Imports

```
# importing packages
import pandas as pd
import glob
import numpy as np
import scipy as sp
from scipy.stats import kurtosis, skew
# Importing matplotlib to plot the graphs.
import matplotlib.pyplot as plt
```

File formatting

Gathers the files in the folder to a dataframe, to then save it to a csv.

```
folder_path = '/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/10Archivos'
file_list_10 = glob.glob(folder_path + "/*")
main_dataframe = pd.DataFrame(pd.read_table(file_list_10[0], header = None))

for i in range(1,len(file_list_10)):
  data = pd.read_table(file_list_10[i], header = None)
  df = pd.DataFrame(data)
  main_dataframe = pd.concat([main_dataframe, df] )#, axis = 1)

filenames = []
for path in file_list_10:
  filenames.append(path.split("/")[-1])

print(main_dataframe)
```

```
           0      1      2      3      4      5      6      7
0     -0.022 -0.039 -0.183 -0.054 -0.105 -0.134 -0.129 -0.142
1     -0.105 -0.017 -0.164 -0.183 -0.049  0.029 -0.115 -0.122
2     -0.183 -0.098 -0.195 -0.125 -0.005 -0.007 -0.171 -0.071
3     -0.178 -0.161 -0.159 -0.178 -0.100 -0.115 -0.112 -0.078
4     -0.208 -0.129 -0.261 -0.098 -0.151 -0.205 -0.063 -0.066
...      ...    ...    ...    ...    ...    ...    ...    ...
20475 -0.142 -0.090  0.059 -0.049 -0.051 -0.010 -0.039  0.022
20476 -0.059 -0.178  0.005 -0.073  0.022 -0.212 -0.063 -0.037
20477 -0.076 -0.156 -0.151 -0.110 -0.007 -0.200 -0.059 -0.022
20478 -0.139 -0.046 -0.176 -0.081 -0.176 -0.142 -0.066  0.017
20479 -0.229  0.054 -0.225 -0.144 -0.054 -0.068 -0.078 -0.007

[204800 rows x 8 columns]
```

```
file_list_10[0].split("/")[-1]
```

```
'2003.10.22.12.06.24'
```

```
filenames
```

```
['2003.10.22.12.06.24',
 '2003.10.22.12.09.13',
 '2003.10.22.12.14.13',
 '2003.10.22.12.19.13',
 '2003.10.22.12.24.13',
 '2003.10.22.12.34.13',
 '2003.10.22.12.29.13',
 '2003.10.22.12.39.13',
 '2003.10.22.12.44.13',
 '2003.10.22.12.49.13']
```

```
folder_path = '/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/5archivosfinal'
file_list = glob.glob(folder_path + "/*")
last_df = pd.DataFrame(pd.read_table(file_list[0], header = None))

for i in range(1,len(file_list)):
    data = pd.read_table(file_list[i], header = None)
    df = pd.DataFrame(data)
```

```
    last_df = pd.concat([last_df, df] )#, axis = 1)
```

```
print(last_df)
```

```
              0      1      2      3      4      5      6      7
0     -0.071 -0.117 -0.295 -0.471  0.132 -0.144 -0.173 -0.020
1     -0.066 -0.068 -0.063 -0.417 -0.271 -0.107 -0.078 -0.081
2     -0.078 -0.154 -0.193 -0.122 -0.254 -0.154  0.034 -0.107
3     -0.146 -0.222 -0.320  0.037  0.205 -0.349  0.090 -0.093
4     -0.083 -0.330 -0.088 -0.176 -0.417  0.103 -0.061 -0.190
...      ...    ...    ...    ...    ...    ...    ...    ...
20475  0.051 -0.393 -0.361 -0.562 -0.195  0.151 -0.022 -0.115
20476  0.159 -0.186 -0.117 -0.391 -0.227  0.276  0.007 -0.188
20477 -0.193  0.186  0.264 -0.156 -0.095  0.513 -0.078 -0.251
20478 -0.432 -0.046  0.017 -0.105 -0.115 -0.012 -0.117 -0.254
20479 -0.022 -0.361 -0.327 -0.190 -0.293  0.288 -0.227 -0.420

[102400 rows x 8 columns]
```

```
main_dataframe
```

