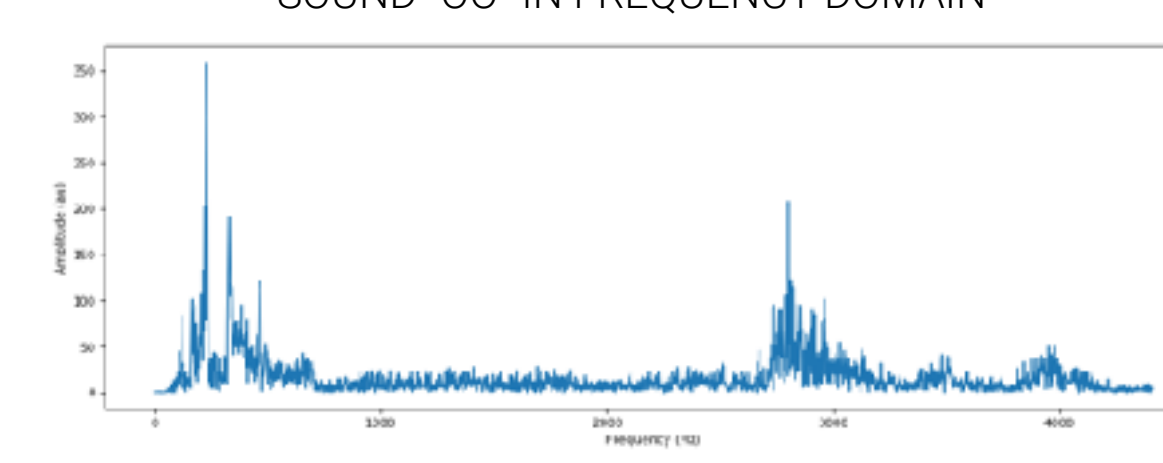
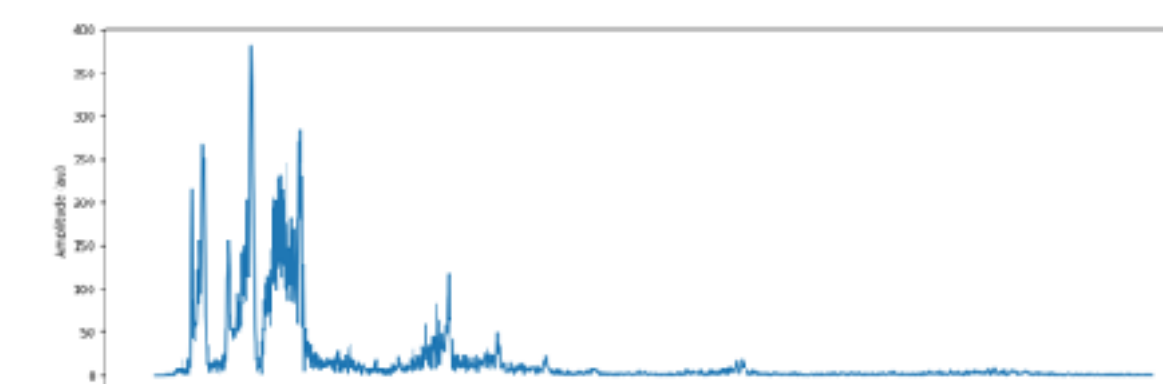


