```
# mount drive from google drive
from google.colab import drive
drive.mount('drive')
```

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

```
# import libraries
import os
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

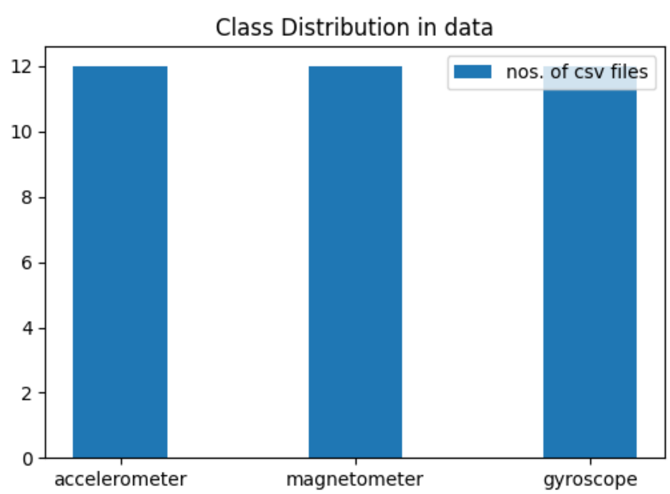
```
# define directiory and classes
data_dir = '/content/drive/MyDrive/Posture_data_F'
classes = (os.listdir(data_dir))
classes = [classes[0], classes[1], classes[2]]
classes
```

```
['accelerometer', 'magnetometer', 'gyroscope']
```

```
# join root directory with subfolders
data_count = []
for i in classes:
   data_path = os.path.join(data_dir, i)
   data_count.append(len(os.listdir(data_path)))
```

```
# Creating a bar plot of the folder and files distributions in root folder ;
fig, ax = plt.subplots(figsize=(6, 4))
ax.bar(np.arange(len(data_count)), data_count, width=0.4, align='center', label='nos. of csv files')
ax.set_xticks(np.arange(len(data_count)))
ax.set_xticklabels(classes)
ax.set_title('Class Distribution in data')
ax.legend()
plt.show()

print('Train :')
print(f'Number of csv files in accelerometer : {[data_count][0][0]}')
print(f'Number of csv files in gyroscope : {[data_count][0][1]}')
print(f'Number of csv files in magnetometer : {[data_count][0][2]}')
```




```
Train :
Number of csv files in accelerometer : 12
Number of csv files in gyroscope : 12
Number of csv files in magnetometer : 12
```

```
# subfolders directory
class_path_dir = []
for idx, class_name in enumerate(classes):
   print(idx)
   print(class_name)
   path_dir = os.path.join(data_dir, class_name)
   class_path_dir.append(path_dir)
```

```
accelerometer_path = class_path_dir[0]
magnetometer_path = class_path_dir[1]
gyroscope_path = class_path_dir[2]

print(magnetometer_path)
print(accelerometer_path)
print(gyroscope_path)
```

```
0
accelerometer
1
magnetometer
2
gyroscope
/content/drive/MyDrive/Posture_data_F/magnetometer
/content/drive/MyDrive/Posture_data_F/accelerometer
/content/drive/MyDrive/Posture_data_F/gyroscope
```

```
# csv files directory for magnetometer
num_mag_files = (os.listdir(magnetometer_path))
num_mag_files
```

```
['Sitting_Data_Magnetometer_Trial1.csv',
 'Supine_Magnetometer_Trial2.csv',
 'Supine_Magnetometer_Trial1.csv',
 'Lateral_Left_Side_Magnetometer_Trial1.csv',
 'Lateral_Right_Side_Magnetometer_Trial1.csv',
 'unknown_data_magnetometer_trial2.csv',
 'Prone_Magnetometer_Trial2.csv',
 'Prone_Magnetometer_Trial1.csv',
 'Lateral_Left_Side_Magnetometer_Trial2.csv',
 'unknown_data_magnetometer_trial1.csv',
 'Sitting_Data_Magnetometer_Trial2.csv',
 'Lateral_Right_Side_Magnetometer_Trial2.csv']
```

```
# csv files directory for accelerometer
num_acc_files = (os.listdir(accelerometer_path))
num_acc_files
```

