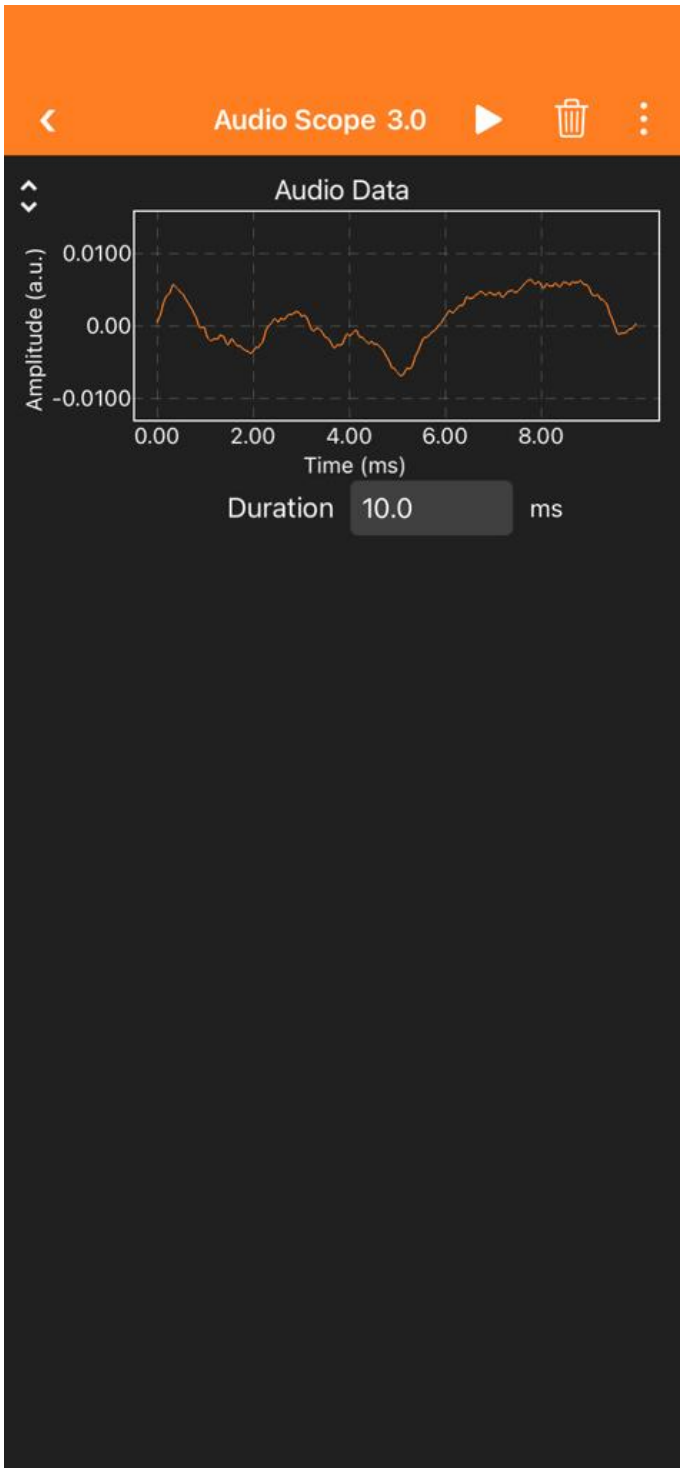
HW 9 Problem 1

For this homework, I have collected some audio data using the phyphox app on iphone. The app has a lot of experimental features , but for this homework, I will work on 2 examples. In this notebook, I will use the " Audio Scope " experiment .

Audio data

First, Using the app I let the app to take the data for around 10 ms. The data plot in the app looks like this :


Audio Scope 3.0
Audio Data
Amplitude (a.u.)
0.0100
0.00
-0.0100
0.00
2.00
4.00
6.00
8.00
Time (ms)
Duration
10.0
ms

From the data is saved in a .csv file which has only 2 column (amplitude an time). From the data I am going to take the fourier transform and sort out the peaks for frequencies. (same as I did in homeowrk 7)

Imports

The necessary imports are given below:

```
import math
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
# %load_ext pycodestyle_magic
# %pycodestyle_on
```

```
df = pd.read_csv('Audio.csv',sep = ";")
df
```