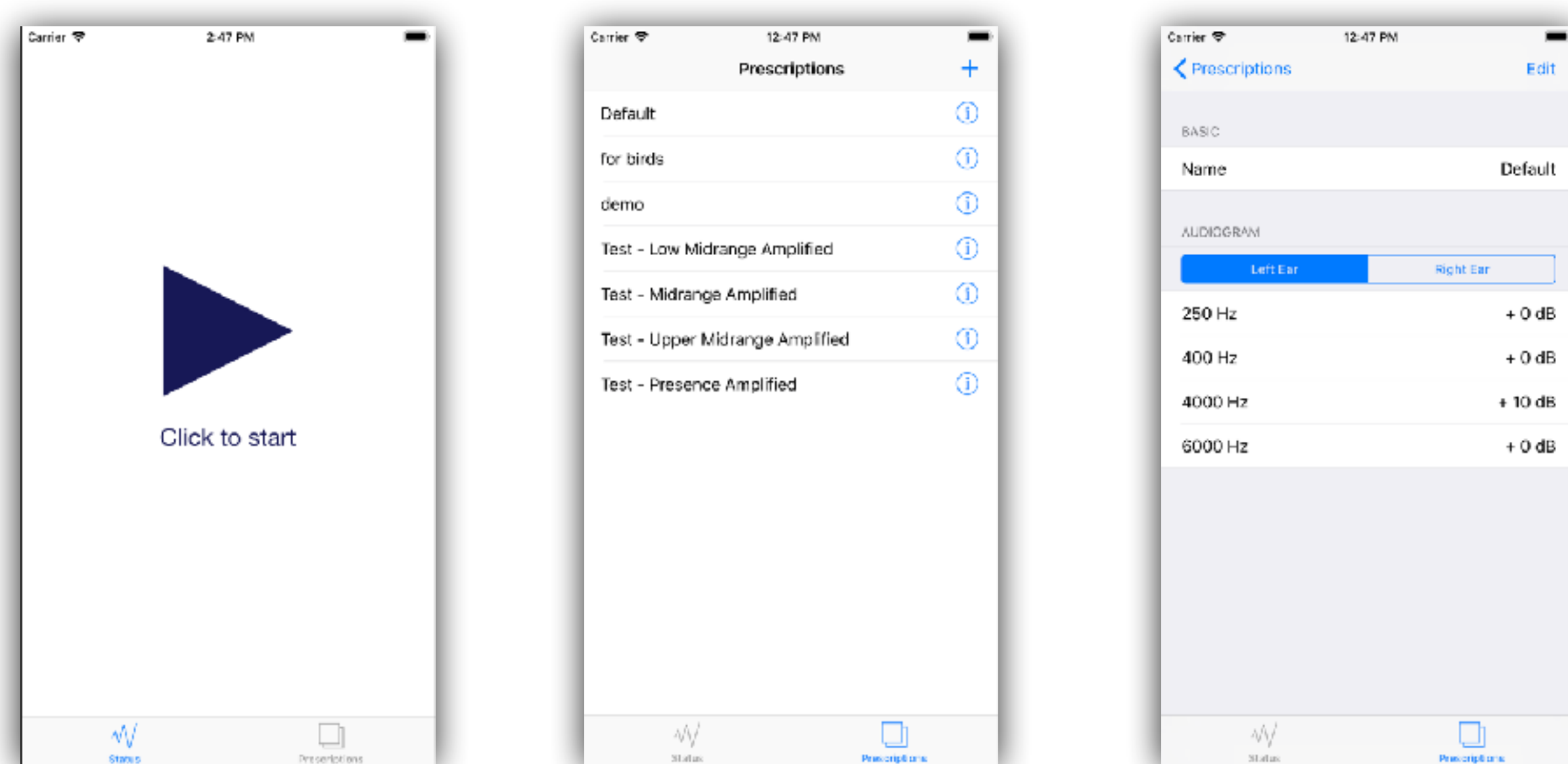
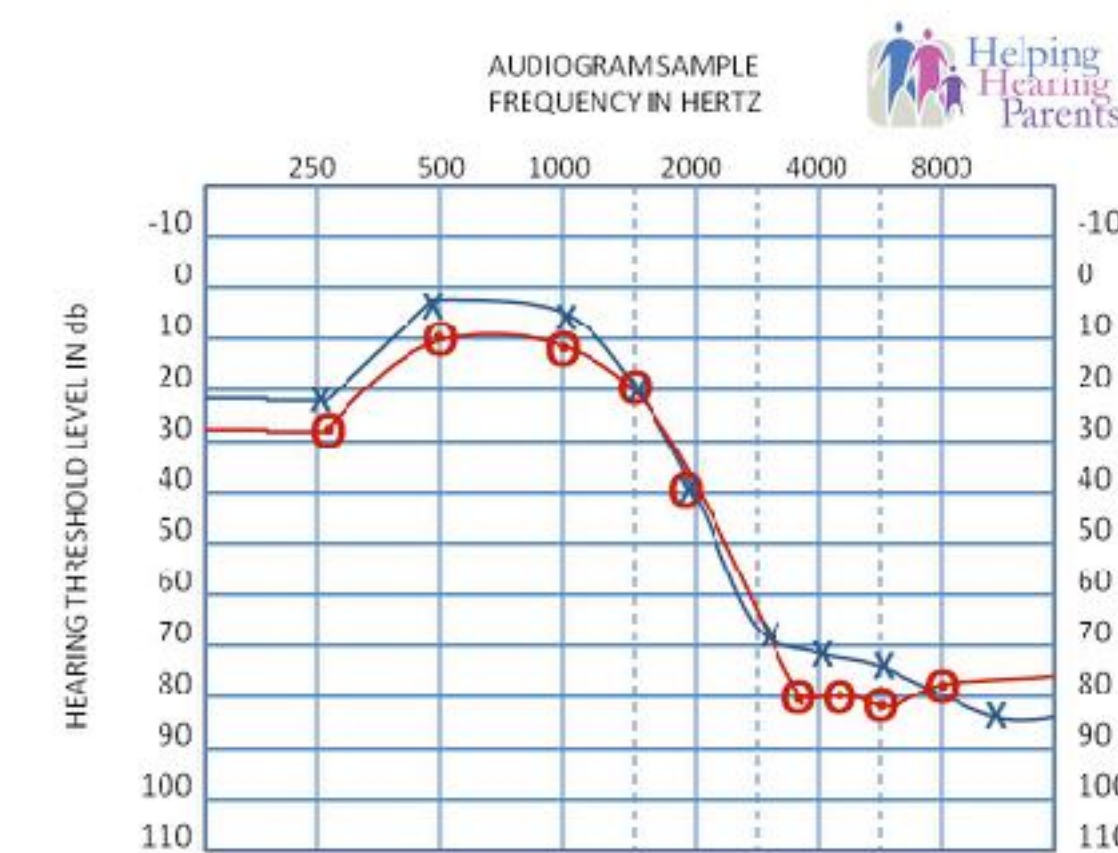
Problem - Decreased Audibility

- The hearing impaired have a difficulty picking up sound at certain frequencies.
- For example, a patient with trouble hearing above 3,000 Hz cannot distinguish the sounds "oo" and "ee" easily.