	0	1	2	3	4	5	6	7
0	-0.022	-0.039	-0.183	-0.054	-0.105	-0.134	-0.129	-0.142
1	-0.105	-0.017	-0.164	-0.183	-0.049	0.029	-0.115	-0.122
2	-0.183	-0.098	-0.195	-0.125	-0.005	-0.007	-0.171	-0.071
3	-0.178	-0.161	-0.159	-0.178	-0.100	-0.115	-0.112	-0.078
4	-0.208	-0.129	-0.261	-0.098	-0.151	-0.205	-0.063	-0.066
...	...	...	...	...	...	...	...	...
20475	-0.142	-0.090	0.059	-0.049	-0.051	-0.010	-0.039	0.022
20476	-0.059	-0.178	0.005	-0.073	0.022	-0.212	-0.063	-0.037
20477	-0.076	-0.156	-0.151	-0.110	-0.007	-0.200	-0.059	-0.022
20478	-0.139	-0.046	-0.176	-0.081	-0.176	-0.142	-0.066	0.017

```
# main_dataframe.to_csv("/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/10Archivos.csv")
```

Reads the files in the directory given in the path argument. Returns a dataframe with all the info and a list with the filenames

Notice that several rows have the same index. At first seems odd, but could be useful

```
def readFiles(folderpath):
  folder_path = folderpath
  file_list = glob.glob(folder_path + "/*")
  res_dataframe = pd.DataFrame(pd.read_table(file_list[0], header = None))

  for i in range(1,len(file_list)):
    data = pd.read_table(file_list[i], header = None)
    df = pd.DataFrame(data)
    res_dataframe = pd.concat([res_dataframe, df] )#, axis = 1)

  names = []
  for path in file_list:
    names.append(path.split("/")[-1])

  return res_dataframe, names
```

```
res_df, fnames = readFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/5archivosfinal')
```

```
res_df.loc[20470]
```

Generic graphs

Over the first 1000 and last 1000 records, to compare initial healthy state with the end of the experiment

20479	-0.105	0.098	-0.061	-0.137	0.100	0.115	-0.059	-0.085

```
channel = 8
bearing = 4
test_number = 1
```

Computations

```
channel_base0= channel-1
```

```
file1 = pd.DataFrame(pd.read_table(file_list[0], header = None))
```

```
file1
```

	0	1	2	3	4	5	6	7
0	-0.071	-0.117	-0.295	-0.471	0.132	-0.144	-0.173	-0.020
1	-0.066	-0.068	-0.063	-0.417	-0.271	-0.107	-0.078	-0.081
2	-0.078	-0.154	-0.193	-0.122	-0.254	-0.154	0.034	-0.107
3	-0.146	-0.222	-0.320	0.037	0.205	-0.349	0.090	-0.093
4	-0.083	-0.330	-0.088	-0.176	-0.417	0.103	-0.061	-0.190
...	...	...	...	...	...	...	...	...
20475	-0.168	-0.068	-0.449	0.190	0.117	1.196	-0.037	-0.122
20476	-0.112	0.088	-0.493	0.266	-0.266	0.342	-0.339	-0.164
20477	-0.081	-0.020	-0.325	-0.049	-0.112	-0.481	-0.300	-0.007
20478	-0.115	-0.146	-0.190	-0.427	0.813	0.049	-0.205	0.105

```
x = df.index.to_series()

y = df[channel_base0]
```

```
print(x)
```

```
0            0
1            1
2            2
3            3
4            4
         ...
20475    20475
20476    20476
20477    20477
20478    20478
20479    20479
Length: 20480, dtype: int64
```

```
X = x[0:1000]
Y = y[0:1000]
```

```
Y
```

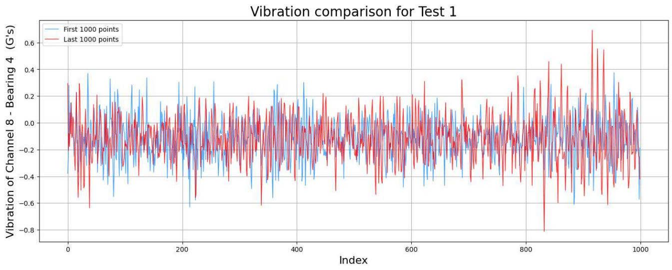
```
0     -0.378
1     -0.251
2      0.281
3     -0.171
4     -0.020
       ...
995    0.115
996    0.015
997   -0.176
998   -0.571
```

```
999    -0.188
Name: 7, Length: 1000, dtype: float64
```

```
X2 = x[-1000:]
Y2 = last_df[channel_base0][-1000:]
```