```
['Lateral_Left_Side_Accelerometer_Trial1.csv',
 'Lateral_Left_Side_Accelerometer_Trial2.csv',
 'Supine_Accelerometer_Trial2.csv',
 'Supine_Accelerometer_Trial1.csv',
 'Sitting_Data_Accelerometer_Trial2.csv',
 'unknown_data_accelerometer_trial2.csv',
 'Sitting_Data_Accelerometer_Trial1.csv',
 'Prone_Accelerometer_Trial1.csv',
 'Lateral_Right_Side_Accelerometer_Trial1.csv',
 'Prone_Accelerometer_Trial2.csv',
 'unknown_data_accelerometer_trial1.csv',
 'Lateral_Right_Side_Aceelerometer_Trial2.csv']
```

```
# csv files directory for gyroscope
num_gyro_files = (os.listdir(gyroscope_path))
num_gyro_files
```

```
['unknown_data_gyroscope_trial1.csv',
 'Lateral_Right_Side_Gyroscope_Trial2.csv',
 'unknown_data_gyroscope_trial2.csv',
 'Sitting_Data_Gyroscope_Trial2.csv',
 'Prone_Gyroscope_Trial1.csv',
 'Prone_Gyroscope_Trial2.csv',
 'Lateral_Left_Side_Gyroscope_Trial2.csv',
 'Supine_Gyroscope_Trial2.csv',
 'Lateral_Left_Side_Gyroscope_Trial1.csv',
 'Sitting_Data_Gyroscope_Trial1.csv',
 'Lateral_Right_Side_Gyroscope_Trial1.csv',
 'Supine_Gyroscope_Trial1.csv']
```

```
# Dictionary to store magnetometer DataFrames
dataframes = {}
for idx, file in enumerate(num_mag_files):
  file_mag_path = os.path.join(magnetometer_path, file)
  dataframes[f"df_mg{idx+1}"] = pd.read_csv(file_mag_path, skiprows=1, header=0)

# dataframes['df_mg1'].head()
dataframes
```

```
# initialize the empty dataframe
df_mag_concatenated = pd.DataFrame()

# get concatenated datafram, iterates over dataframes
for idx, df in dataframes.items():
  df_mag_concatenated = pd.concat([df_mag_concatenated, df], axis=0, ignore_index=True)

df_mag_concatenated = df_mag_concatenated[['P','X_M','Y_M','Z_M']]
print(df_mag_concatenated.shape)
df_mag_concatenated
```

(3609, 4)

	P	X_M	Y_M	Z_M
0	Sitting	42.04	23.82	-83.01
1	Sitting	42.22	24.28	-83.50
2	Sitting	42.47	23.58	-82.59
3	Sitting	42.48	23.91	-82.82
4	Sitting	42.20	23.95	-82.45
...	...	...	...	...
3604	Side	4.04	21.57	34.94
3605	Side	3.65	21.19	34.19
3606	Side	3.91	20.92	34.52
3607	Side	4.32	21.02	35.34
3608	Side	4.28	20.96	34.91

3609 rows × 4 columns

```
# Dictionary to store accelerometer DataFrames
dataframes = {}
for idx, file in enumerate(num_acc_files):
  file_acc_path = os.path.join(accelerometer_path, file)
  dataframes[f"df_acc{idx+1}"] = pd.read_csv(file_acc_path, skiprows=1, header=0)

dataframes

## initialize the empty dataframe
df_acc_concatenated = pd.DataFrame()

# get concatenated datafram, iterates over dataframes
for idx, df in dataframes.items():
  df_acc_concatenated = pd.concat([df_acc_concatenated, df], axis=0, ignore_index=True)

df_acc_concatenated = df_acc_concatenated[['P','X_A','Y_A','Z_A']]
df_acc_concatenated = df_acc_concatenated.iloc[:-3]
print(df_acc_concatenated.shape)
```

```
# Dictionary to store gyroscope DataFrames
dataframes = {}
for idx, file in enumerate(num_gyro_files):
  file_gyro_path = os.path.join(gyroscope_path, file)
  dataframes[f"df_mg{idx+1}"] = pd.read_csv(file_gyro_path, skiprows=1, header=0)

dataframes

## initialize the empty dataframe
df_gyro_concatenated = pd.DataFrame()

# get concatenated datafram, iterates over dataframes
for idx, df in dataframes.items():
  df_gyro_concatenated = pd.concat([df_gyro_concatenated, df], axis=0, ignore_index=True)

df_gyro_concatenated = df_gyro_concatenated[['P','X_G','Y_G','Z_G']]
df_gyro_concatenated = df_gyro_concatenated.iloc[:-3]
print(df_gyro_concatenated.shape)
df_gyro_concatenated.head()
```

(3609, 4)

	P	X_G	Y_G	Z_G
0	Unknown	1.71	2.14	-0.73
1	Unknown	1.34	2.20	-0.92
2	Unknown	0.73	2.50	-1.04
3	Unknown	1.10	2.20	-0.67

Perform Machine Learning training