Solution - Selective Amplification

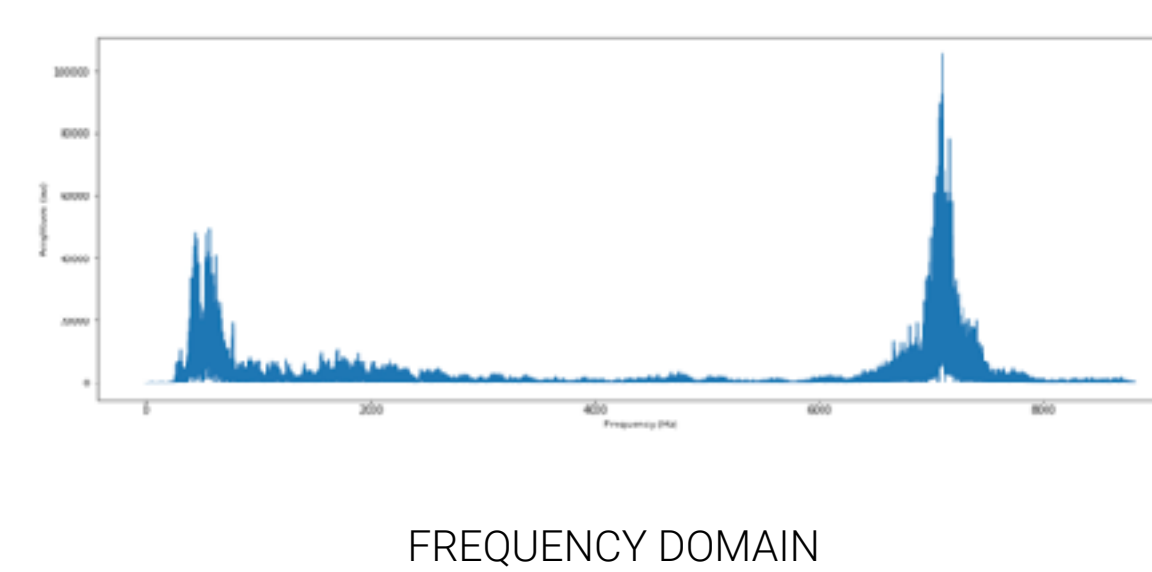
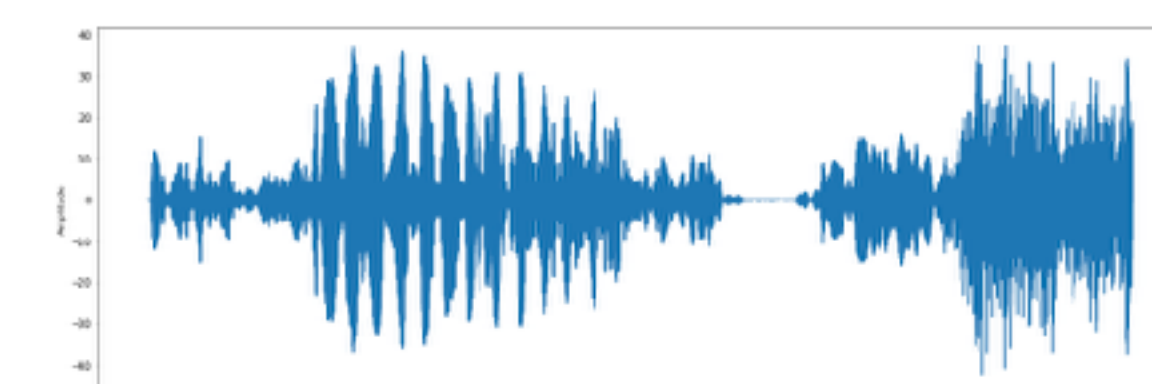
- Doctors prescribe audiograms similar to the one on the right.
- From this graph, Distinct Sound can estimate the amount of amplification a patient needs at any frequency.