Result

```
plt.figure(figsize=(17,6))

plt.plot(X, Y, 'dodgerblue', label = 'First 1000 points', linewidth = 1, alpha=0.8)

plt.plot(X, Y2, 'red', label = 'Last 1000 points', linewidth = 1, alpha=0.8)

# X-axis label.
plt.xlabel('Index', fontsize = 16)

# Y-axis label.
plt.ylabel(f'Vibration of Channel {channel} - Bearing {bearing}  (G\'s)', fontsize = 16)

# Title
plt.title(f"Vibration comparison for Test {test_number}", fontsize = 20)


# Grid
plt.grid(True)
# plt.grid(False)

# Legend for the plot.
plt.legend()

# Saving the figure on disk.
#plt.savefig('Line_plot.png')

# Displays the plot.
plt.show()
```



Characteristics

For one file

```
file1
```

```
file1
```

	0	1	2	3	4	5	6	7
0	-0.071	-0.117	-0.295	-0.471	0.132	-0.144	-0.173	-0.020
1	-0.066	-0.068	-0.063	-0.417	-0.271	-0.107	-0.078	-0.081
2	-0.078	-0.154	-0.193	-0.122	-0.254	-0.154	0.034	-0.107
3	-0.146	-0.222	-0.320	0.037	0.205	-0.349	0.090	-0.093
4	-0.083	-0.330	-0.088	-0.176	-0.417	0.103	-0.061	-0.190
...	...	...	...	...	...	...	...	...
20475	-0.168	-0.068	-0.449	0.190	0.117	1.196	-0.037	-0.122
20476	-0.112	0.088	-0.493	0.266	-0.266	0.342	-0.339	-0.164
20477	-0.081	-0.020	-0.325	-0.049	-0.112	-0.481	-0.300	-0.007
20478	-0.115	-0.146	-0.190	-0.427	0.813	0.049	-0.205	0.105

```
file1.iloc[:, 0].mean()
```

```
-0.117158154296875
```

```
def rms(array):
  return np.sqrt(np.mean(array**2))
```

Function to compute characteristics, only for this set of files and dataset.

```
def computeFunction(df, function):
  print("Function applied:", function)
  result = []
  for i in range(0,8):
    #print("Channel", i)
    data = function(df.iloc[:, i])
    #print(data)
    result.append(data)
  return result
```

Computes a ton of functions and returns the result all nicely wrapped up

```
def computeFunctionsDepracated(df):
  functions = [np.mean, np.std, kurtosis, skew, rms, max, min]
  result = pd.DataFrame(columns = [0, 1, 2, 3, 4, 5, 6, 7],
                    index = [f.__name__ for f in functions])

  for f in functions:
    # Yes, I am completly aware that this is not very efficient
    row = computeFunction(df, f)
    print(row)
    print(f.__name__)
    result = result.append(row)
```

```
np.mean.__name__
```

```
'mean'
```

```
functions = [np.mean, np.std, kurtosis, skew, rms, max, min]
result = pd.DataFrame(columns = [0, 1, 2, 3, 4, 5, 6, 7],
                    index = [f.__name__ for f in functions])
print(result)
```

```
           0    1    2    3    4    5    6    7
mean     NaN  NaN  NaN  NaN  NaN  NaN  NaN  NaN
std      NaN  NaN  NaN  NaN  NaN  NaN  NaN  NaN
kurtosis NaN  NaN  NaN  NaN  NaN  NaN  NaN  NaN
skew     NaN  NaN  NaN  NaN  NaN  NaN  NaN  NaN
rms      NaN  NaN  NaN  NaN  NaN  NaN  NaN  NaN
```

```
max       NaN  NaN  NaN  NaN  NaN  NaN  NaN  NaN
min       NaN  NaN  NaN  NaN  NaN  NaN  NaN  NaN
```

