Pitch Shifting

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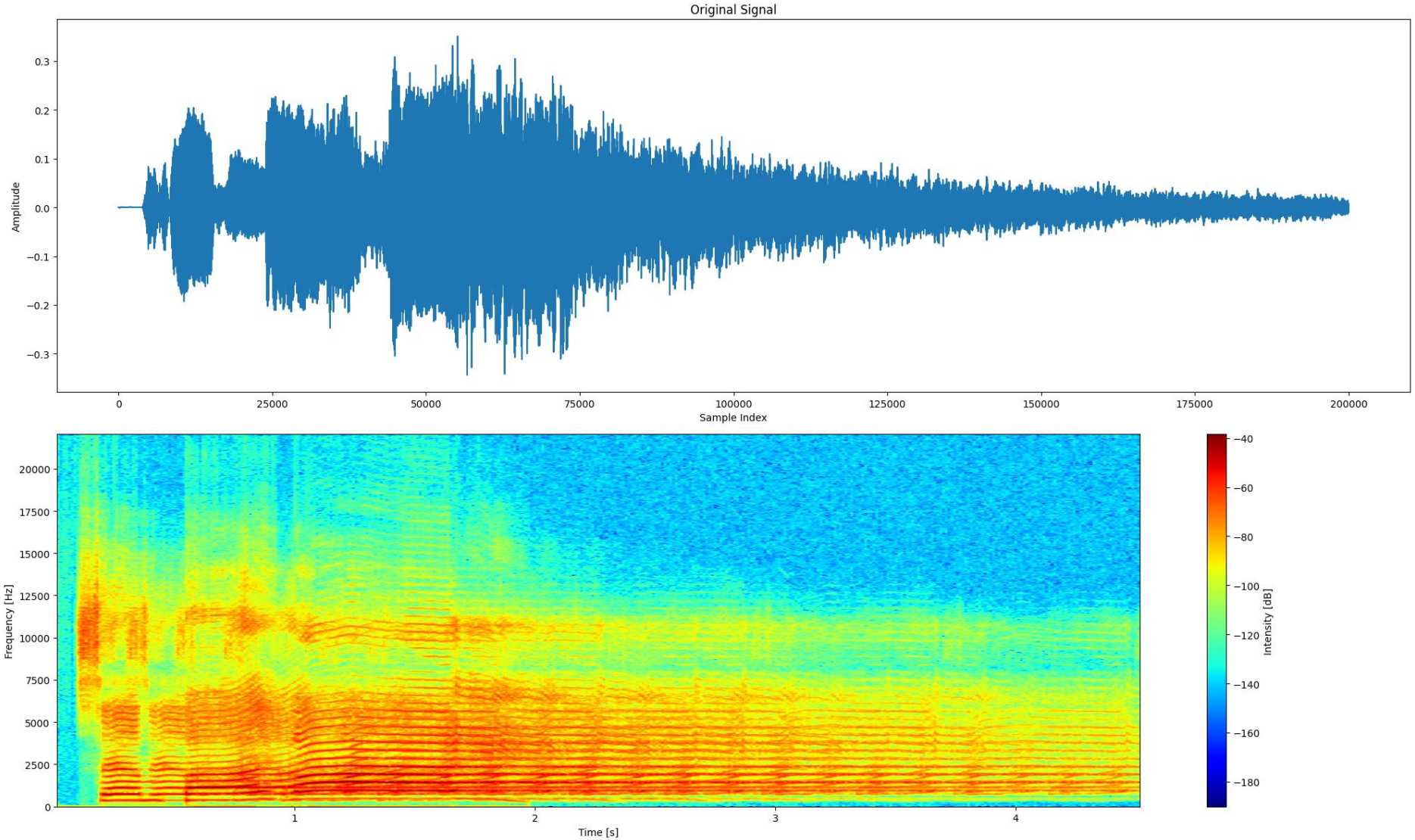
Motivation

