X_test), axis=-1)

df_test = pd.DataFrame({'true': Y_test.tolist(), 'pred':Y_pred})
df_test['true'] = df_test['true'].apply(lambda x: np.argmax(x))
print("confusion matrix",confusion_matrix(df_test.true, df_test.pred))
print(classification_report(df_test.true, df_test.pred))
```

```
     57/57 [==============================] - 1s 7ms/step
     confusion matrix [[330 250  24]
      [114 418  81]
      [ 33 195 355]]
                   precision    recall  f1-score   support

               0       0.69      0.55      0.61       604
               1       0.48      0.68      0.57       613
               2       0.77      0.61      0.68       583

        accuracy                           0.61      1800
       macro avg       0.65      0.61      0.62      1800
    weighted avg       0.65      0.61      0.62      1800
```

## Federated Learning

```
import numpy as np
import random
import cv2
import os
from imutils import paths
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelBinarizer
from sklearn.model_selection import train_test_split
from sklearn.utils import shuffle
from sklearn.metrics import accuracy_score

import tensorflow as tf
```

To undo cell deletion use Ctrl+M Z or the Undo option in the Edit menu ✕

```
from tensorflow.keras.layers import MaxPooling2D
from tensorflow.keras.layers import Activation
from tensorflow.keras.layers import Flatten
from tensorflow.keras.layers import Dense
from tensorflow.keras.optimizers import SGD
from tensorflow.keras import backend as K


def create_clients(Xdata, label_list, num_clients=3, initial='clients'):
    ''' return: a dictionary with keys clients' names and value as
                data shards - tuple of images and label lists.
        args:
            image_list: a list of numpy arrays of training images
            label_list:a list of binarized labels for each image
            num_client: number of fedrated members (clients)
            initials: the clients'name prefix, e.g, clients_1

    '''
    import random

    #create a list of client names
    client_names = ['{}_{}'.format(initial, i+1) for i in range(num_clients)]

    #randomize the data
    data = list(zip(Xdata, label_list))
    random.shuffle(data)

    #shard data and place at each client
    size = len(data)//num_clients
    shards = [data[i:i + size] for i in range(0, size*num_clients, size)]

    #number of clients must equal number of shards
    assert(len(shards) == len(client_names))

    return {client_names[i] : shards[i] for i in range(len(client_names))}


class FLModel:
  def build(self):
    embed_dim = 128
    lstm_out = 196
    max_features = 1000
    noOfClasses = 3
    model = Sequential()
    model.add(Embedding(max_features, embed_dim,input_length = X_local.shape[1]))
    model.add(Conv1D(filters=32, kernel_size=3, padding='same', activation='relu'))
    model.add(MaxPooling1D(pool_size=2))
    model.add(Bidirectional(LSTM(32)))
    model.add(Dropout(0.4))
    model.add(Dense(noOfClasses, activation='softmax'))

    return model



clients = create_clients(X_train, Y_train, num_clients=5, initial='client')


def sum_scaled_weights(scaled_weight_list):
      '''Return the sum of the listed scaled weights. The is equivalent to scaled avg of the weights'''
      avg_grad = list()
      #get the average grad accross all client gradients
      for grad_list_tuple in zip(*scaled_weight_list):
          layer_mean = tf.math.reduce_sum(grad_list_tuple, axis=0)
          avg_grad.append(layer_mean)

      return avg_grad

def scale_model_weights(weight):
      '''function for scaling a models weights'''
      weight_final = []
      steps = len(weight)
      scalar  = 1/5

      for i in range(steps):
          weight_final.append(scalar * weight[i])
      return weight_final


comms_round = 30
lr = 0.01
```

To undo cell deletion use Ctrl+M Z or the Undo option in the Edit menu ✕

```
optimizer = tf.keras.optimizers.legacy.SGD(learning_rate=lr)

#initialize global model
smlp_global = FLModel()
global_model = smlp_global.build()
global_acc = []
global_loss = 10

noOfClasses = 3


#commence global training loop
while global_loss>=0.01 and comms_round!=0:

    # get the global model's weights - will serve as the initial weights for all local models
    global_weights = global_model.get_weights()
    #initial list to collect local model weights after scalling
    local_weight_list = list()

    #randomize client data - using keys
    client_names= list(clients.keys())
    random.shuffle(client_names)

    #loop through each client and create new local model
    print("-----------------Workers Building Up------------------------------")
    for client in client_names:
        smlp_local = FLModel()
        local_model = smlp_local.build()
        local_model.compile(loss=loss,
                      optimizer=optimizer,
                      metrics=metrics)

        #set local model weight to the weight of the global model
        local_model.set_weights(global_weights)

        #fit local model with client's data
        df_local = clients[client] #[(xdata,ydata)]
        X_local = []
        Y_local = []
        for i in df_local:
          X_local.append(i[0])
          Y_local.append(i[1])

        X_local = np.array(X_local)
```

```
      Y_local = np.array(Y_local)

      print(X_local.shape)
      print(Y_local.shape)

      local_model.fit(X_local,Y_local, epochs=10, verbose=0)
      scaled_weights = scale_model_weights(local_model.get_weights())
      local_weight_list.append(scaled_weights)

      lYpred =np.argmax(local_model.predict(X_local), axis=-1)

      lY_pred = []
      for i in lYpred:
        temp = []
        for j in range(noOfClasses):
          if j==i:
            temp.append(1)
          else:
            temp.append(0)
        lY_pred.append(temp)

      cce = tf.keras.losses.CategoricalCrossentropy(from_logits=True)
      llogits = model.predict(X_local)
      lloss = cce(Y_local, llogits)
      lacc =  accuracy_score(Y_local,lY_pred)
      print('comm_round: {} |  Client: {}| Local_acc: {:.3%} | local_loas: {}'.format(comms_round,client, lacc, lloss))