Function to compute a ton of functions

(but this time, it will work)

```
def computeFunctions(df, filename = "Archivo 1"):
  index = []
  for i in range(0,df.shape[1]):
    index.append("{}: CH{}".format(filename,i))

  functions = [np.mean, np.std, kurtosis, skew, rms, max, min]
  columns = [f.__name__ for f in functions]

  result = pd.DataFrame(columns = columns,
                    index = index)

  for i in range(0,df.shape[1]):
    for f in functions:
      data = f(df.iloc[:,i])
      result.loc["{}: CH{}".format(filename,i),f.__name__] = data

  return result
```

```
computeFunctions(file1, filenames[0])
```

	mean	std	kurtosis	skew	rm
2003.10.22.12.06.24: CH0	-0.117158	0.128892	0.557575	-0.040126	0.17418
2003.10.22.12.06.24: CH1	-0.11681	0.10638	0.571086	0.065542	0.15799
2003.10.22.12.06.24: CH2	-0.117671	0.176177	0.270289	0.071844	0.2118
2003.10.22.12.06.24: CH3	-0.11721	0.164022	0.367768	-0.011991	0.20159

```
id = []
for i in range(0,8):
  id.append("Archivo 1: CH{}".format(i))
id
```

```
['Archivo 1: CH0',
 'Archivo 1: CH1',
 'Archivo 1: CH2',
 'Archivo 1: CH3',
 'Archivo 1: CH4',
 'Archivo 1: CH5',
 'Archivo 1: CH6',
 'Archivo 1: CH7']
```

Tests

```
result = computeFunctions(file1);
```

```
print(result)
```

```
                    mean       std  kurtosis      skew       rms    max    min
Archivo 1: CH0 -0.117158  0.128892  0.557575 -0.040126  0.174181   0.63 -0.808
Archivo 1: CH1  -0.11681   0.10638  0.571086  0.065542  0.157991  0.518 -0.632
Archivo 1: CH2 -0.117671  0.176177  0.270289  0.071844   0.21186  0.715 -0.806
Archivo 1: CH3  -0.11721  0.164022  0.367768 -0.011991  0.201597  0.503 -0.754
Archivo 1: CH4  0.129027  0.579418  5.902675  0.067194   0.59361  4.998   -5.0
Archivo 1: CH5 -0.115777  0.482299  4.265731  0.026523  0.496001  3.516 -3.833
Archivo 1: CH6 -0.115535  0.197923  0.626049 -0.018384  0.229176  0.764  -1.03
Archivo 1: CH7 -0.114618  0.175876  0.584465  0.051768  0.209928  0.796 -0.889
```

```
prueba = computeFunction(file1, np.mean)
```

```
Function applied: <function mean at 0x7f1c208b4af0>
```

```
prueba
```

```
[-0.117158154296875,
 -0.1168099609375,
 -0.11767128906249999,
 -0.117210400390625,
 0.1290267578125,
 -0.1157771484375,
 -0.11553481445312501,
 -0.114618359375]
```

```
computeFunction(file1, np.std)
```

```
Function applied: <function std at 0x7f1c208b4ca0>
[0.12889192813209446,
 0.10638008497319751,
 0.1761768682937003,
 0.16402159376713177,
 0.5794176170670109,
 0.4822990912526361,
 0.19792268001549584,
 0.17587576113364684]
```

Kurtosis determines whether a distribution is heavy-tailed in respect of the normal distribution. It provides information about the shape of a frequency distribution.

- kurtosis for normal distribution is equal to 3.
- For a distribution having kurtosis < 3: It is called playkurtic.
- For a distribution having kurtosis > 3, It is called leptokurtic and it signifies that it tries to produce more outliers rather than the normal distribution.

But as this is the Fisher's definiton, instead of 3, its around 0

```
computeFunction(file1, kurtosis)
```

```
Function applied: <function kurtosis at 0x7f1bd1963430>
[0.5575748372320817,
 0.571086184576941,
 0.2702887667202525,
 0.3677675422408475,
 5.902675469579055,
 4.2657312613533644,
 0.6260492622109828,
 0.5844654230765194]
```

Skewness estimates the asymmetrical behavior rather than computing frequency distribution. Skewness can be two types:

