Using Fourier Analysis to Classify Running Water Noise

New Mexico

Supercomputing Challenge

Final Report

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In our world, there are noises and sounds everywhere. Noise comes from many objects such as the voice of a person, the fans running in the AC, or the taps of a computer keyboard. From all these sources, more of these seem static and have no clear sound. Some examples could be the waterfall from a cliff, the waves of the beach, or the running water from a faucet. Each contains different frequencies and wavelengths that can be classified into several categories. My goal is to identify what noise is produced from specific sources, running water. Using various methods, I will create a program that will analyze a sound file of running water. The program will then assist me in classifying the sound file. The results of the program have been fruitful. The program provided the expected result, assisting me in classifying a diverse selection of sources.

There are several classifications of noise in our world. Each noise is classified based on its frequencies. Each noise contains a different amount of frequencies from high to low frequencies. One well-known classification is white noise. An example of white noise is the static that comes from tv. Running water provides a static source of noise, a collection of frequencies. Did I question, what type of noise is produced from these sources?

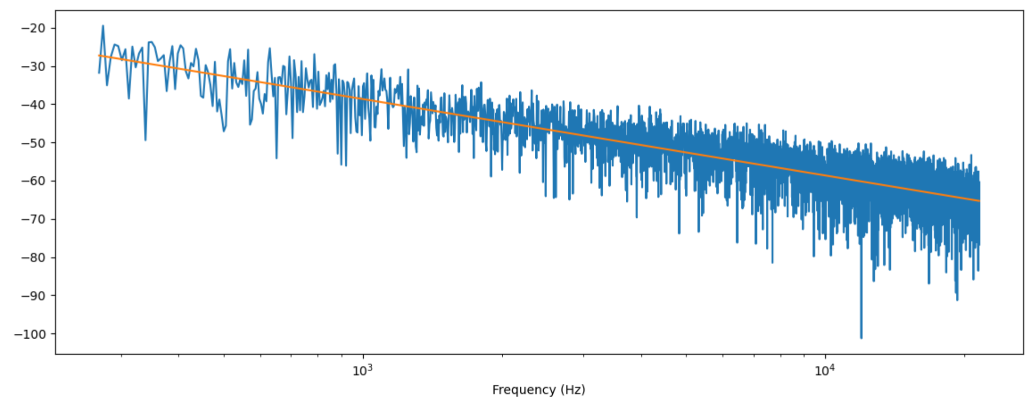
To solve my problem, I used a program to analyze the sound file and create a spectrogram of the found file. Yet, how would I have the program gain data from a sound file and provided a spectrogram using it? With the help of my mentor, I discovered a method used to create spectrograms. The program would use a Fourier transform to gather data from the sound file. After the program analyzed the sound file, we compared the data from the program to other data provided online. First, we grabbed spectrograms and sound files of the classifications of noise to use. Next, we compared the spectrograms collected from our program and those we gathered from the internet. We're able to confirm if the program worked if the data collected from the code match those from the internet. After much debugging, we were able to confirm that the models provided were correct.

The results of the study were unexpected from our initial predictions. There are many different classifications of noise. From the lowest to highest collections of frequencies go from brown noise, blue noise, white noise, pink noise, violet noise. We predicted that most of the sound files would be pink noise due to the general high pitch that comes from running water. But, during the process, close to half of the sound files outputted as blue noise. We noticed a pattern between the collection of sound files. Half of the sound files we used came from sources within a house, a man-made construct. Examples could be the running water from a faucet of a sink or bathtub. Most of the sound files collected from man-made sources resulted in blue noise. Few of the sound files were classified as either brown or white noise. In comparison, most of the sound files of running water from natural sources outputted as pink noise.

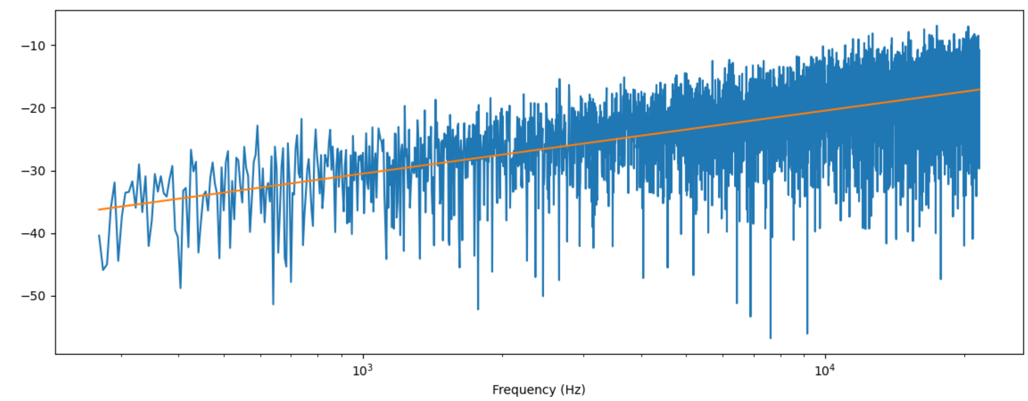
While there was some variation of the results, a clear pattern was discovered. We concluded that within the classifications, running water from man-made sources is more likely blue noise and running water from natural sources is more likely pink noise. Also, we identified that blue and pink noise is the most common noise produced from running water.

