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/Test3-10Archivos'
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
    0      0.034  0.264  0.039 -0.046
    1      0.103  0.083 -0.061 -0.012
    2      0.095 -0.039 -0.007  0.039
    3      0.000  0.110  0.022 -0.002
    4      0.005  0.154 -0.127 -0.020
    ...      ...    ...    ...    ...
    20475 -0.225 -0.137  0.051 -0.120
    20476  0.005  0.142  0.007 -0.134
    20477  0.095  0.159  0.073  0.110
    20478  0.068 -0.125  0.015  0.200
    20479 -0.012 -0.125 -0.076  0.049

    [204800 rows x 4 columns]
```

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

```
    '2004.03.04.09.27.46'
```

```
filenames
```

```
['2004.03.04.09.27.46',
 '2004.03.04.09.32.46',
 '2004.03.04.09.42.46',
 '2004.03.04.10.42.46',
 '2004.03.04.10.22.46',
 '2004.03.04.10.02.46',
 '2004.03.04.10.12.46',
 '2004.03.04.09.52.46',
 '2004.03.04.10.32.46',
 '2004.03.04.10.52.46']
```

```
folder_path = '/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/Test3-5Final'
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
     0      0.002  0.002  0.002  0.002
     1      0.002  0.002  0.002  0.002
     2      0.002  0.002  0.005  0.002
     3      0.000  0.002  0.002  0.002
     4      0.000  0.002  0.005  0.002
     ...      ...    ...    ...    ...
     20475 -0.051 -0.024 -0.088  0.095
     20476 -0.059 -0.457  0.159  0.110
     20477 -0.024 -0.286  0.042  0.134
     20478  0.142  0.154 -0.129  0.005
     20479 -0.012  0.059 -0.703 -0.195

     [102400 rows x 4 columns]
```

```
main_dataframe
```

	0	1	2	3
0	0.034	0.264	0.039	-0.046
1	0.103	0.083	-0.061	-0.012

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

3	0.000	0.110	0.022	-0.002

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

20470	0.005	0.142	0.007	0.124

```
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]
```

	0	1	2	3	4	5	6	7
20470	-0.012	-0.085	-0.049	-0.085	0.105	-0.779	-0.273	-0.239
20470	-0.015	-0.010	0.159	-0.078	-0.042	-0.049	-0.176	-0.105
20470	-0.105	0.098	-0.061	-0.137	0.100	0.115	-0.039	-0.085
20470	-0.144	0.000	-0.117	0.005	-0.344	-0.161	-0.078	-0.251
20470	-0.068	-0.098	-0.374	-0.071	0.164	-0.249	-0.273	-0.349

Generic graphs

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

```
channel = 4
bearing = 4
test_number = 3
```

Computations

```
channel_base0= channel-1
```

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

```
file1
```

	0	1	2	3
0	0.002	0.002	0.002	0.002
1	0.002	0.002	0.002	0.002
2	0.002	0.002	0.005	0.002
3	0.000	0.002	0.002	0.002
4	0.000	0.002	0.005	0.002
...	...	...	...	...
20475	0.000	0.002	0.005	0.000
20476	0.000	0.002	0.002	0.000
20477	0.000	0.002	0.005	0.000
20478	0.002	0.002	0.002	0.002
20479	0.000	0.002	0.005	0.000

20480 rows × 4 columns

```
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]
```

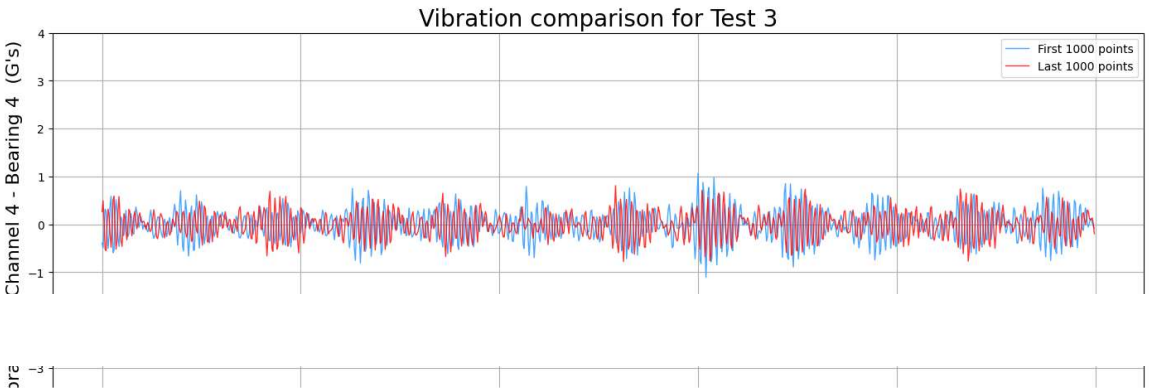
```
Y
```