DISTINCT SOUND USER INTERFACE

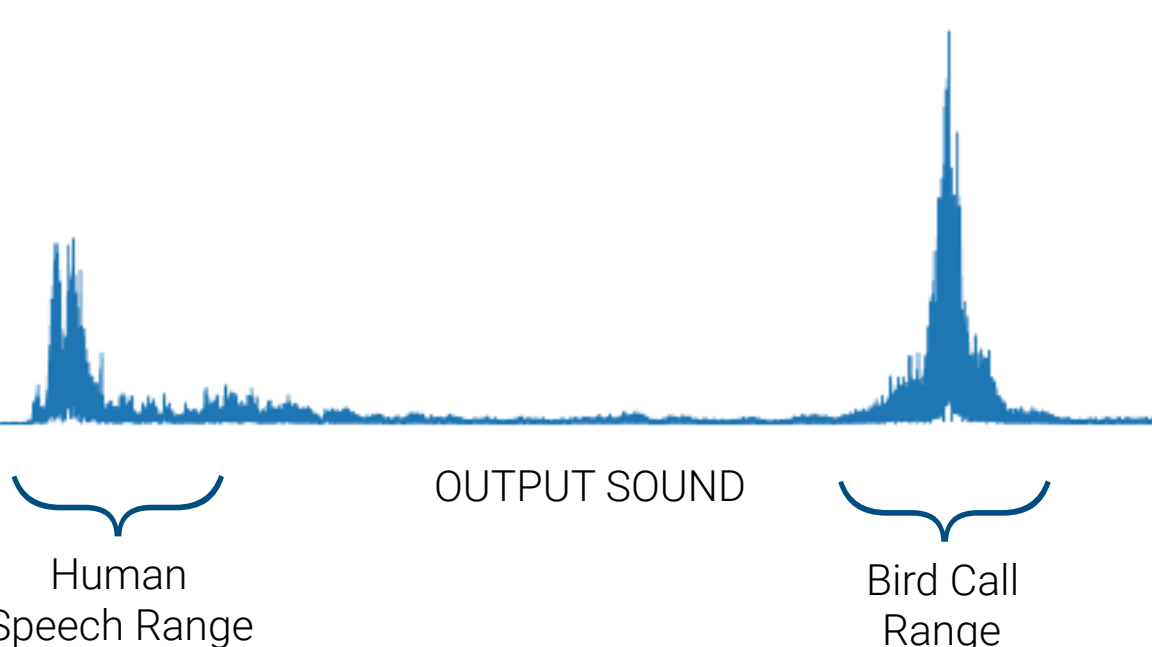
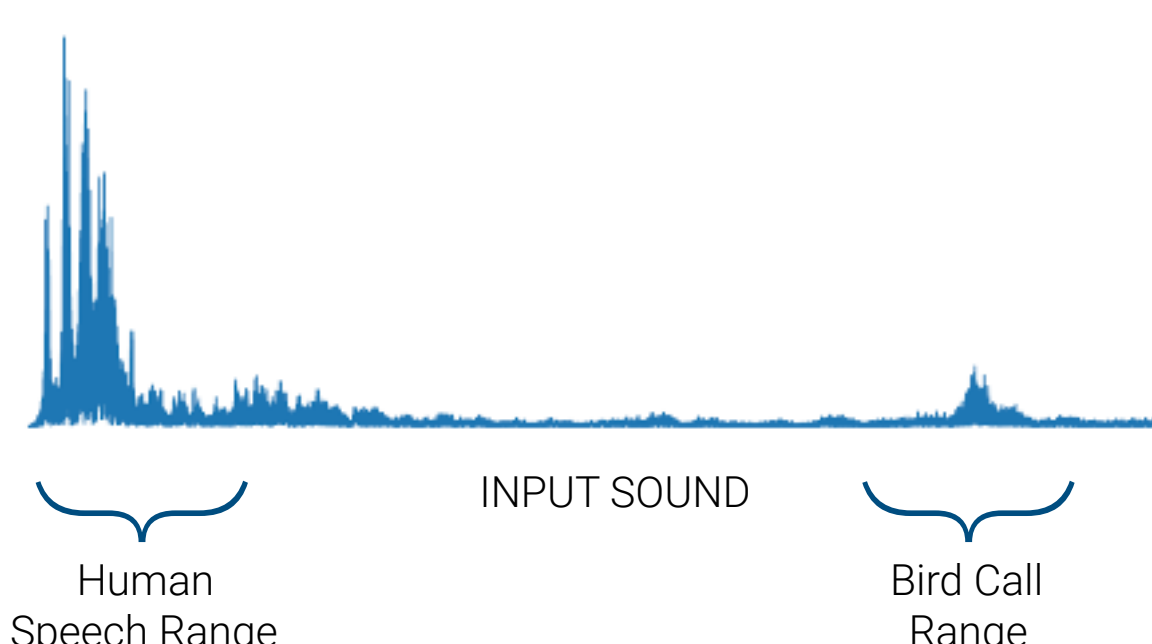
Audio Representation

- Sound is air vibrating, and we hear sound at different frequencies.
- The iPhone perceives sound as air pressure measurements. The iPhone 7 can measure 48,000 samples per second.
- Fast Fourier Transform (FFT) converts the measurements from time domain to frequency domain.



Amplification

- A flat amplification of all frequencies can irritate a patient.
- Distinct Sound amplifies according to an input prescription and normalizes the amplitude across the entire frequency domain.

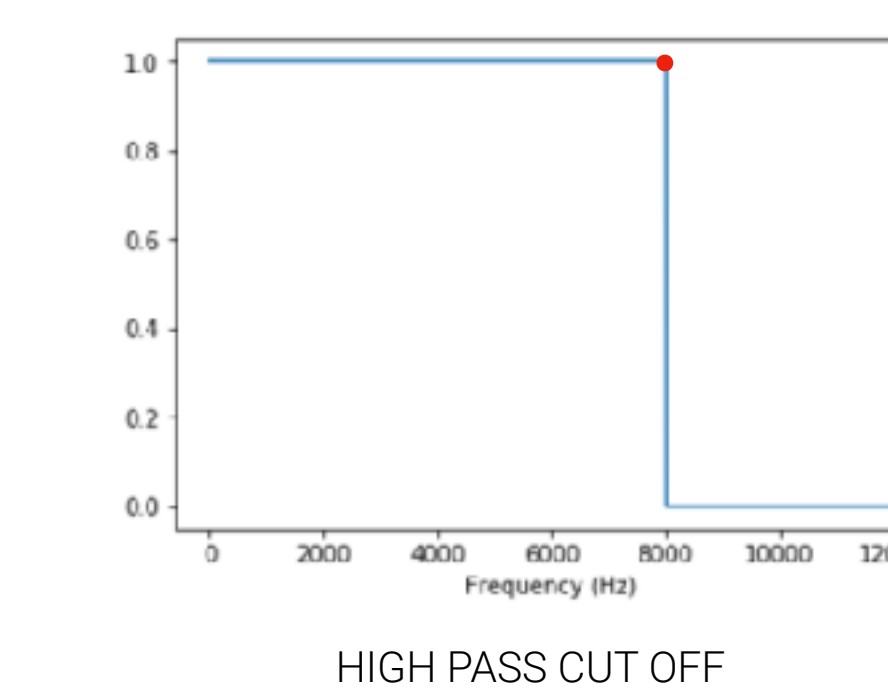
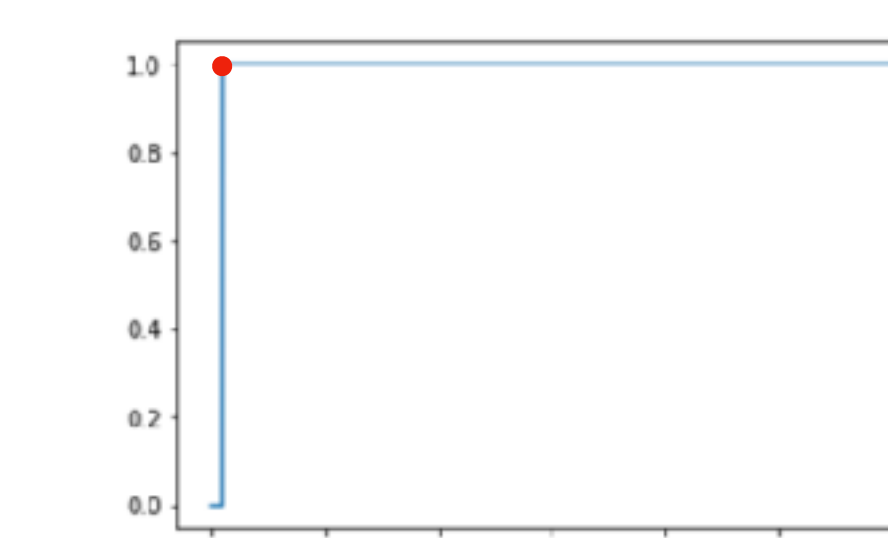