- Symmetrical: A distribution can be called symmetric if it appears the same from the left and right from the center point. Then, skewness = 0
- Asymmetrical: A distribution can be called asymmetric if it doesn’t appear the same from the left and right from the center point.

```
computeFunction(file1, skew)
```

```
Function applied: <function skew at 0x7f1bd19633a0>
[-0.04012632683677568,
 0.06554175310140613,
 0.0718436803483262,
 -0.011991040943440072,
 0.0671942218961487,
 0.026522703698348457,
 -0.018384064430841264,
 0.05176833155723915]
```

```
computeFunction(file1, rms)
```

```
Function applied: <function rms at 0x7f1bd1002c10>
[0.17418140617143776,
 0.15799142208716585,
 0.21186038136330787,
 0.2015970267182545,
 0.5936098712110663,
 0.49600076766416146,
 0.2291760908455207,
 0.2099277296122555]
```

```
computeFunction(file1, max)
```

```
Function applied: <built-in function max>
[0.63, 0.518, 0.715, 0.503, 4.998, 3.516, 0.764, 0.796]
```

```
computeFunction(file1, min)
```

```
Function applied: <built-in function min>
[-0.808, -0.632, -0.806, -0.754, -5.0, -3.833, -1.03, -0.889]
```

For a lot of files

Like the previous functions, but for more files, so to compare how they change with time

It is very time consuming

```
#   folder_path = '/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/test1'
#   file_list = glob.glob(folder_path + "/*")
#   main_dataframe = pd.DataFrame(pd.read_table(file_list[0], header = None))
#
#
#   filenames = []
#   i = 0
#   for path in file_list:
#     i = i+1
#
#     data = pd.read_table(file_list[i], header = None)
#     df = pd.DataFrame(data)
#     main_dataframe = pd.concat([main_dataframe, df] )#, axis = 1)
#     filenames.append(path.split("/")[-1])
#
#   print(main_dataframe)
```

Another approach: Read a file, compute everything and repeat

```
folder_path = '/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/test1'
file_list = glob.glob(folder_path + "/*")


df = pd.DataFrame(pd.read_table(file_list[0], header = None))
res = computeFunctions(df, filename = "Archivo 1")
print(res)
```

```
                       mean       std  kurtosis      skew       rms    max    min
Archivo 1: CH0 -0.118469  0.097826  0.879857 -0.039519  0.153639  0.483 -0.688
Archivo 1: CH1 -0.119506  0.089263  1.140088  0.090826  0.149163  0.654 -0.654
Archivo 1: CH2  -0.11776  0.092779  0.315984 -0.061028  0.149918   0.31 -0.791
Archivo 1: CH3 -0.118254   0.07583  0.362793  -0.01728  0.140479  0.234 -0.508
Archivo 1: CH4 -0.115443  0.113252  0.568761  0.024861  0.161719  0.461 -0.698
Archivo 1: CH5 -0.115118  0.119898  0.555058 -0.016134  0.166215  0.522 -0.884
Archivo 1: CH6 -0.114694  0.076305  0.698221 -0.004425  0.137758  0.291 -0.571
Archivo 1: CH7 -0.113825  0.079905   0.62012  0.001561  0.139072   0.32 -0.503
```

```
for i in range(1, 10): #len(file_list)
  df = computeFunctions(
      pd.DataFrame(pd.read_table(file_list[i], header = None)),
      filename = "Archivo {}".format(i+1)
  )
  res = res.append(df)
  print("Progress: {}/{}".format(i+1,10))
```

```
Progress: 2/10
Progress: 3/10
Progress: 4/10
Progress: 5/10
Progress: 6/10
Progress: 7/10
Progress: 8/10
Progress: 9/10
Progress: 10/10
```

```
res
```

	mean	std	kurtosis	skew	rms	max
Archivo 1: CH0	-0.118469	0.097826	0.879857	-0.039519	0.153639	0.483
Archivo 1: CH1	-0.119506	0.089263	1.140088	0.090826	0.149163	0.654
Archivo 1: CH2	-0.11776	0.092779	0.315984	-0.061028	0.149918	0.31
Archivo 1: CH3	-0.118254	0.07583	0.362793	-0.01728	0.140479	0.234
Archivo 1: CH4	-0.115443	0.113252	0.568761	0.024861	0.161719	0.461
...	...	...	...	...	...	...

```
len(file_list)
```

```
2156
```

```
def computeFiles(path, amount = -1):
  folder_path = path
  file_list = glob.glob(folder_path + "/*")

  filenames = []
  for filepath in file_list:
    filenames.append(path.split("/")[-1])

  df = pd.DataFrame(pd.read_table(file_list[0], header = None))
  res = computeFunctions(df, filename = filenames[0])

  if (amount <0 or amount > len(file_list)):
    amount = len(file_list)

  for i in range(1, amount):
    temp_df = computeFunctions(
        pd.DataFrame(pd.read_table(file_list[i], header = None)),
        filename = filenames[i]
    )
    res = res.append(temp_df)
    print("Progress: {}/{}".format(i+1,amount))

  return res
```