```
0     -0.391
1     -0.491
2     -0.105
3      0.317
4      0.278
       ...
995    0.115
996    0.115
997    0.024
998   -0.029
999   -0.073
Name: 3, 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)

plt.ylim(-4, 4)


# 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

	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
20479	-0.098	-0.166	0.012	-0.552	-0.071	0.588	-0.159	0.232

20480 rows × 8 columns

```
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	rms	max	min
2003.10.22.12.06.24: CH0	-0.117158	0.128892	0.557575	-0.040126	0.174181	0.63	-0.808
2003.10.22.12.06.24: CH1	-0.11681	0.10638	0.571086	0.065542	0.157991	0.518	-0.632
2003.10.22.12.06.24: CH2	-0.117671	0.176177	0.270289	0.071844	0.21186	0.715	-0.806
2003.10.22.12.06.24: CH3	-0.11721	0.164022	0.367768	-0.011991	0.201597	0.503	-0.754
2003.10.22.12.06.24: CH4	0.129027	0.579418	5.902675	0.067194	0.59361	4.998	-5.0
2003.10.22.12.06.24:							

```
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	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 10: CH3	-0.116743	0.075809	0.510618	-0.031597	0.139197	0.317	-0.583
Archivo 10: CH4	-0.113397	0.113908	0.598173	0.049803	0.160729	0.544	-0.818
Archivo 10: CH5	-0.113073	0.11779	0.465862	0.009958	0.163279	0.544	-0.72

```
len(file_list)
```

```
2156
```

80 rows × 7 columns

```
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	min
test1: CH0	-0.118469	0.097826	0.879857	-0.039519	0.153639	0.483	-0.688
test1: CH1	-0.119506	0.089263	1.140088	0.090826	0.149163	0.654	-0.654
test1: CH2	-0.11776	0.092779	0.315984	-0.061028	0.149918	0.31	-0.791
test1: CH3	-0.118254	0.07583	0.362793	-0.01728	0.140479	0.234	-0.508
test1: CH4	-0.115443	0.113252	0.568761	0.024861	0.161719	0.461	-0.698
...	...	...	...	...	...	...	...
test1: CH3	-0.116743	0.075809	0.510618	-0.031597	0.139197	0.317	-0.583
test1: CH4	-0.113397	0.113908	0.598173	0.049803	0.160729	0.544	-0.818
test1: CH5	-0.113073	0.11779	0.465862	0.009958	0.163279	0.544	-0.72
test1: CH6	-0.114098	0.071734	0.898533	-0.041657	0.134774	0.249	-0.527
test1: CH7	-0.11251	0.078618	1.374239	0.009803	0.137257	0.398	-0.688

80 rows × 7 columns

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
```

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]
```

```
      20475  -0.142  -0.090   0.059  -0.049  -0.051  -0.010  -0.039   0.022
```

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

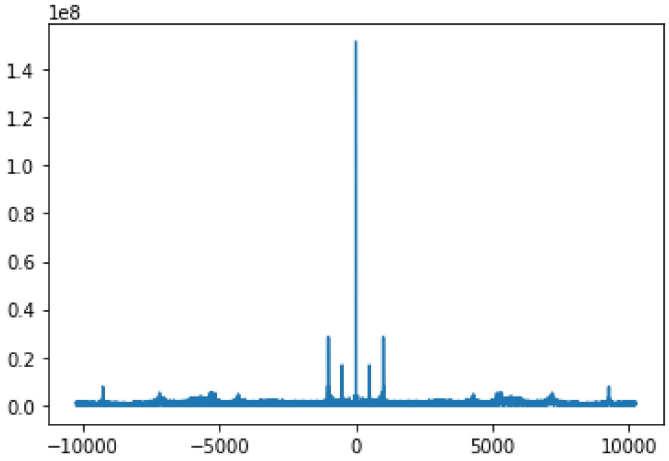
```
bearing3_file0
```

	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
20479	-0.002	-0.342

20480 rows × 2 columns