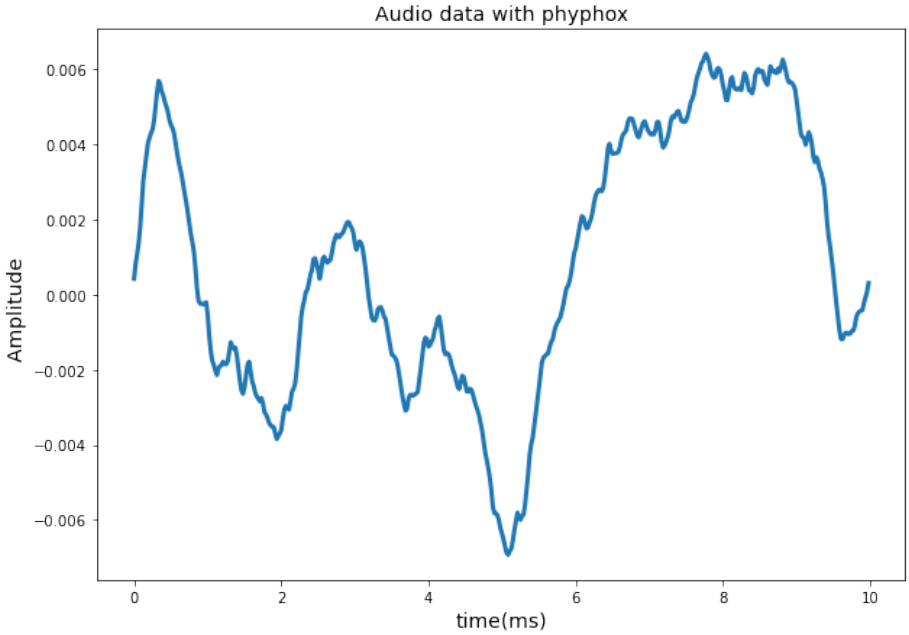
```
     Time (ms)  Recording (a.u.)
0     0.000000          0.000426
1     0.020834          0.000827
2     0.041668          0.001085
3     0.062502          0.001382
4     0.083336          0.001814
..         ...               ...
475   9.896208         -0.000407
476   9.917042         -0.000216
477   9.937876         -0.000071
478   9.958711          0.000077
479   9.979545          0.000308

[480 rows x 2 columns]
```

```
X = df['Time (ms)']
Y = df['Recording (a.u.)']
```

The plot of the data in my jupyter notebook :

```
fig, ax = plt.subplots(figsize=(10,7))
ax.plot(X,Y, lw=3)
ax.set_xlabel('time(ms)',fontsize=14)
ax.set_ylabel('Amplitude ',fontsize=14)
ax.set_title('Audio data with phyphox',fontsize=14)
```

```
Text(0.5, 1.0, 'Audio data with phyphox')
```



So far, Its just the same as the picture above . Now I am going to do some analysis bases on what I have learned so far.

Data analysis

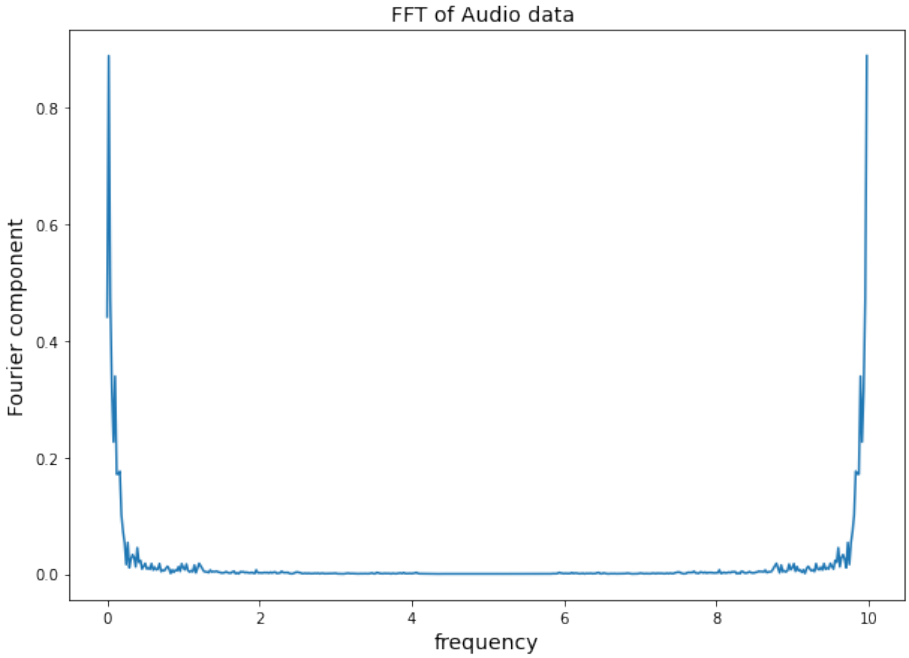
First I am going to take the fourier transfer of the acceleration using numpy fft.

```
from numpy import fft
y = np.fft.fft(Y)
y_abs = abs(y)
print(len(y_abs),len(X))
```

```
480 480
```

```
fig, ax = plt.subplots(figsize=(10,7))
plt.rcParams["figure.dpi"] = 100  # just to have a better view
ax.plot(X, y_abs)
ax.set_xlabel('frequency',fontsize=14)
ax.set_ylabel('Fourier component',fontsize=14)
ax.set_title('FFT of Audio data ',fontsize=14)
```

```
Text(0.5, 1.0, 'FFT of Audio data ')
```