*Note: Not all spectrograms are available as there is a lot of data to present.

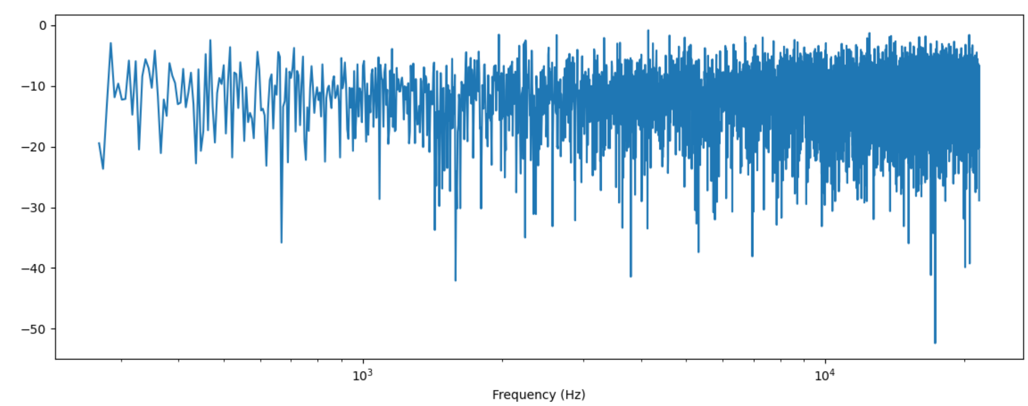
Brown Noise:



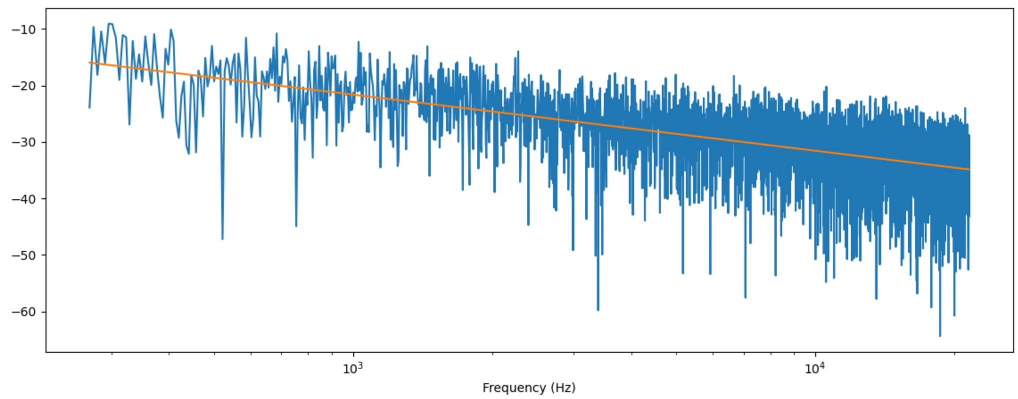
Blue Noise:



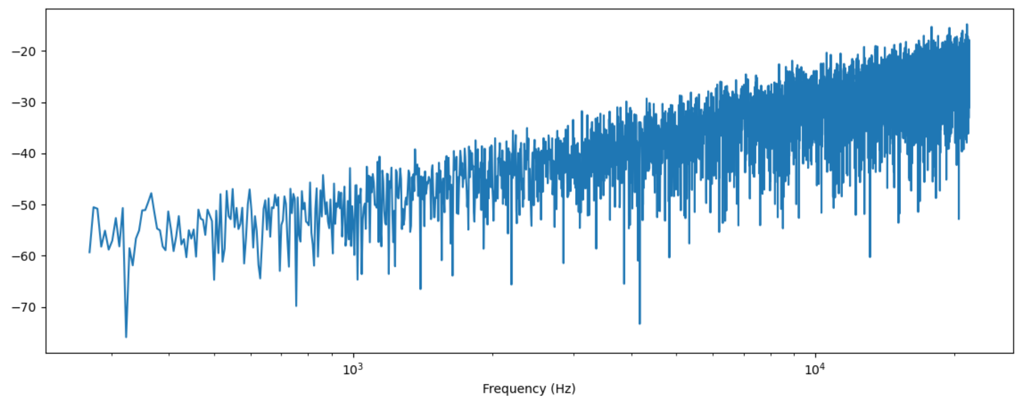
White Noise:



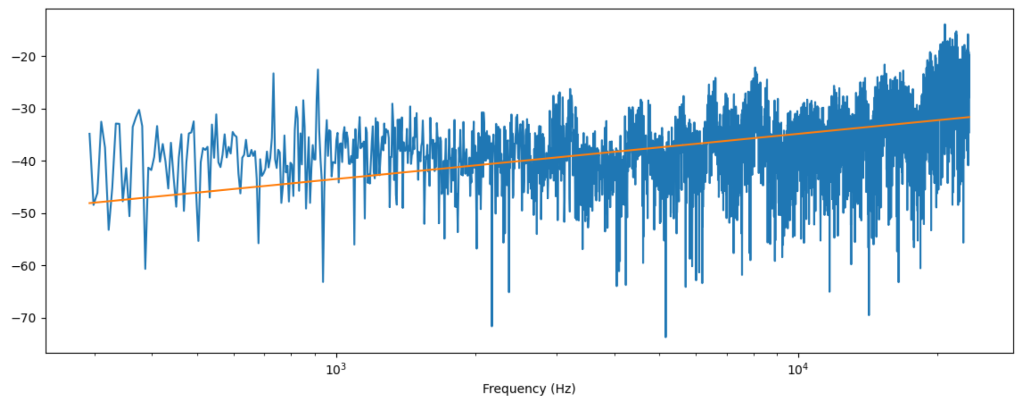
Pink Noise:



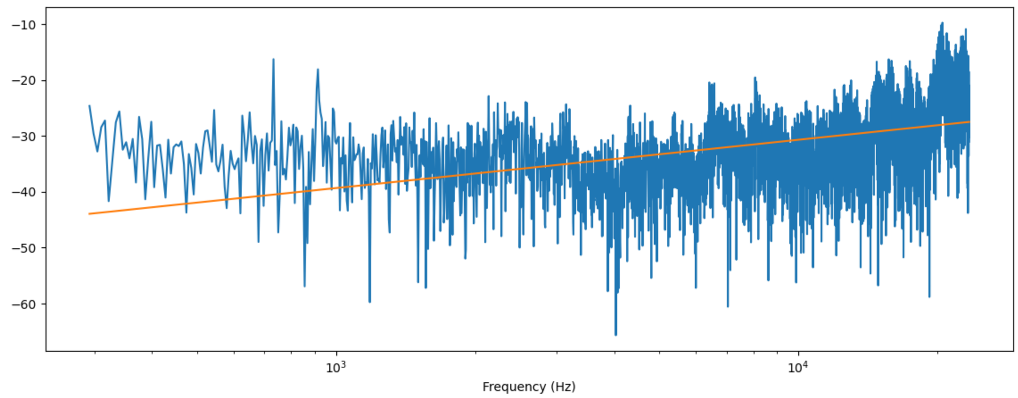
Violet Noise:



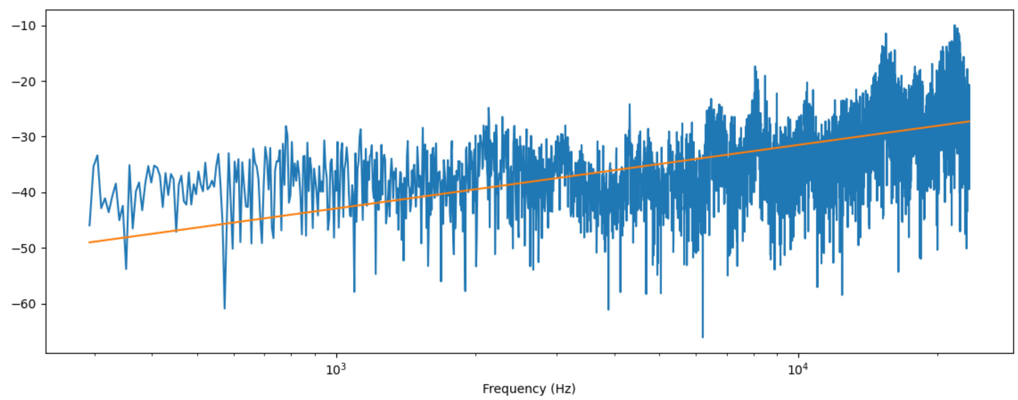
Water Sound #1-1:



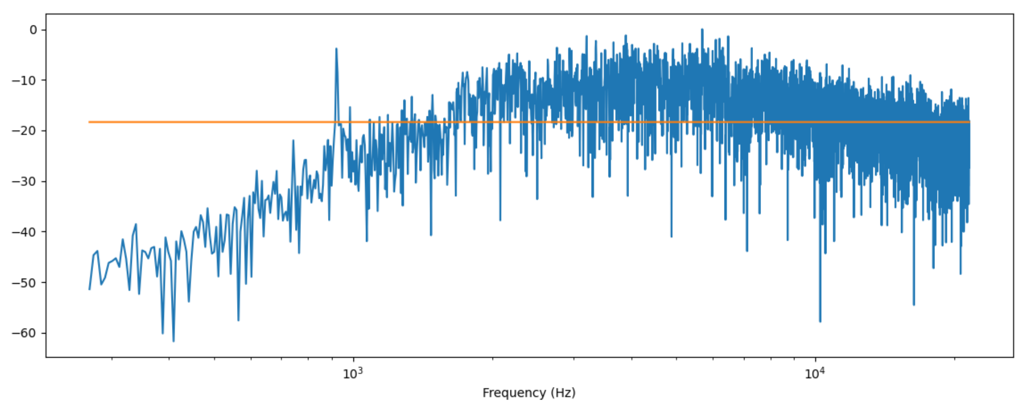
Water Sound #1-2:



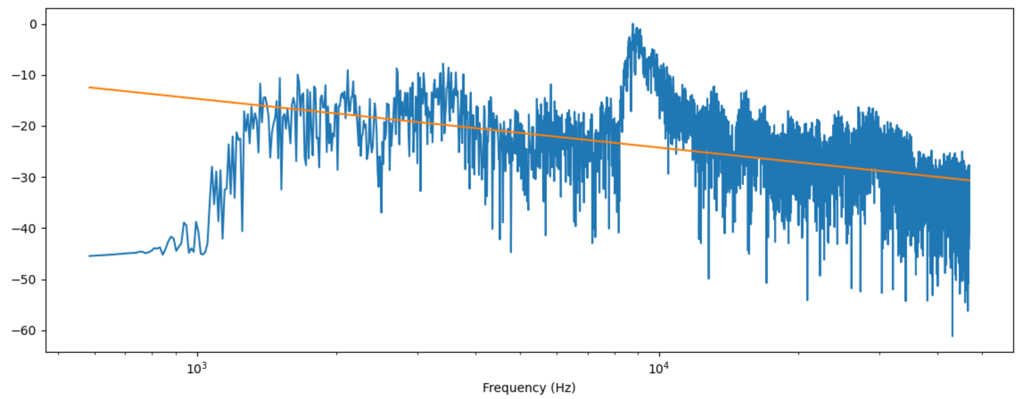
Water Sound #1-3:



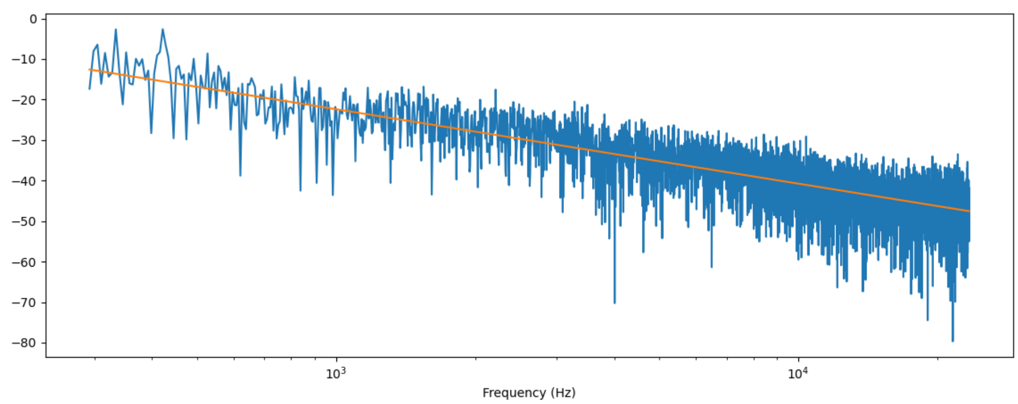
Lakeshore Waves:



Frozen Stream:



Creek Falls:



[Spreadsheet of Data]

[Spectrograms]

The greatest achievement of the project was when we were able to successfully use the Fourier transform to gather data from the sound files. Initially, it was difficult to understand how the Fourier transform is used to gather data from the sound file. After much research, I was able to understand the basic concept of the Fourier transform and how to use the data gathered properly. It was very rewarding to finally manage to use the Fourier transform properly as it was an essential part of the program.

I would like to acknowledge my teachers who helped me organize myself in this competition, Irina Cislaru and Barbara Teterycz.

I would like to acknowledge my mentors who helped me learn and research the various parts of the projects I needed to know, Mohit Dubey and Maximo S. Lazo.