```
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()
```

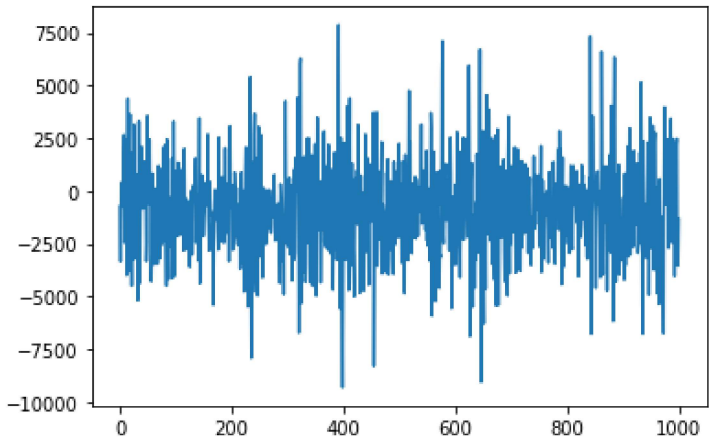


FFT preview for last files

```
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
1	-0.510	0.005
2	0.037	-0.107
3	0.063	-0.205
4	-0.115	0.027

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

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

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

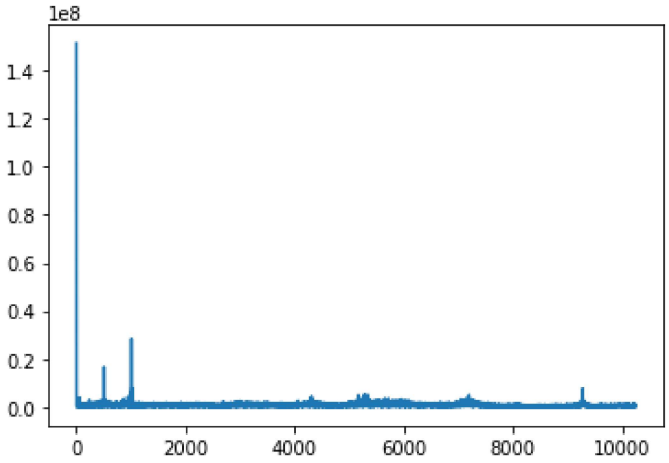



```
SAMPLE_RATE = 20480 # (...).shape[0]
DURATION = 1 # Just 1 file of 1 second



# 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)
```

