Data Science Project - Wrist Accelerometer Analysis

Institution: Instituto Federal de Brasília

Developer: Pedro Plá

Dataset: Public Dataset of Accelerometer Data for Human Motion Primitives Detection (HPD)

Importing of relevant python libraries

In [2]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import regex as re #For extracting data from file names
import glob2 as glob #For looping over directories
import os #For looping over directories
```

Data Gathering

Dataframe creation framework

Here we create the framework for importing this not fully organized data into a dataframe, in this step, we use read_csv to create a single dataframe from a single file, later we will use this tested framework to iterate over all files.

In [4]:

```
folder = 'Brush_teeth'
file = "Brush_teeth/Accelerometer-2011-04-11-13-28-18-brush_teeth-f1.txt"
file_re = re.split('[/ -]',file)
df = pd.read_csv(file, sep=' ')
df.columns = ('x_axis','y_axis','z_axis')
df['file_name']=file
df['movement'] = file_re[0]
df['sex'] = file[-6]
df['date'] = file_re[2]+'-'+file_re[3]+'-'+file_re[4]
df['time'] =  file_re[5]+'h'+file_re[6]+'min'+file_re[7]
df.head()
```

Out[4]:

```
   x_axis  y_axis  z_axis                                   file_name     movement  sex        date       time
0      22      49      35  Brush_teeth/Accelerometer-2011-04-11-13-28-  Brush_teeth    f    2011-04-  13h28min18
                                                                  18-...                          11
1      22      52      35  Brush_teeth/Accelerometer-2011-04-11-13-28-  Brush_teeth    f    2011-04-  13h28min18
                                                                  18-...                          11
2      22      52      35  Brush_teeth/Accelerometer-2011-04-11-13-28-  Brush_teeth    f    2011-04-  13h28min18
                                                                  18-...                          11
3      21      52      34  Brush_teeth/Accelerometer-2011-04-11-13-28-  Brush_teeth    f    2011-04-  13h28min18
                                                                  18-...                          11
4      22      51      34  Brush_teeth/Accelerometer-2011-04-11-13-28-  Brush_teeth    f    2011-04-  13h28min18
                                                                  18-...                          11
```

Looping through all files

Goes through all directories and files on the main movements file which contains all non-model measurement data:

In [5]:

```
movements_folder = os.listdir('Movements')
print(movements_folder)
```

```
['Brush_teeth', 'Climb_stairs', 'Comb_hair', 'Descend_stairs', 'Drink_glass', 'Eat_meat', 'Eat_sou
p', 'Getup_bed', 'Liedown_bed', 'Pour_water', 'Sitdown_chair', 'Standup_chair', 'Use_telephone',
'Walk']
```

Here, we create the df_medidas concatenated dataframe by looping the function we tested on the framework creation phase. For verification purposes there's a alert for each added directory and a counter for how many files were read and aggregated

In [6]:

```
small_dfs = []
total_files = 0
for j in range(len(movements_folder)):
    folder = movements_folder[j]
    print(folder+ ' added')

    files=os.listdir(movements_folder[j])
    for i in range(len(os.listdir(movements_folder[j]))):
        file = folder+'/'+files[i]
        file_re = re.split('[/ -]',file)
        df = pd.read_csv(file, sep=' ')
        df.columns = ('x_axis','y_axis','z_axis')
        df['file_name']=file
        df['movement'] = file_re[0]
        df['sex'] = file_re[-1][0]
        df['date'] = file_re[2]+'-'+file_re[3]+'-'+file_re[4]
        df['time'] =  file_re[5]+'h'+file_re[6]+'min'+file_re[7]
        small_dfs.append(df)
        total_files = total_files+1

df_medidas = pd.concat(small_dfs,ignore_index=True)
print('Concatenated a total of '+str(total_files)+ ' files')
```

```
Brush_teeth added
Climb_stairs added
Comb_hair added
Descend_stairs added
Drink_glass added
Eat_meat added
Eat_soup added
Getup_bed added
Liedown_bed added
Pour_water added
Sitdown_chair added
Standup_chair added
Use_telephone added
Walk added
Concatenated a total of 839 files
```

This is the how the df_medidas file looks, we'll also apply some measurements for dinamically adjusting datatypes for size reduction

In [7]:

```
df_medidas.head()
```

Out[7]:

	x_axis	y_axis	z_axis	file_name	movement	sex	date	time
0	22	49	35	Brush_teeth/Accelerometer-2011-04-11-13-28-18-...	Brush_teeth	f	2011-04-11	13h28min18
1	22	52	35	Brush_teeth/Accelerometer-2011-04-11-13-28-18-...	Brush_teeth	f	2011-04-11	13h28min18

	x_axis	y_axis	z_axis	file_name	movement	sex	date	time
2	22	52	35	Brush_teeth/Accelerometer-2011-04-11-13-28-18-...	Brush_teeth	f	2011-04-11	13h28min18
3	21	52	34	Brush_teeth/Accelerometer-2011-04-11-13-28-18-...	Brush_teeth	f	2011-04-11	13h28min18
4	22	51	34	Brush_teeth/Accelerometer-2011-04-11-13-28-18-...	Brush_teeth	f	2011-04-11	13h28min18

In [9]:

```
df_medidas.info(memory_usage = "deep")
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 445690 entries, 0 to 445689
Data columns (total 8 columns):
 #   Column     Non-Null Count   Dtype 
---  ------     --------------   ----- 
 0   x_axis     445690 non-null  int64 
 1   y_axis     445690 non-null  int64 
 2   z_axis     445690 non-null  int64 
 3   file_name  445690 non-null  object
 4   movement   445690 non-null  object
 5   sex        445690 non-null  object
 6   date       445690 non-null  object
 7   time       445690 non-null  object
dtypes: int64(3), object(5)
memory usage: 222.6 MB
```

In [10]:

```
#Downcasting, attempts to reduce dataframe size by changing dtype as possible
for column in df_medidas:
 if df_medidas[column].dtype == 'int64':
     df_medidas[column]=pd.to_numeric(df_medidas[column], downcast='integer')
```

Below we can see the final datatypes and final filesize

In [12]:

```
df_medidas.info(memory_usage = "deep")
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 445690 entries, 0 to 445689
Data columns (total 8 columns):
 #   Column     Non-Null Count   Dtype 
---  ------     --------------   ----- 
 0   x_axis     445690 non-null  int8  
 1   y_axis     445690 non-null  int8  
 2   z_axis     445690 non-null  int8  
 3   file_name  445690 non-null  object
 4   movement   445690 non-null  object
 5   sex        445690 non-null  object
 6   date       445690 non-null  object
 7   time       445690 non-null  object
dtypes: int8(3), object(5)
memory usage: 213.7 MB
```

In [13]:

```
#df_medidas.to_csv()
```

Data Exploration

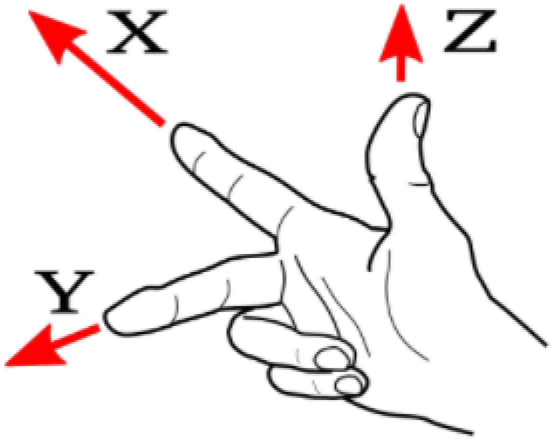
From MANUAL.txt included with the dataset, we have the information that the accelerometer is attached to the right wrist that the axes are.

x axis: pointing toward the hand;

y axis: pointing toward the left;

z axis: perpendicular to the plane of the hand.

Also included in the dataset, we have the date and time that the measurements were collected as well as the gender of the volunteer.



In [14]:

```
df=df_medidas
```

Overview

In [16]:

```
df.info(memory_usage = "deep")
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 445690 entries, 0 to 445689
Data columns (total 8 columns):
 #   Column     Non-Null Count   Dtype 
---  ------     --------------   ----- 
 0   x_axis     445690 non-null  int8  
 1   y_axis     445690 non-null  int8  
 2   z_axis     445690 non-null  int8  
 3   file_name  445690 non-null  object
 4   movement   445690 non-null  object
 5   sex        445690 non-null  object
 6   date       445690 non-null  object
 7   time       445690 non-null  object
dtypes: int8(3), object(5)
memory usage: 213.7 MB
```

1 - Breakdown of sex and movement

In [17]:

```
df_sex = (df['sex'].value_counts()).rename_axis('sex').reset_index(name='occurrences')
df_sex
```

Out[17]:

	sex	occurrences
0	f	282666
1	m	163024

In [18]:

```
total_rows = df_sex['occurrences'].sum(axis=0)
```

In [20]:

```
df_sex['frequency(percentage)'] = 100*df_sex['occurrences']/total_rows
df_sex['frequency(percentage)'] = df_sex['frequency(percentage)'].round(decimals=2)
df_sex
```

Out[20]:

	sex	occurrences	frequency(percentage)
0	f	282666	63.42
1	m	163024	36.58

We have on the table above, the number of measurements collected for male and female volunteers, as well as their relllative frequency when categorized as such

In [21]:

```
df_movement = (df['movement'].value_counts()).rename_axis('movement').reset_index(name='occurrence
df_movement
```

Out[21]:

	movement	occurrences
0	Walk	92154
1	Getup_bed	45700
2	Drink_glass	42692
3	Pour_water	41573
4	Climb_stairs	40156
5	Eat_meat	31231
6	Brush_teeth	29817
7	Standup_chair	25315
8	Sitdown_chair	24936
9	Comb_hair	23473
10	Descend_stairs	15333
11	Use_telephone	15212
12	Liedown_bed	11418
13	Eat_soup	6680

In [23]:

```
df_movement['frequency(percentage)'] = (100*df_movement['occurrences']/total_rows)
df_movement['frequency(percentage)'] = df_movement['frequency(percentage)'].round(decimals=2)
df_movement
```

Out[23]:

	movement	occurrences	frequency(percentage)
0	Walk	92154	20.68
1	Getup_bed	45700	10.25
2	Drink_glass	42692	9.58
3	Pour_water	41573	9.33
4	Climb_stairs	40156	9.01
5	Eat_meat	31231	7.01
6	Brush_teeth	29817	6.69
7	Standup_chair	25315	5.68
8	Sitdown_chair	24936	5.59

	movement	occurrences	frequency(percentage)
9	Comb_hair	23473	5.27
10	Descend_stairs	15333	3.44
11	Use_telephone	15212	3.41
12	Liedown_bed	11418	2.56
13	Eat_soup	6680	1.50

Just as with the previous df_sex table, here with have the count of measurements separated by movement type, as well as their relative frequencies

2 - Correlation between the three acceleration axes

In [24]:

```
df.corr().round(decimals=3)
```

Out[24]:

	x_axis	y_axis	z_axis
x_axis	1.000	-0.037	0.603
y_axis	-0.037	1.000	-0.167
z_axis	0.603	-0.167	1.000

In the above correlation table, we can see the x and y axes have negligible correlation between them; while the x-axis has considerable positive correlation with z-axis acceleration and the y axis has a moderate negative correlation with the z-axis.

3 - Histogram of X-Axis movement

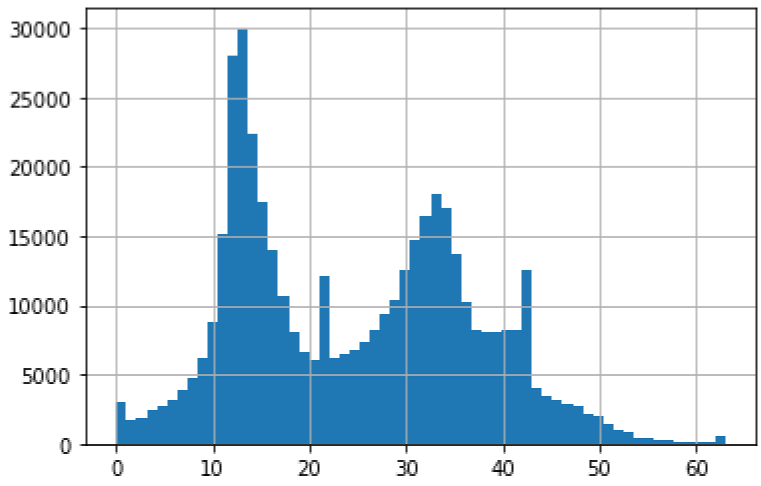
Creating two x-axis histograms with two different granularities

In [25]:

```
df['x_axis'].hist(bins=60)
```

Out[25]:

```
<AxesSubplot:>
```

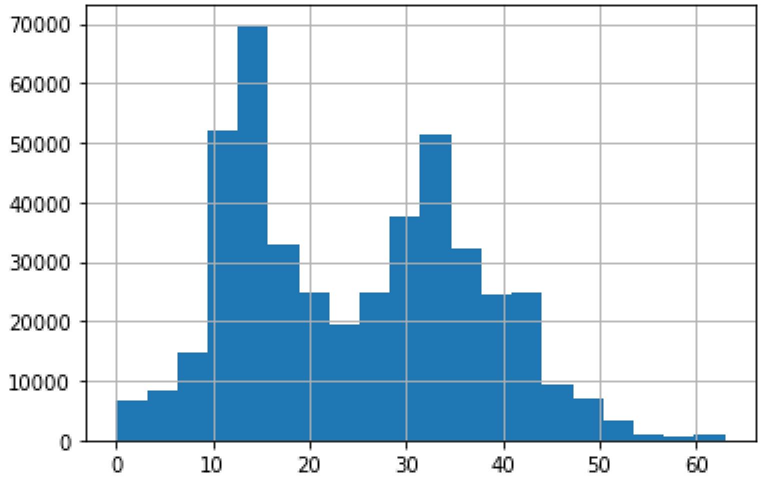


In [27]:

```
df['x_axis'].hist(bins=20)
```

Out[27]:

```
<AxesSubplot:>
```



By analysing the graph, the x-axis accelerations seem to fall roughly under a bimodal distribution, with a concentration around 14 and another around 33.

4 - Plot of number of occurrences per movement

In [28]:

```
df_movement_count = (df['movement'].value_counts()).rename_axis('movement').reset_index(name='occu
df_movement_count
```

Out[28]:

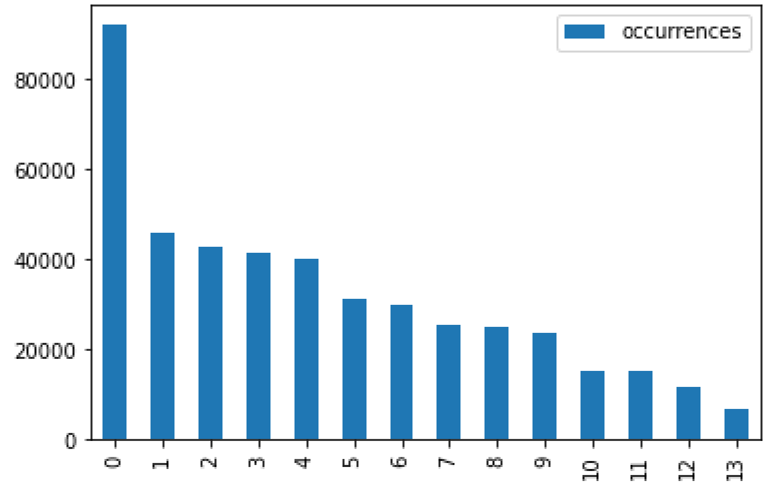
	movement	occurrences
0	Walk	92154
1	Getup_bed	45700
2	Drink_glass	42692
3	Pour_water	41573
4	Climb_stairs	40156
5	Eat_meat	31231
6	Brush_teeth	29817
7	Standup_chair	25315
8	Sitdown_chair	24936
9	Comb_hair	23473
10	Descend_stairs	15333
11	Use_telephone	15212
12	Liedown_bed	11418
13	Eat_soup	6680

In [29]:

```
df_movement_count.plot(kind='bar')
```

Out[29]:

```
<AxesSubplot:>
```



The plot brings in visual form the amount of data the dataset has on each movement. We can see the most measurements we have is of the walking motion (labeled 0, with 92154 measurements) and the one we have the least measurements of is the soup eating movement (labeled 13, with 6680 measurements)