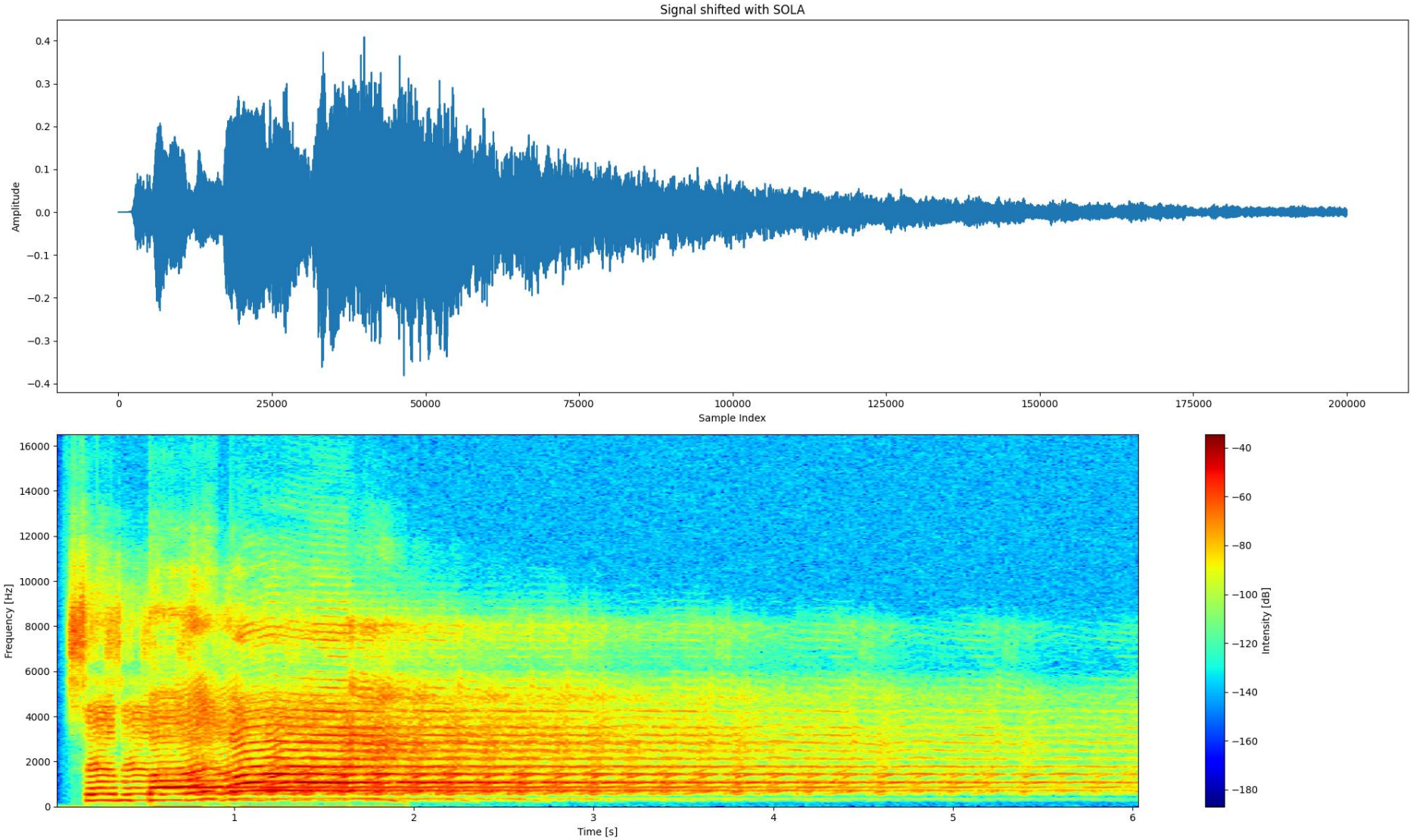
- Implement a basic pitch-shifting algorithm that maintains audio quality and is computationally efficient.
- Compare the audio quality with different pitch shifting techniques.
- Compared techniques:
  - Change of sampling frequency
  - Synchronized Overlap-Add (SOLA)
  - Phase Vocoder
  - Librosa Vocoder