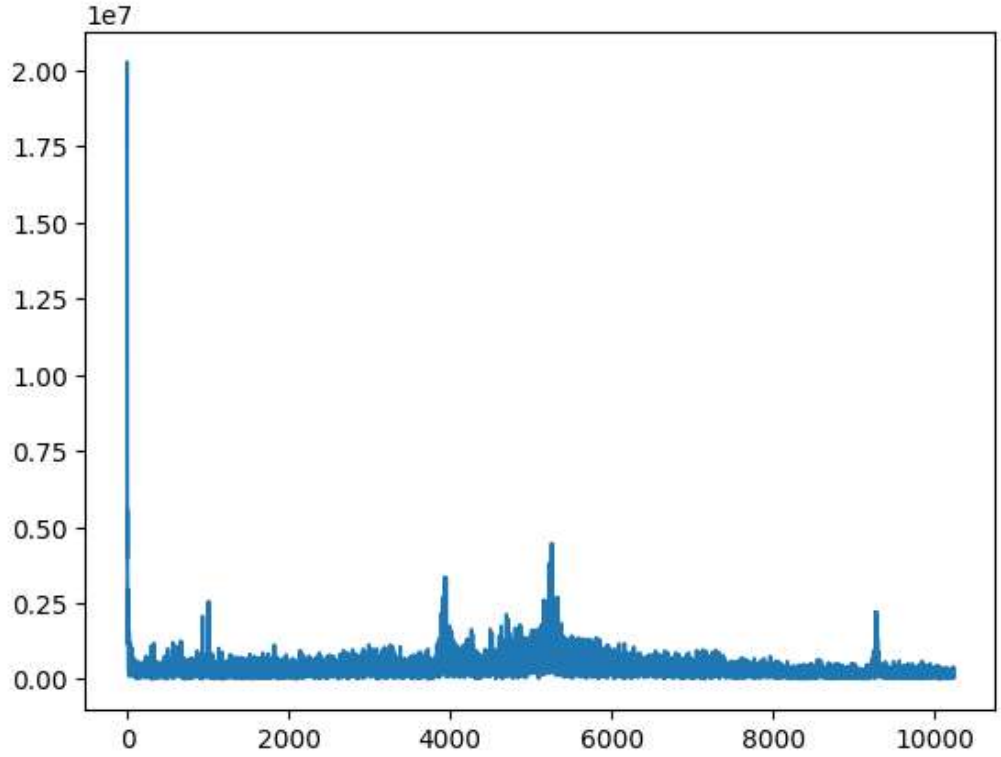
```
np.mean(yf)
```

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

For the Amp Bin () we need a special formula

testing the sample rate

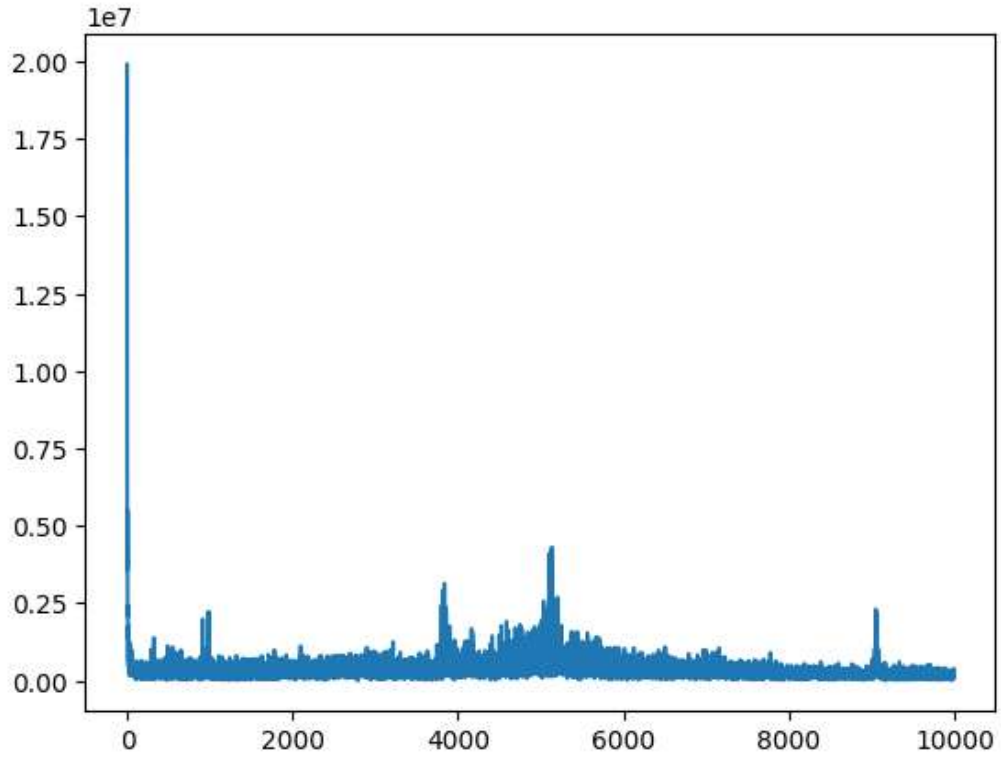
```
df, names = readFiles('/content/drive/MyDrive/Colab Notebooks/TFG/Trasteo/5archivosfinal')
df = df.iloc[0:20480]

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

```
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
6	3.757759e+06
8	3.376593e+06
11	2.419935e+06
3805	2.435778e+06
3827	2.943546e+06
3838	3.124288e+06
3845	2.402536e+06
5039	2.553440e+06
5046	2.308129e+06
5047	2.300294e+06
5093	2.342970e+06
5107	4.108399e+06
5129	2.770287e+06
5136	4.297222e+06
5140	2.900177e+06
5148	2.605604e+06
5181	2.485372e+06
5204	2.683544e+06
5210	2.639702e+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
10000	10000.0

10001 rows × 1 columns