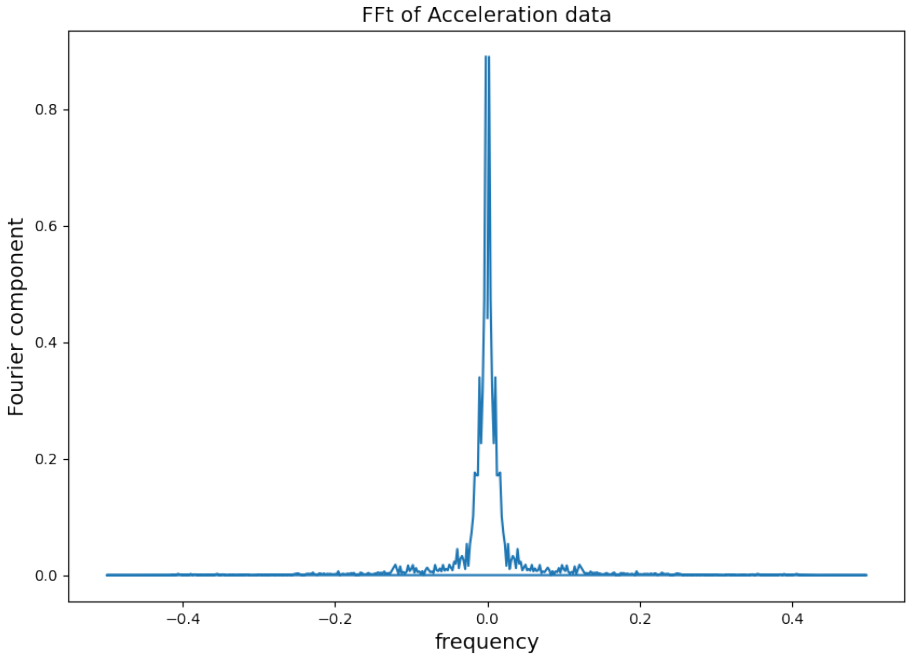


Here, my understanding is that we got storng frequencies between o to 2 and 8 to 10. In between 2 to 8 we have very weak frequencies .

I will use the numpy fftfreq to retrieve the frequencies from the data .

```
freqs = np.fft.fftfreq(len(y_abs))
fig, ax = plt.subplots(figsize=(10,7))
ax.plot(freqs,y_abs)
ax.set_xlabel('frequency',fontsize=14)
ax.set_ylabel('Fourier component',fontsize=14)
ax.set_title('FFt of Acceleration data',fontsize=14)
```

```
Text(0.5, 1.0, 'FFt of Acceleration data')
```