It takes a lot of time, so better not to test it with too many

```
result = computeFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/test1', amount = 10)
```

```
Progress: 2/10
Progress: 3/10
Progress: 4/10
Progress: 5/10
Progress: 6/10
Progress: 7/10
Progress: 8/10
Progress: 9/10
Progress: 10/10
```

```
result
```

	mean	std	kurtosis	skew	rms	max	m
test1: CH0	-0.118469	0.097826	0.879857	-0.039519	0.153639	0.483	-0.6
test1: CH1	-0.119506	0.089263	1.140088	0.090826	0.149163	0.654	-0.6

FFT

First steps into how to make this transformation. [Info about how to use scipy.fft]()

```
df, names = readFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/10Archivos')
```

```
df
```

	0	1	2	3	4	5	6	7
0	-0.022	-0.039	-0.183	-0.054	-0.105	-0.134	-0.129	-0.142
1	-0.105	-0.017	-0.164	-0.183	-0.049	0.029	-0.115	-0.122
2	-0.183	-0.098	-0.195	-0.125	-0.005	-0.007	-0.171	-0.071
3	-0.178	-0.161	-0.159	-0.178	-0.100	-0.115	-0.112	-0.078
4	-0.208	-0.129	-0.261	-0.098	-0.151	-0.205	-0.063	-0.066
...	...	...	...	...	...	...	...	...
20475	-0.142	-0.090	0.059	-0.049	-0.051	-0.010	-0.039	0.022
20476	-0.059	-0.178	0.005	-0.073	0.022	-0.212	-0.063	-0.037
20477	-0.076	-0.156	-0.151	-0.110	-0.007	-0.200	-0.059	-0.022
20478	-0.139	-0.046	-0.176	-0.081	-0.176	-0.142	-0.066	0.017

FFT preview for first files

First just one bearing, get only the wanted info from the 10 files

(3 because it has a failure in the set being used)

```
bearing3 = df.loc[:,4:5]
```

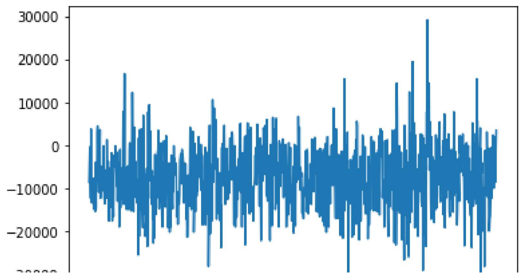
```
bearing3_file0 = bearing3.iloc[0:20480]
```

```
bearing3_file0
```

	4	5
0	-0.105	-0.134
1	-0.049	0.029
2	-0.005	-0.007
3	-0.100	-0.115
4	-0.151	-0.205
...	...	...
20475	-0.200	-0.198
20476	-0.159	-0.071
20477	-0.237	-0.251
20478	-0.027	-0.002

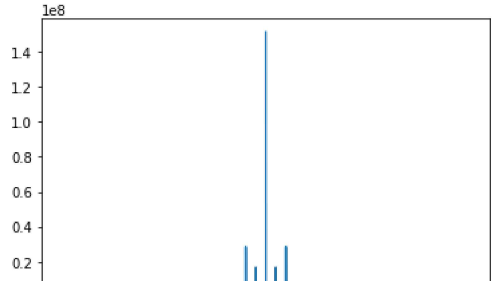
```
tone = bearing3_file0.loc[:,4] # Just 1 channel
```

```
normalized_tone = np.int16((tone / tone.max()) * 32767)

plt.plot(normalized_tone[:1000])
plt.show()
```




```
from scipy.fft import fft, fftfreq

SAMPLE_RATE = 20480 # (...).shape[0]
DURATION = 1 # Just 1 file of 1 second
```

```
# Number of samples in normalized_tone
N = SAMPLE_RATE * DURATION

yf = fft(normalized_tone)
xf = fftfreq(N, 1 / SAMPLE_RATE)

plt.plot(xf, np.abs(yf))
plt.show()
```