```
import numpy as np
import pandas as pd
import tensorflow as tf
from tensorflow.keras import layers, models
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import StandardScaler
```

Accelerometer ML *model*

```
########Accelerometer######
# define input and output
X = df_acc_concatenated[['X_A', 'Y_A', 'Z_A']].values
y = df_acc_concatenated['P'].values

# encoding categorical feature into integer
label_encoder = LabelEncoder()
y_encoded = label_encoder.fit_transform(y)

# Split dataset
X_train, X_test, y_train, y_test = train_test_split(X, y_encoded, test_size=0.2, random_state=42)

# Normalization
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

# Define model
model = models.Sequential()
model.add(layers.Input(shape=(3,)))
model.add(layers.Dense(128, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(num_classes, activation='softmax'))
model.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
model.summary()

num_classes = len(label_encoder.classes_)
print('num_classes', num_classes)

# model training
model.fit(X_train, y_train, epochs=10, batch_size=32, validation_split=0.1)

# evaluation
test_loss, test_accuracy = model.evaluate(X_test, y_test)
print('test_loss', test_loss)
print(f"Test Accuracy: {test_accuracy * 100:.2f}%")
```

```
##### GYROSCOPE#

# define input and output
X = df_gyro_concatenated[['X_G', 'Y_G', 'Z_G']].values
y = df_gyro_concatenated['P'].values

# encode into integer
label_encoder = LabelEncoder()
y_encoded = label_encoder.fit_transform(y)

# split dataset
X_train, X_test, y_train, y_test = train_test_split(X, y_encoded, test_size=0.1, random_state=42)
```

```
# normalization
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

# normalization
model = models.Sequential()
model.add(layers.Input(shape=(3,)))
model.add(layers.Dense(512, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(128, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(num_classes, activation='softmax'))

# define loss function and optimizer
model.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
model.summary()
num_classes = len(label_encoder.classes_)
print('num_classes', num_classes)

# moidel training
model.fit(X_train, y_train, epochs=30, batch_size=32, validation_split=0.1)

# evaluation
test_loss, test_accuracy = model.evaluate(X_test, y_test)
print('test_loss', test_loss)
print(f"Test Accuracy: {test_accuracy * 100:.2f}%")
```

```
#####Magnetometer########

# define input and output
X = df_mag_concatenated[['X_M', 'Y_M', 'Z_M']].values
y = df_mag_concatenated['P'].values

# encode categorical into integer
label_encoder = LabelEncoder()
y_encoded = label_encoder.fit_transform(y)

# split dataset
X_train, X_test, y_train, y_test = train_test_split(X, y_encoded, test_size=0.2, random_state=42)

# normalization
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

# define model
model = models.Sequential()
model.add(layers.Input(shape=(3,)))
model.add(layers.Dense(128, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(num_classes, activation='softmax'))

# define loss function and optimizer
model.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
model.summary()

num_classes = len(label_encoder.classes_)
print('num_classes', num_classes)

# model training
model.fit(X_train, y_train, epochs=10, batch_size=32, validation_split=0.1)

# evaluation
test_loss, test_accuracy = model.evaluate(X_test, y_test)
print('test_loss', test_loss)
print(f"Test Accuracy: {test_accuracy * 100:.2f}%")
```