If I want to have a look at the peaks only, I can just sor it out using scipy find peaks.

```
from scipy.signal import find_peaks
peaks, _ = find_peaks(y_abs, height=0)
freqs[peaks]
```

```
array([ 0.00208333,  0.01041667,  0.01666667,  0.02708333,  0.03333333,
        0.03958333,  0.04375   ,  0.05      ,  0.05416667,  0.05833333,
        0.0625    ,  0.06875   ,  0.07291667,  0.07916667,  0.08541667,
        0.08958333,  0.09375   ,  0.09791667,  0.10416667,  0.11041667,
        0.11458333,  0.12083333,  0.13541667,  0.13958333,  0.14375   ,
        0.15625   ,  0.16666667,  0.17083333,  0.175     ,  0.17916667,
        0.18333333,  0.18958333,  0.19583333,  0.20625   ,  0.21041667,
        0.21458333,  0.22083333,  0.22916667,  0.2375    ,  0.25      ,
        0.26041667,  0.26458333,  0.27291667,  0.27708333,  0.28333333,
        0.2875    ,  0.29166667,  0.3       ,  0.30625   ,  0.31666667,
        0.32083333,  0.32916667,  0.33333333,  0.3375    ,  0.34791667,
        0.35416667,  0.36458333,  0.37083333,  0.375     ,  0.38541667,
        0.38958333,  0.39791667,  0.40625   ,  0.41458333,  0.42083333,
        0.42708333,  0.43125   ,  0.4375    ,  0.44166667,  0.44791667,
        0.45625   ,  0.4625    ,  0.47291667,  0.48333333,  0.4875    ,
        0.49375   , -0.5       , -0.49375   , -0.4875    , -0.48333333,
       -0.47291667, -0.4625    , -0.45625   , -0.44791667, -0.44166667,
       -0.4375    , -0.43125   , -0.42708333, -0.42083333, -0.41458333,
```

```
-0.40625   , -0.39791667, -0.38958333, -0.38541667, -0.375     ,
-0.37083333, -0.36458333, -0.35416667, -0.34791667, -0.3375    ,
-0.33333333, -0.32916667, -0.32083333, -0.31666667, -0.30625   ,
-0.3       , -0.29166667, -0.2875    , -0.28333333, -0.27708333,
-0.27291667, -0.26458333, -0.26041667, -0.25      , -0.2375    ,
-0.22916667, -0.22083333, -0.21458333, -0.21041667, -0.20625   ,
-0.19583333, -0.18958333, -0.18333333, -0.17916667, -0.175     ,
-0.17083333, -0.16666667, -0.15625   , -0.14375   , -0.13958333,
-0.13541667, -0.12083333, -0.11458333, -0.11041667, -0.10416667,
-0.09791667, -0.09375   , -0.08958333, -0.08541667, -0.07916667,
-0.07291667, -0.06875   , -0.0625    , -0.05833333, -0.05416667,
-0.05      , -0.04375   , -0.03958333, -0.03333333, -0.02708333,
-0.01666667, -0.01041667])
```

Convert the data analysis to python

I will create a file name audio_fft.py with the following codes (taken from above)

import math import numpy as np import matplotlib.pyplot as plt from numpy import fft

def audio_fft(X,Y):

```
fig, ax = plt.subplots(figsize=(10,7))
ax.plot(X,Y, lw=3)
ax.set_xlabel('time(ms)',fontsize=14)
ax.set_ylabel('Amplitude ',fontsize=14)
ax.set_title('Audio data with phyphox',fontsize=14)
plt.show()
y = np.fft.fft(Y)
y_abs = abs(y)
fig, ax = plt.subplots(figsize=(10,7))
plt.rcParams["figure.dpi"] = 100  # just to have a better view
ax.plot(X, y_abs)
ax.set_xlabel('frequency',fontsize=14)
ax.set_ylabel('Fourier component',fontsize=14)
ax.set_title('FFT of Audio data ',fontsize=14)
plt.show()
freqs = np.fft.fftfreq(len(y_abs))
fig, ax = plt.subplots(figsize=(10,7))
ax.plot(freqs,y_abs)
ax.set_xlabel('frequency',fontsize=14)
ax.set_ylabel('Fourier component',fontsize=14)
ax.set_title('FFt of Acceleration data',fontsize=14)
plt.show()
from scipy.signal import find_peaks
peaks, _ = find_peaks(y_abs, height=0)
```

```
return freqs[peaks]
```