FFT preview for last files

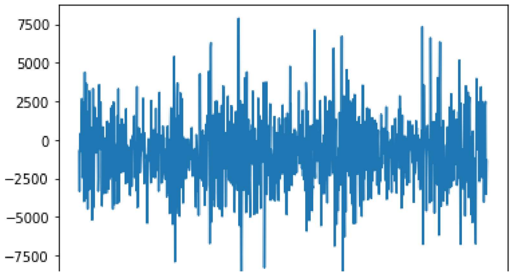
```
df, names = readFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/5archivosfinal')
```

```
bearing3 = df.loc[:,4:5]
bearing3_last = bearing3.iloc[-20480:]
```

```
bearing3_last
```

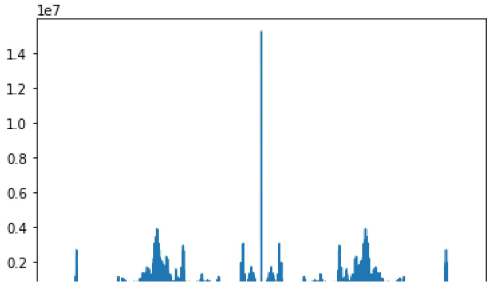
	4	5
0	-0.112	0.471

```
tone = bearing3_last.loc[:,4] # Just 1 channel

normalized_tone = np.int16((tone / tone.max()) * 32767)

plt.plot(normalized_tone[:1000])
plt.show()
```




```
SAMPLE_RATE = 20480 # (...).shape[0]
DURATION = 1 # Just 1 file of 1 second
```

```
# Number of samples in normalized_tone
N = SAMPLE_RATE * DURATION

yf = fft(normalized_tone)
xf = fftfreq(N, 1 / SAMPLE_RATE)

plt.plot(xf, np.abs(yf))
plt.show()
```



Characteristics for FFT

Small test to compute characteristics in the frequency domain. They are in the complex numbers, and for their interpretation, they should be put in absolute terms. Nonetheless, this will not be included in the proyect.

```
df, names = readFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/10Archivos')
df = df.iloc[0:20480]

tone = df.loc[:,4] # Just 1 channel
normalized_tone = np.int16((tone / tone.max()) * 32767)

SAMPLE_RATE = 20480 # (...).shape[0]
DURATION = 1 # Just 1 file of 1 second

# Number of samples in normalized_tone
N = SAMPLE_RATE * DURATION

from scipy.fft import rfft, rfftfreq

# Note the extra 'r' at the front
yf = rfft(normalized_tone)
xf = rfftfreq(N, 1 / SAMPLE_RATE)
```

```
plt.plot(xf, np.abs(yf))
plt.show()
```


```
yf
```

```
array([-1.51296418e+08      +0.j        ,
       -1.29083580e+06 +390290.90411122j,
        2.75528338e+05+1541673.79490654j, ...,
       -7.53619931e+05 -198313.47051488j,
        5.17216133e+05 +251547.28188151j,
        1.51100000e+04      +0.j        ])
```

```
xf
```

```
array([0.0000e+00, 1.0000e+00, 2.0000e+00, ..., 1.0238e+04, 1.0239e+04,
       1.0240e+04])
```

Yes, complex numbers, my favourites

```
rms(yf)
```

```
(1475783.6584744467-32895.95199129747j)
```

```
np.std(yf)
```

```
1842273.0398067578
```

```
max(yf)
```

```
(11612740.40666751-26006715.57693314j)
```

```
min(yf)
```

```
(-151296418+0j)
```

```
np.mean(yf)
```

