Audio Visualization Using Python with DSP

By Bowen Qin

1 DSP

Digital signal processing (DSP) is the use of digital processing. DSP applications include audio and speech processing, sonar, radar and other sensor array processing, spectral density estimation, statistical signal processing, digital image processing, data compression, video coding, audio coding, image compression, signal processing for telecommunications, control systems, biomedical engineering, and seismology, among others. In this report, I will using DSP to convert a .wav audio file into a waveform picture.

2 Imported Libraries

2.1 Wave

The wave module provides a convenient interface to the WAV sound format. It does not support compression/decompression, but it does support mono/stereo. I used wave.open(file) to read the file, which return a Wave_read object. Then I used Wave_read.getnframes() to get the number of audio frames.

2.2 Numpy

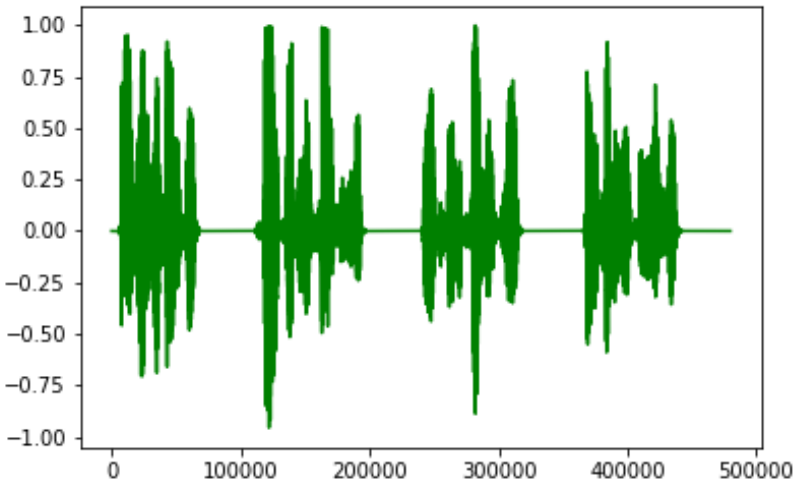
NumPy is the fundamental package for scientific computing with Python. It contains a powerful N-dimensional array object, sophisticated (broadcasting) functions, tools for integrating C/C++ and Fortran code, useful linear algebra, Fourier transform, and random number capabilities. I used numpy.frombuffer to process the data of audio frames, which will initialize a new 1-D array from input data for future convenience in calculation. By using numpy array, I can easily divide all number by the maximum to get data ranging from -1 to 1.

2.3 Matplotlib

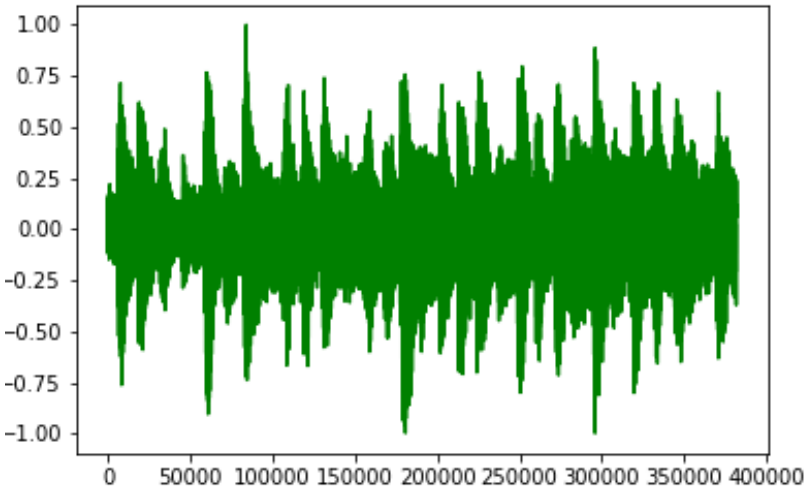
Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and IPython shells, the Jupyter notebook, web application servers, and four graphical user interface toolkits. I mainly used matplotlib.pyplot which is a state-based interface to matplotlib that provides a MATLAB-like way of plotting. By using its matplotlib.pyplot .plot, matplotlib.pyplot .savefig and matplotlib.pyplot .show function, I got the final waveform picture.

3 Waveform Visualization

This is the waveform of a sound recording of reading poems. Without listening to the sound file, we can vaguely find out the poem read in the sound recoding have 4 paragraphs from the waveform picture since there are 3 pauses between 4 taking periods.



This is the waveform of a sound recording of piano performance. Without listening to the audio file, we can vaguely surmise that this piano performance is relatively soft from the waveform picture because most part of spectrum are between -0.4 to 0.4.



4 Conclusion

To put it in a nutshell, one can retrieve information by converting the movement of objects into a series of digital signal, which is the meaning of DSP.

In this report, I simulated the basic process of visualize audio, which can be applied to sound recognition, audio compression, audio restoration, and other audio areas.

DSP also plays a significant role in image analysis, video coding, sonar, radar, and other areas. The application of digital computation to signal processing allows for many advantages over analog processing in many applications.

5 References

[1] https://docs.python.org/3/library/wave.html
[2] https://numpy.org/
[3] https://matplotlib.org/
[4] https://matplotlib.org/3.1.1/api/_as_gen/matplotlib.pyplot.html