Example

- Input: Human speech with bird chirping (9,000 Hz) in the background.
- Output: Human speech proportionally softened and bird chirping amplified.

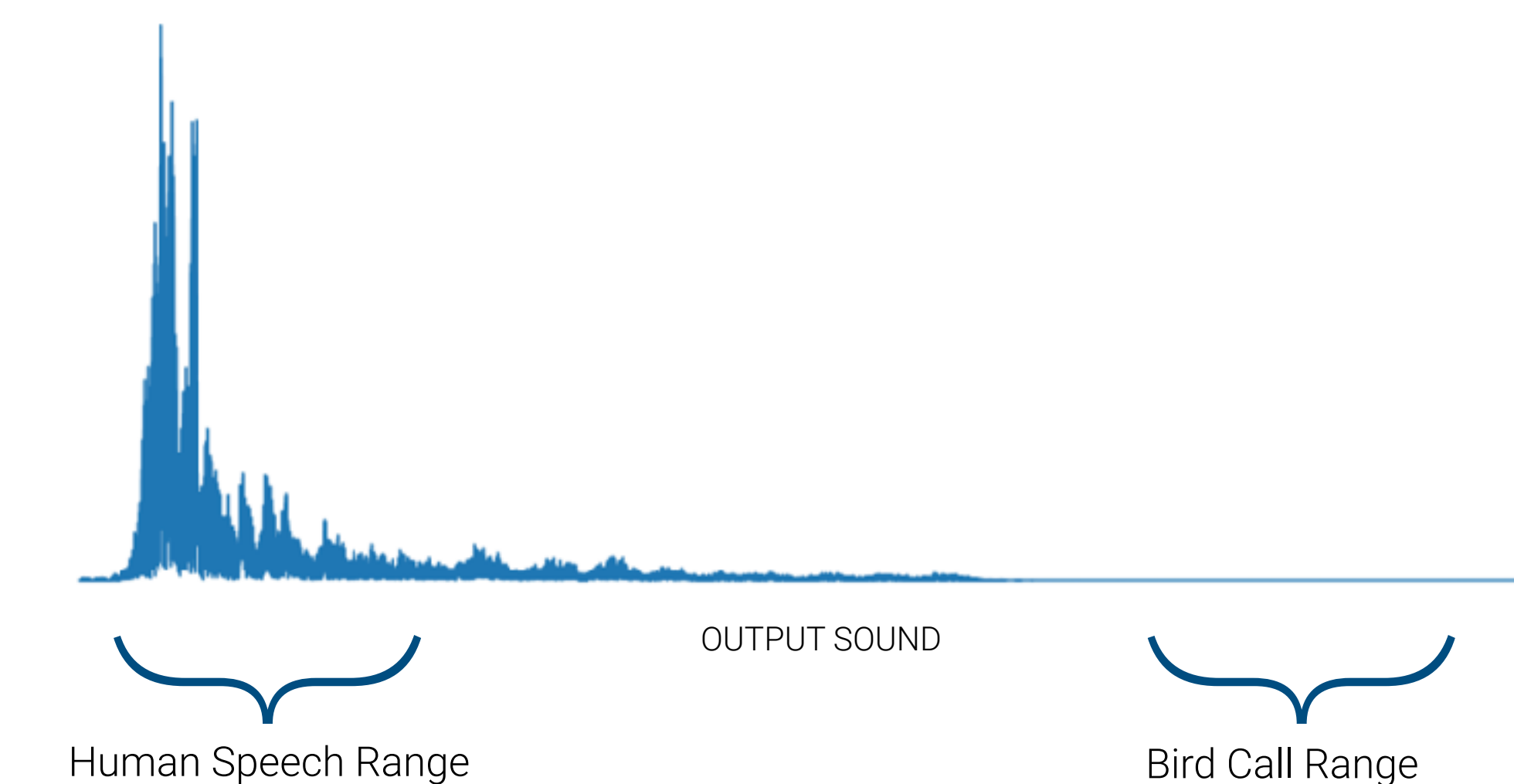
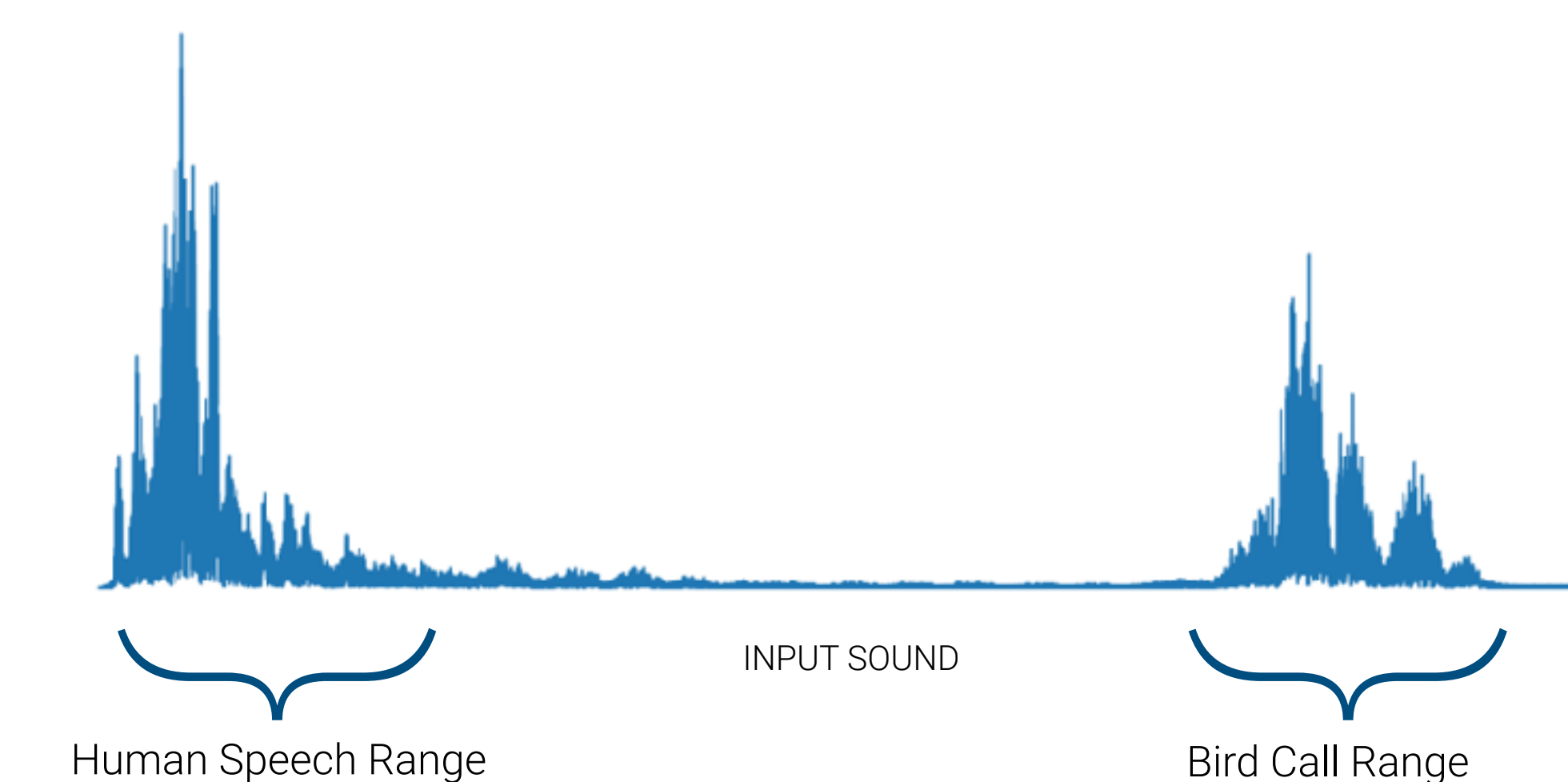
Noise Filtering