```
num_classes 5
Model: "sequential_7"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

```
=================================================================
 dense_20 (Dense)            (None, 128)               512

 dropout_14 (Dropout)        (None, 128)               0

 dense_21 (Dense)            (None, 64)                8256

 dropout_15 (Dropout)        (None, 64)                0

 dense_22 (Dense)            (None, 5)                 325

=================================================================
Total params: 9093 (35.52 KB)
Trainable params: 9093 (35.52 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
Epoch 1/10
82/82 [==============================] - 3s 8ms/step - loss: 0.9976 - accuracy: 0.7036 - val_loss: 0.4321 - val_accuracy: 1.
Epoch 2/10
82/82 [==============================] - 0s 6ms/step - loss: 0.3451 - accuracy: 0.9303 - val_loss: 0.1090 - val_accuracy: 1.
Epoch 3/10
82/82 [==============================] - 0s 6ms/step - loss: 0.1551 - accuracy: 0.9707 - val_loss: 0.0358 - val_accuracy: 1.
Epoch 4/10
82/82 [==============================] - 0s 5ms/step - loss: 0.0994 - accuracy: 0.9827 - val_loss: 0.0166 - val_accuracy: 1.
Epoch 5/10
82/82 [==============================] - 0s 4ms/step - loss: 0.0640 - accuracy: 0.9888 - val_loss: 0.0070 - val_accuracy: 1.
Epoch 6/10
82/82 [==============================] - 0s 4ms/step - loss: 0.0419 - accuracy: 0.9935 - val_loss: 0.0046 - val_accuracy: 1.
Epoch 7/10
82/82 [==============================] - 0s 4ms/step - loss: 0.0338 - accuracy: 0.9958 - val_loss: 0.0027 - val_accuracy: 1.
Epoch 8/10
82/82 [==============================] - 0s 5ms/step - loss: 0.0313 - accuracy: 0.9915 - val_loss: 0.0020 - val_accuracy: 1.
Epoch 9/10
82/82 [==============================] - 0s 4ms/step - loss: 0.0244 - accuracy: 0.9958 - val_loss: 0.0013 - val_accuracy: 1.
Epoch 10/10
82/82 [==============================] - 0s 4ms/step - loss: 0.0208 - accuracy: 0.9954 - val_loss: 0.0012 - val_accuracy: 1.
23/23 [==============================] - 0s 3ms/step - loss: 0.0016 - accuracy: 1.0000
test_loss 0.0015728322323411703
Test Accuracy: 100.00%
```

```python
# get actual index for different classes after encoding
unique_encoded_values = np.unique(y_encoded)
original_labels = label_encoder.inverse_transform(unique_encoded_values)

print("encoded values:",unique_encoded_values )
print("actual classes:", original_labels)
```

```
encoded values: [0 1 2 3 4]
actual classes: ['Prone' 'Side' 'Sitting' 'Supine' 'Unknown']
```

```python
# save trained model and convert into .tflite
model_file = "posture_magf.h5"

model.save("posture_magf.h5")

model = tf.keras.models.load_model(model_file)

converter = tf.lite.TFLiteConverter.from_keras_model(model)
tflite_model = converter.convert()
open("posture_magf.tflite", "wb").write(tflite_model)
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3000: UserWarning: You are saving your model as an HDF5
  saving_api.save_model(
38520
```

```python
# save trained model and convert into .tflite
model_file = "posture_gyrof.h5"

model.save("posture_gyrof.h5")

model = tf.keras.models.load_model(model_file)

converter = tf.lite.TFLiteConverter.from_keras_model(model)
tflite_model = converter.convert()
open("posture_gyrof.tflite", "wb").write(tflite_model)
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3000: UserWarning: You are saving your model as an HDF5
  saving_api.save_model(
308020
```

```
# save trained model and convert into .tflite
model_file = "posture_acc.h5"

model.save("posture_acc.h5")

model = tf.keras.models.load_model(model_file)

converter = tf.lite.TFLiteConverter.from_keras_model(model)
tflite_model = converter.convert()
open("posture_acc.tflite", "wb").write(tflite_model)
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3000: UserWarning: You are saving your model as an HDF5
  saving_api.save_model(
38536
```

```
# Test on some random new data
# new_data = np.array([[0.04, 0.02, -1.01]]) # Actual prone data
# new_data = np.array([[-1.01, -0.03, 0.02]]) # Actual Sitting data
# new_data = np.array([[-0.03, -0.1, 0.97]]) # Actual Supine data
# new_data = np.array([[-0.01, -1, -0.04]]) # Actual Side data
# new_data = np.array([[0.74, -0.67, -0.08]]) # Actual Unknown data

# Make predictions on new data
predictions = model.predict(new_data)

# Decode the predicted class index to obtain the posture label
predicted_class_index = np.argmax(predictions, axis=1)
predicted_class = label_encoder.inverse_transform(predicted_class_index)

# The 'predicted_class'
print('predictions', predictions)
print(predicted_class)
```

```
1/1 [==============================] - 0s 57ms/step
predictions [[1.2908266e-03 9.9149137e-04 2.2209149e-02 2.7093731e-04 9.7523767e-01]]
['Unknown']
```