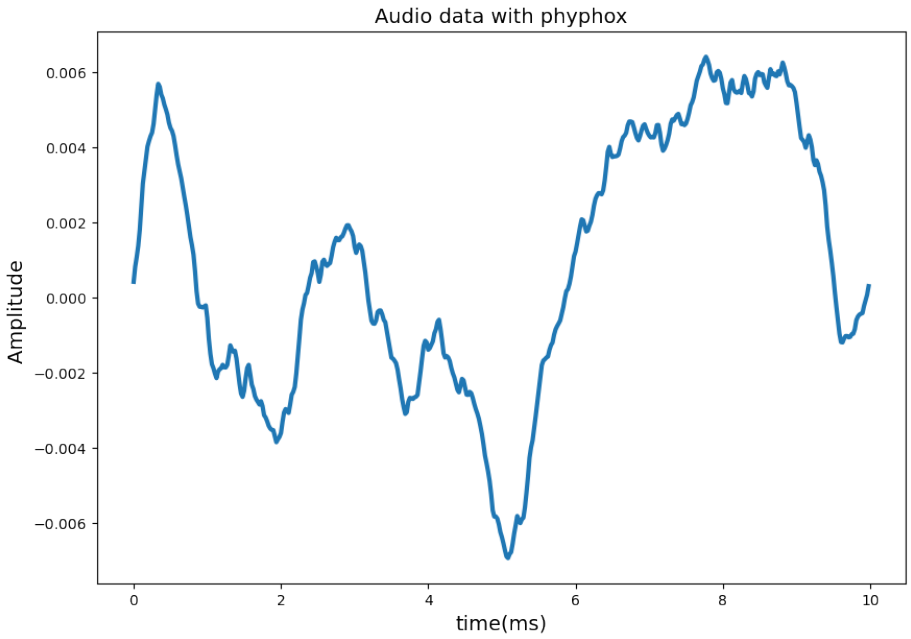
No we can call this python program to produce all of the result above . But we will have to provide tha values for x and y , which we already have listed above.