- All sound has a certain level of unwanted background noise.
- Distinct Sound uses high pass and low pass filters.
- A filter will remove all sound above (and/or below) a defined cut off point.



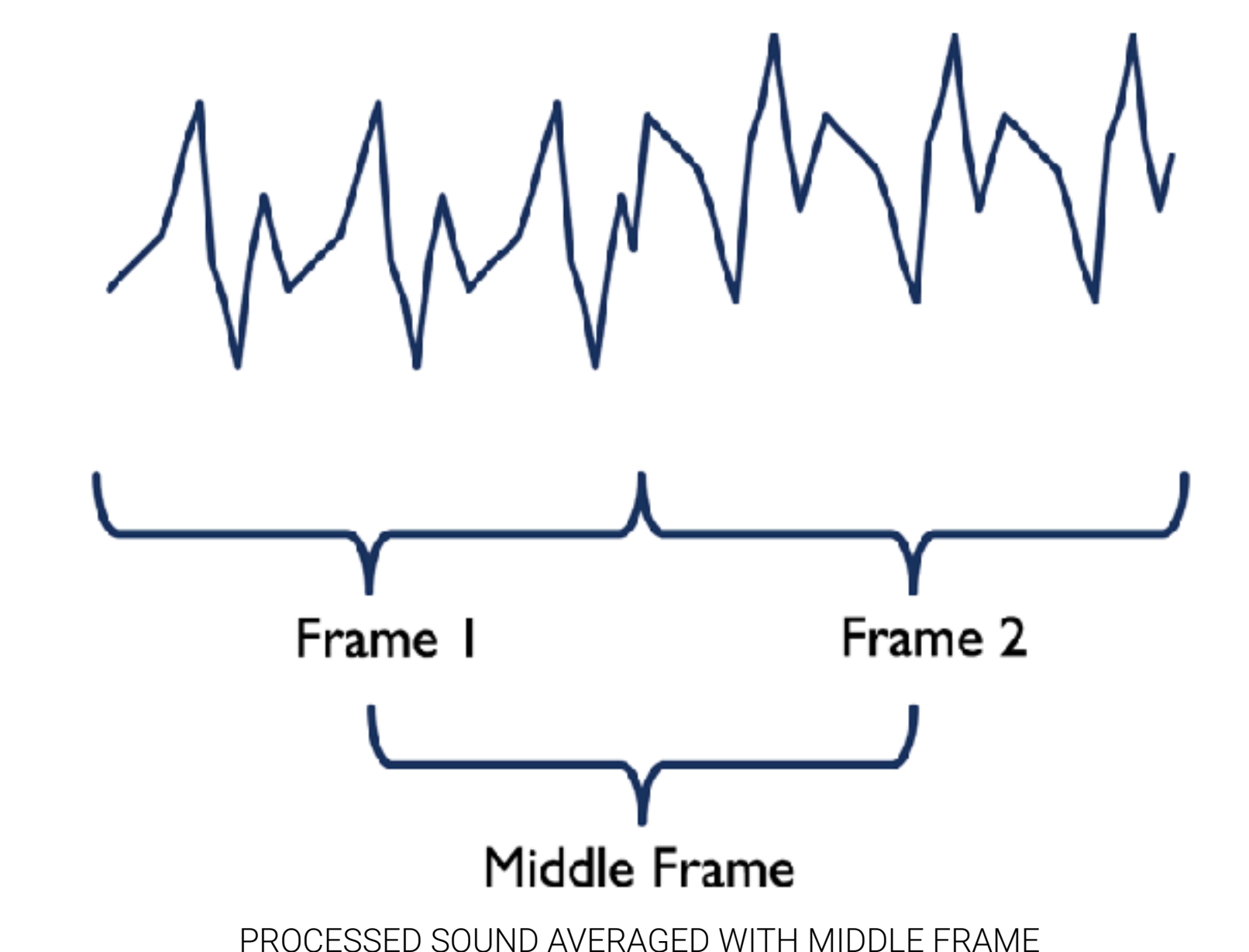
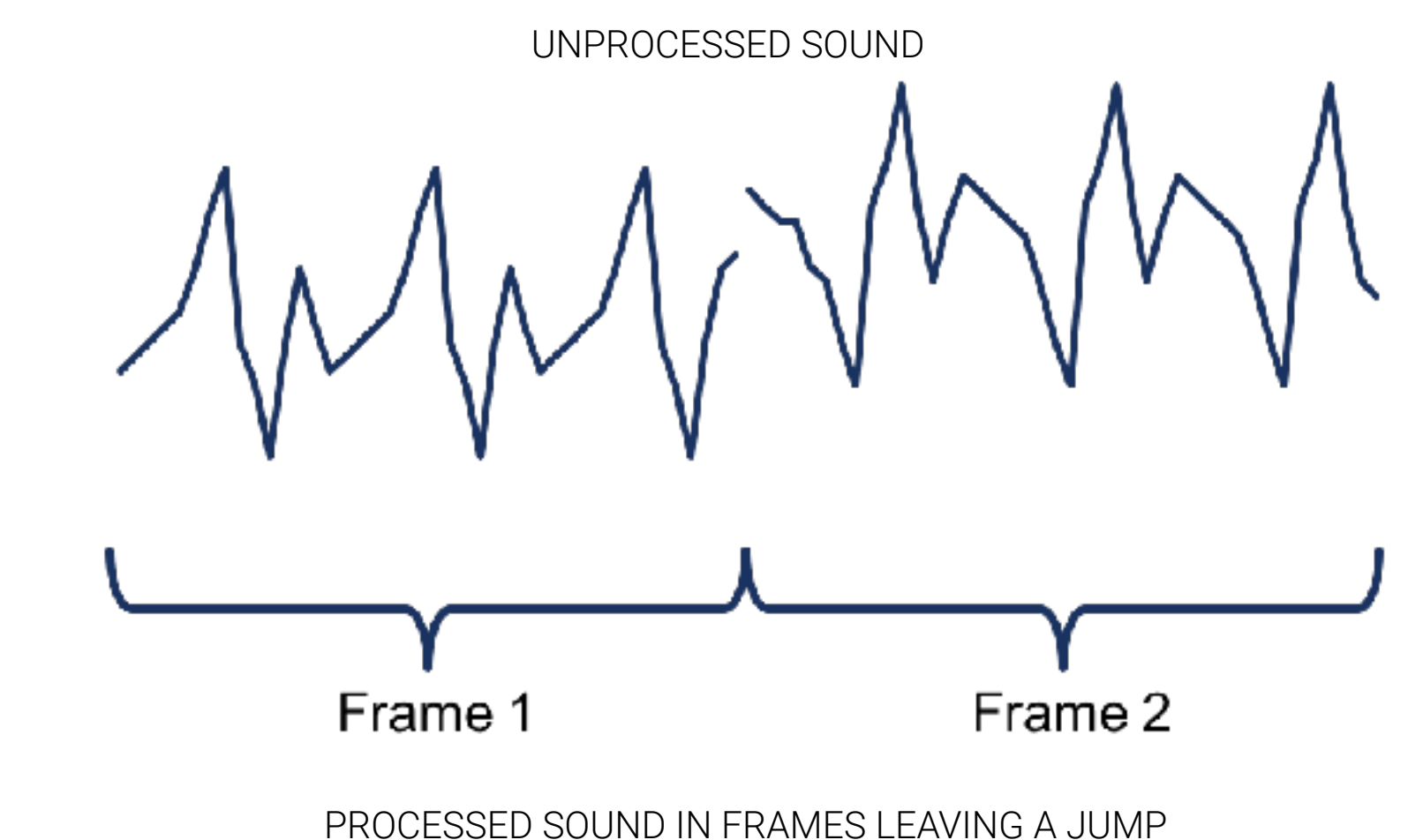
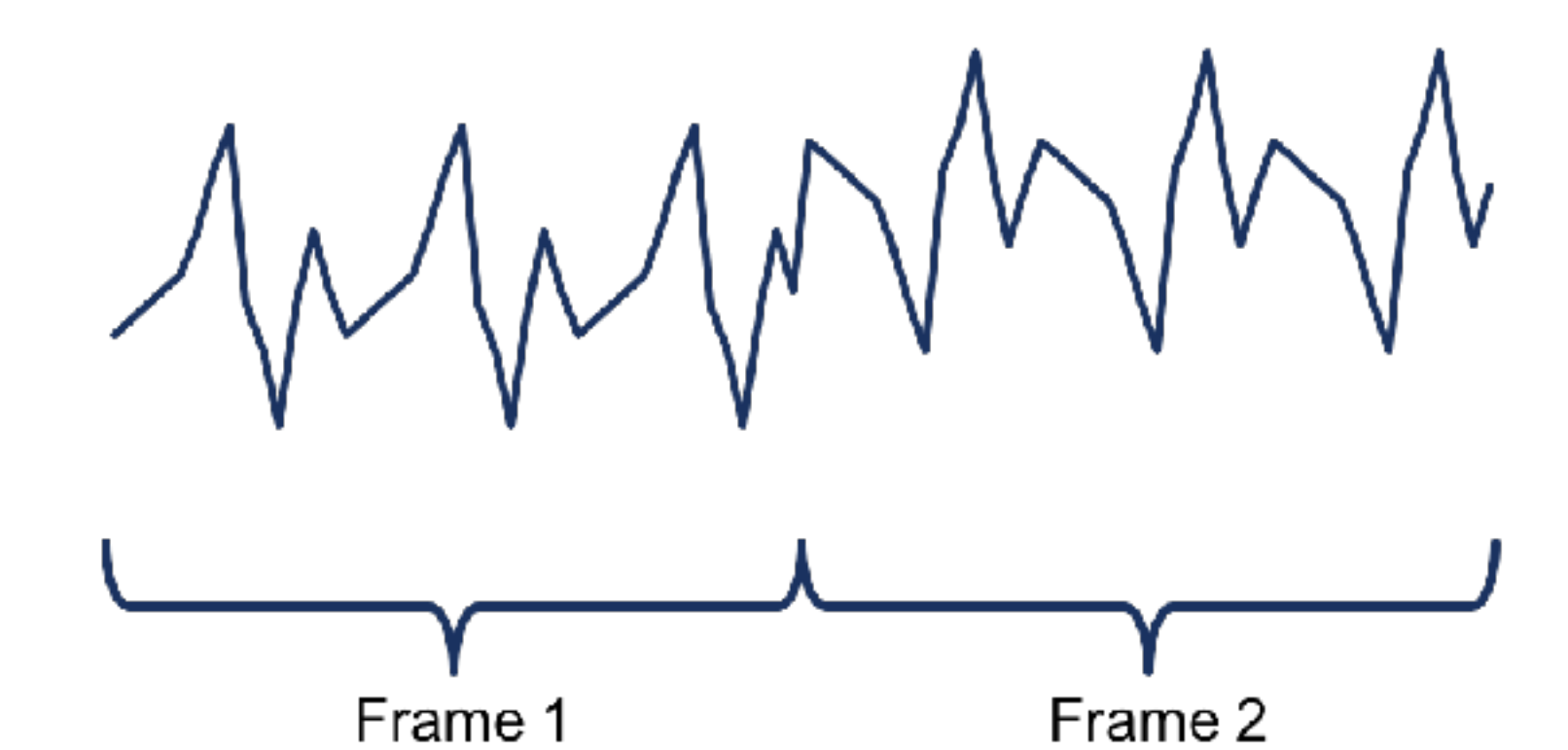
Example