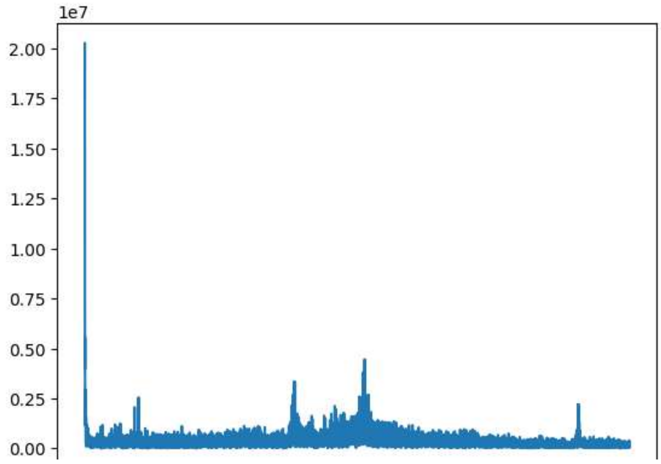
```
(-15986.221462747782+387.75663501900874j)
```

For the Amp Bin () we need a special formula

testing the sample rate

```
df, names = readFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/5archivosfinal')
df = df.iloc[0:20480]

tone = df.loc[:,4] # Just 1 channel
normalized_tone = np.int16((tone / tone.max()) * 32767)

SAMPLE_RATE = 20480 # (...).shape[0]
DURATION = 1 # Just 1 file of 1 second

# Number of samples in normalized_tone
N = SAMPLE_RATE * DURATION

from scipy.fft import rfft, rfftfreq
```

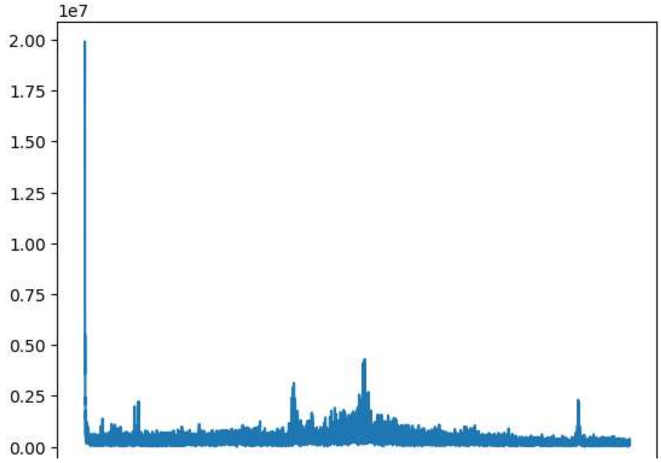
```
# Note the extra 'r' at the front
yf = rfft(normalized_tone)
xf = rfftfreq(N, 1 / SAMPLE_RATE)

plt.plot(xf, np.abs(yf))
plt.show()
```




```
x = pd.DataFrame(xf)
y = pd.DataFrame(np.abs(yf))
y[y[0] > 0.23e+07]
```

	0
0	1.751872e+07
1	2.024846e+07
2	1.181447e+07
3	7.402675e+06
4	3.981408e+06
5	5.538116e+06
6	3.729754e+06
8	3.784287e+06
11	2.953352e+06
1011	2.549845e+06
3918	2.708040e+06
3919	2.321503e+06
3930	3.346512e+06
3952	3.330442e+06
5160	2.593923e+06
5167	2.346879e+06
5182	2.564964e+06
5215	2.331237e+06
5229	3.806486e+06
5252	2.992542e+06
5259	4.457549e+06

```
df, names = readFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/5archivosfinal')
df = df.iloc[0:20000]
tone = df.loc[:,4] # Just 1 channel
normalized_tone = np.int16((tone / tone.max()) * 32767)

SAMPLE_RATE = 20000 # (...).shape[0]
DURATION = 1 # Just 1 file of 1 second

# Number of samples in normalized_tone
N = SAMPLE_RATE * DURATION

from scipy.fft import rfft, rfftfreq

# Note the extra 'r' at the front
yf = rfft(normalized_tone)
xf = rfftfreq(N, 1 / SAMPLE_RATE)


plt.plot(xf, np.abs(yf))
plt.show()
```




```
x = pd.DataFrame(xf)
y = pd.DataFrame(np.abs(yf))


y[y[0] > 0.23e+07]
```

	0
0	1.708571e+07
1	1.990715e+07
2	1.209413e+07
3	7.187506e+06
4	3.556627e+06
5	5.501526e+06

	0
0	0.0
1	1.0
2	2.0
3	3.0
4	4.0
...	...
9996	9996.0
9997	9997.0
9998	9998.0
9999	9999.0