Checking the python file : Lets import the audio.py

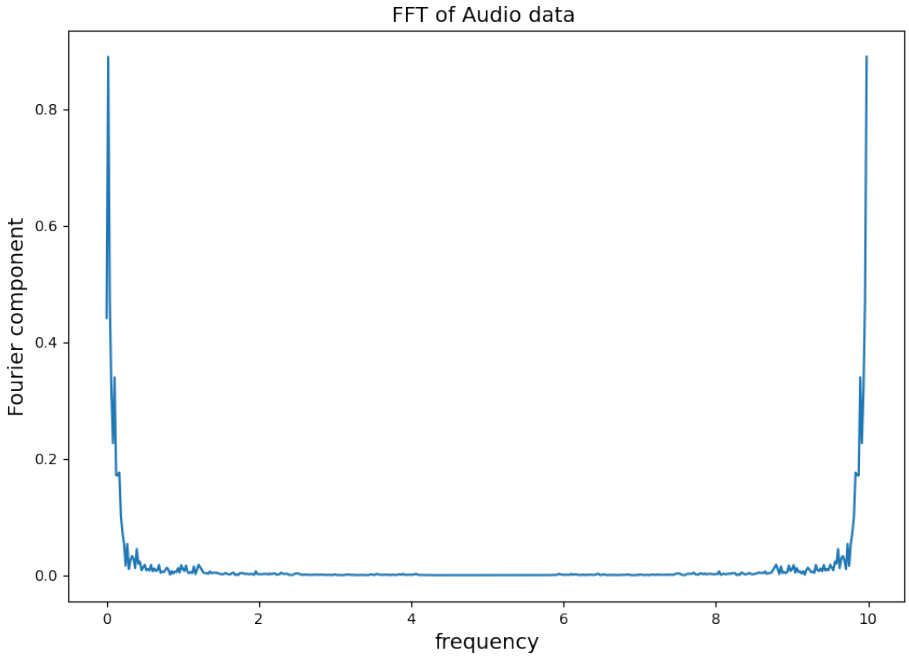
```
import audio_fft
```

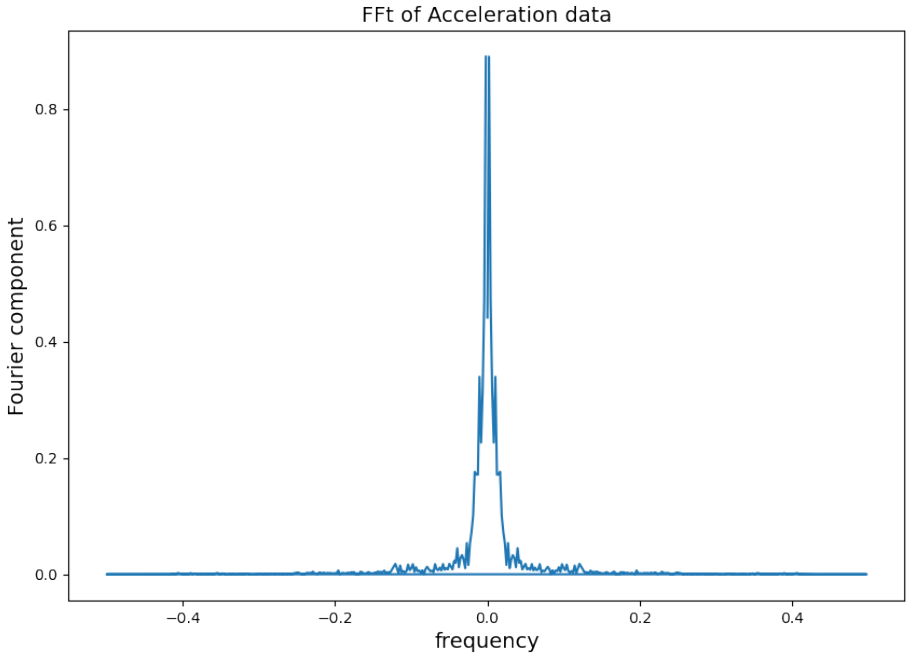
No I am going to call the function "audio_fft" with the values fo X and Y

```
audio_fft.audio_fft(X,Y)
```




```
480 480
```






```
array([ 0.00208333,  0.01041667,  0.01666667,  0.02708333,  0.03333333,
        0.03958333,  0.04375   ,  0.05      ,  0.05416667,  0.05833333,
```

```
 0.0625    ,  0.06875   ,  0.07291667,  0.07916667,  0.08541667,
 0.08958333,  0.09375   ,  0.09791667,  0.10416667,  0.11041667,
 0.11458333,  0.12083333,  0.13541667,  0.13958333,  0.14375   ,
 0.15625   ,  0.16666667,  0.17083333,  0.175     ,  0.17916667,
 0.18333333,  0.18958333,  0.19583333,  0.20625   ,  0.21041667,
 0.21458333,  0.22083333,  0.22916667,  0.2375    ,  0.25      ,
 0.26041667,  0.26458333,  0.27291667,  0.27708333,  0.28333333,
 0.2875    ,  0.29166667,  0.3       ,  0.30625   ,  0.31666667,
 0.32083333,  0.32916667,  0.33333333,  0.3375    ,  0.34791667,
 0.35416667,  0.36458333,  0.37083333,  0.375     ,  0.38541667,
 0.38958333,  0.39791667,  0.40625   ,  0.41458333,  0.42083333,
 0.42708333,  0.43125   ,  0.4375    ,  0.44166667,  0.44791667,
 0.45625   ,  0.4625    ,  0.47291667,  0.48333333,  0.4875    ,
 0.49375   , -0.5       , -0.49375   , -0.4875    , -0.48333333,
-0.47291667, -0.4625    , -0.45625   , -0.44791667, -0.44166667,
-0.4375    , -0.43125   , -0.42708333, -0.42083333, -0.41458333,
-0.40625   , -0.39791667, -0.38958333, -0.38541667, -0.375     ,
-0.37083333, -0.36458333, -0.35416667, -0.34791667, -0.3375    ,
-0.33333333, -0.32916667, -0.32083333, -0.31666667, -0.30625   ,
-0.3       , -0.29166667, -0.2875    , -0.28333333, -0.27708333,
-0.27291667, -0.26458333, -0.26041667, -0.25      , -0.2375    ,
-0.22916667, -0.22083333, -0.21458333, -0.21041667, -0.20625   ,
-0.19583333, -0.18958333, -0.18333333, -0.17916667, -0.175     ,
-0.17083333, -0.16666667, -0.15625   , -0.14375   , -0.13958333,
-0.13541667, -0.12083333, -0.11458333, -0.11041667, -0.10416667,
-0.09791667, -0.09375   , -0.08958333, -0.08541667, -0.07916667,
-0.07291667, -0.06875   , -0.0625    , -0.05833333, -0.05416667,
-0.05      , -0.04375   , -0.03958333, -0.03333333, -0.02708333,
-0.01666667, -0.01041667])
```

I am not sure how to get rid of some of this low frequencies . It could have been nice if I could do so.