- Input: Human speech with bird chirping (9,000 Hz) in the background.
- Output: Distinct Sound's output through a low pass filter with a cut off point of 8,000 Hz.



Partition of Unity

- Processing sound in real time creates jumps between each processing frame.
- Distinct Sound smooths out the jumps with Partition of Unity by processing a middle frame and averaging that frame into the resulting sound.



Conclusions and Future Work

- Distinct Sound amplifies sound and filters out a tunable range of noise.
- Through unit testing and point by point comparison, we verified the sound manipulating functionalities of the application.
- The application is ready for clinical trial.
- Distinct Sound will be able to help communities where access to audiologists or traditional hearing aids are limited.

Technologies Used



Swift is the native language for iOS development.



Jupyter Notebook is our testing and visualizing environment.



Python is the native language of Jupyter Notebooks.



XCode is the IDE developed by Apple for Swift.

References

- Audiogram Information:** <http://helpinghearingparents.com/communication-information/audiograms-an-explanation-on-interpretation/>
- Swift Information:** <https://developer.apple.com/swift/>
- Jupyter Notebook:** <https://jupyter-notebook.readthedocs.io/en/stable/>

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- Dr. Liran Ma** for advising the team throughout the project and giving us an interesting and challenging project.
 - Dr. Ken Richardson** for guiding the team on mathematical concepts behind sound processing.
 - Dr. Lisa Ball** for intensively supervising the team throughout the year.