      #clear session to free memory after each communication round
      K.clear_session()
  print("-----------------Workers Building Done------------------------------")
  #to get the average over all the local model, we simply take the sum of the scaled weights
  average_weights = sum_scaled_weights(local_weight_list)
  #update global model

  global_model.set_weights(average_weights)
  #test global model and print out metrics after each communications round:
```

To undo cell deletion use Ctrl+M Z or the Undo option in the Edit menu ×

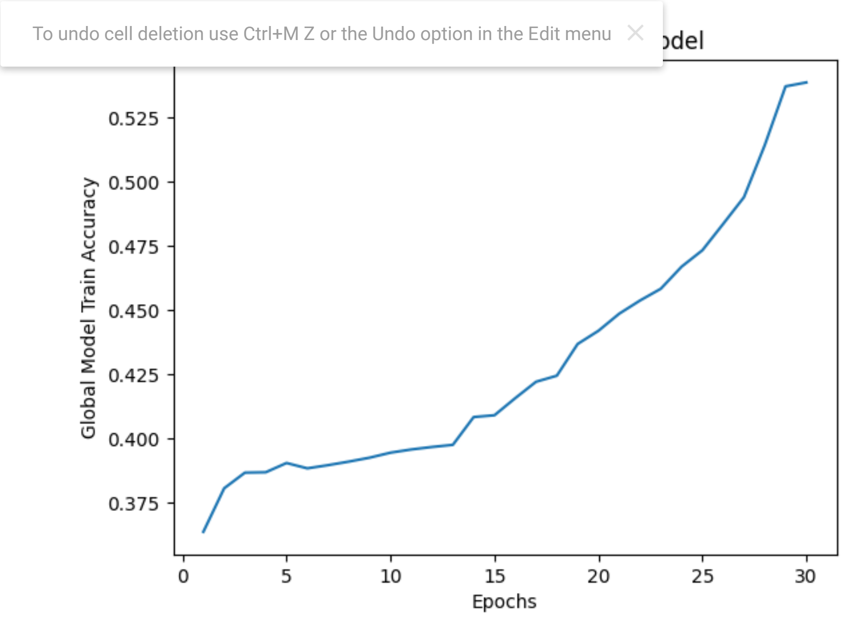
```
  Y_pred = []
  for i in Ypred:
    temp = []
    for j in range(noOfClasses):
      if j==i:
        temp.append(1)
      else:
        temp.append(0)
    Y_pred.append(temp)

  cce = tf.keras.losses.CategoricalCrossentropy(from_logits=True)
  logits = model.predict(X_train)
  global_loss = cce(Y_train, logits)
  acc =  accuracy_score(Y_train,Y_pred)
  global_acc.append(acc)
  print('comm_round: {} | global_acc: {:.3%} | global_loss: {}'.format(comms_round, acc, global_loss))
  print("-----------------------------------------------------------------------------------------")
  comms_round-=1
```

```
-----------------Workers Building Up------------------------------
(1440, 32)
(1440, 3)
45/45 [==============================] - 3s 8ms/step
45/45 [==============================] - 0s 9ms/step
comm_round: 1 |  Client: client_1| Local_acc: 45.278% | local_loas: 0.5870653986930847
(1440, 32)
(1440, 3)
45/45 [==============================] - 1s 8ms/step
45/45 [==============================] - 1s 8ms/step
comm_round: 1 |  Client: client_2| Local_acc: 54.792% | local_loas: 0.5975772142410278
(1440, 32)
(1440, 3)
45/45 [==============================] - 1s 8ms/step
45/45 [==============================] - 1s 8ms/step
comm_round: 1 |  Client: client_3| Local_acc: 58.750% | local_loas: 0.5897355079650879
(1440, 32)
(1440, 3)
45/45 [==============================] - 1s 7ms/step
45/45 [==============================] - 1s 8ms/step
comm_round: 1 |  Client: client_5| Local_acc: 52.639% | local_loas: 0.5869148373603821
(1440, 32)
(1440, 3)
45/45 [==============================] - 1s 8ms/step
45/45 [==============================] - 1s 8ms/step
comm_round: 1 |  Client: client_4| Local_acc: 57.569% | local_loas: 0.588005542755127
-----------------Workers Building Done------------------------------
225/225 [==============================] - 2s 8ms/step
225/225 [==============================] - 2s 8ms/step
comm_round: 1 | global_acc: 53.875% | global_loss: 0.589859664440155
------------------------------------------------------------------------------------------
```

```
import matplotlib.pyplot as plt

plt.plot([i for i in range(1,len(global_acc)+1)],global_acc)
plt.xlabel("Epochs")
plt.ylabel("Global Model Train Accuracy")
plt.title("Accuracy vs Epochs of Global Model")
plt.show()
```



To undo cell deletion use Ctrl+M Z or the Undo option in the Edit menu

✓ 3s completed at 3:30 PM ● ×

To undo cell deletion use Ctrl+M Z or the Undo option in the Edit menu ×