Original Audio



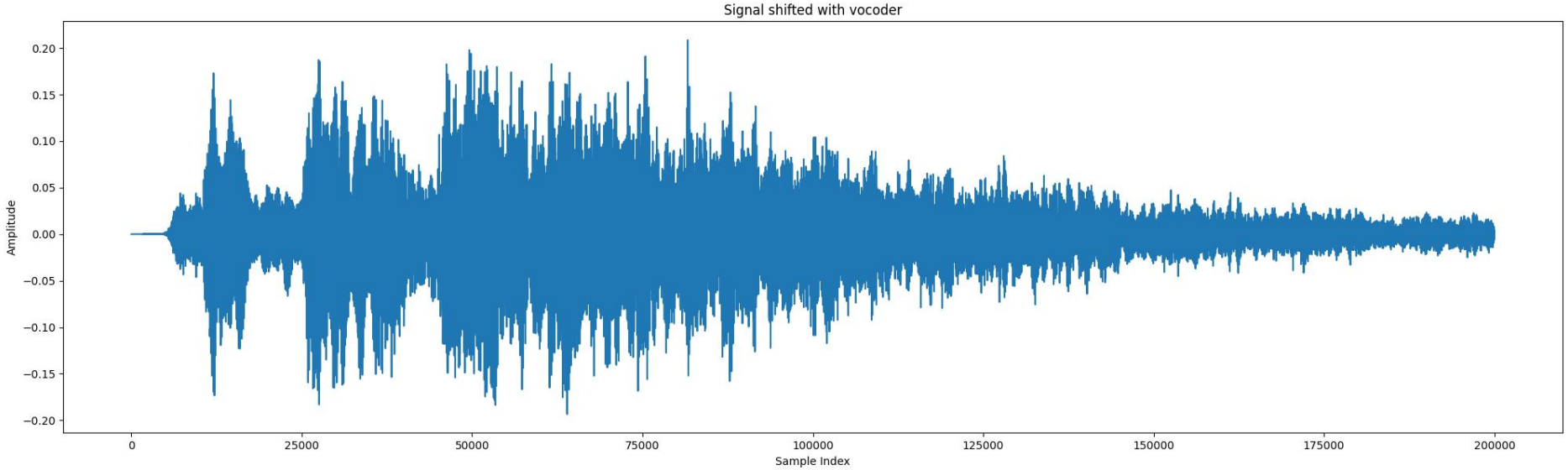
- Technique based on splitting the signal into short frames, which are shifted by selected number of semitones and then added back together.
- To ensure smaller number of artifacts, this algorithm tries to match the waveforms across overlapping frames.
- The similarity of waveforms is determined by autocorrelation, which computes the inner product between a signal and its shifted (lagged) version over a specified time lag. The time lag that produces the highest correlation indicates the best placement of the window. This method also considers the signs of the signal.

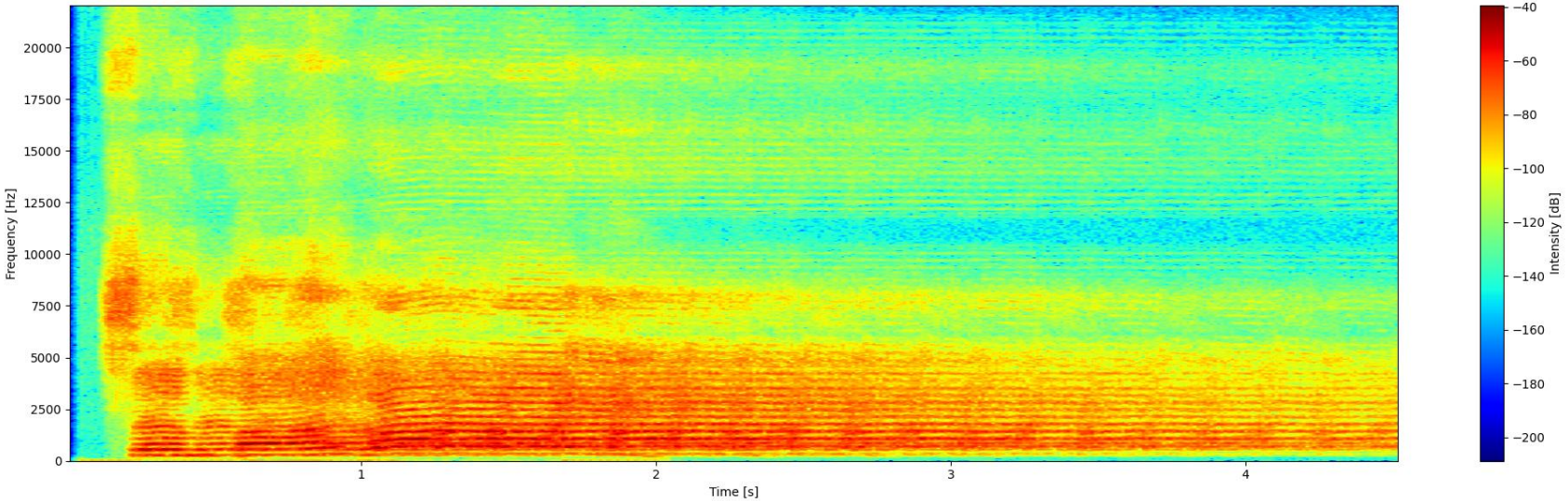
SOLA


Signal shifted with SOLA
Amplitude
Sample Index
Frequency [Hz]
Time [s]
Intensity [dB]

- This algorithm works by modifying the signal in the frequency domain and then reconstructing the signal.
- Signal altered in three phases:
  - Analysis
    - The input signal is divided into small frames, and its spectral components are extracted using a Fourier transform (STFT).
  - Processing
    - The spectral components are modified, such as altering the pitch, time, or adding effects like modulation or filtering.
  - Synthesis
    - The modified spectral components are then transformed back into the time domain using an inverse Fourier transform, reconstructing the processed signal.

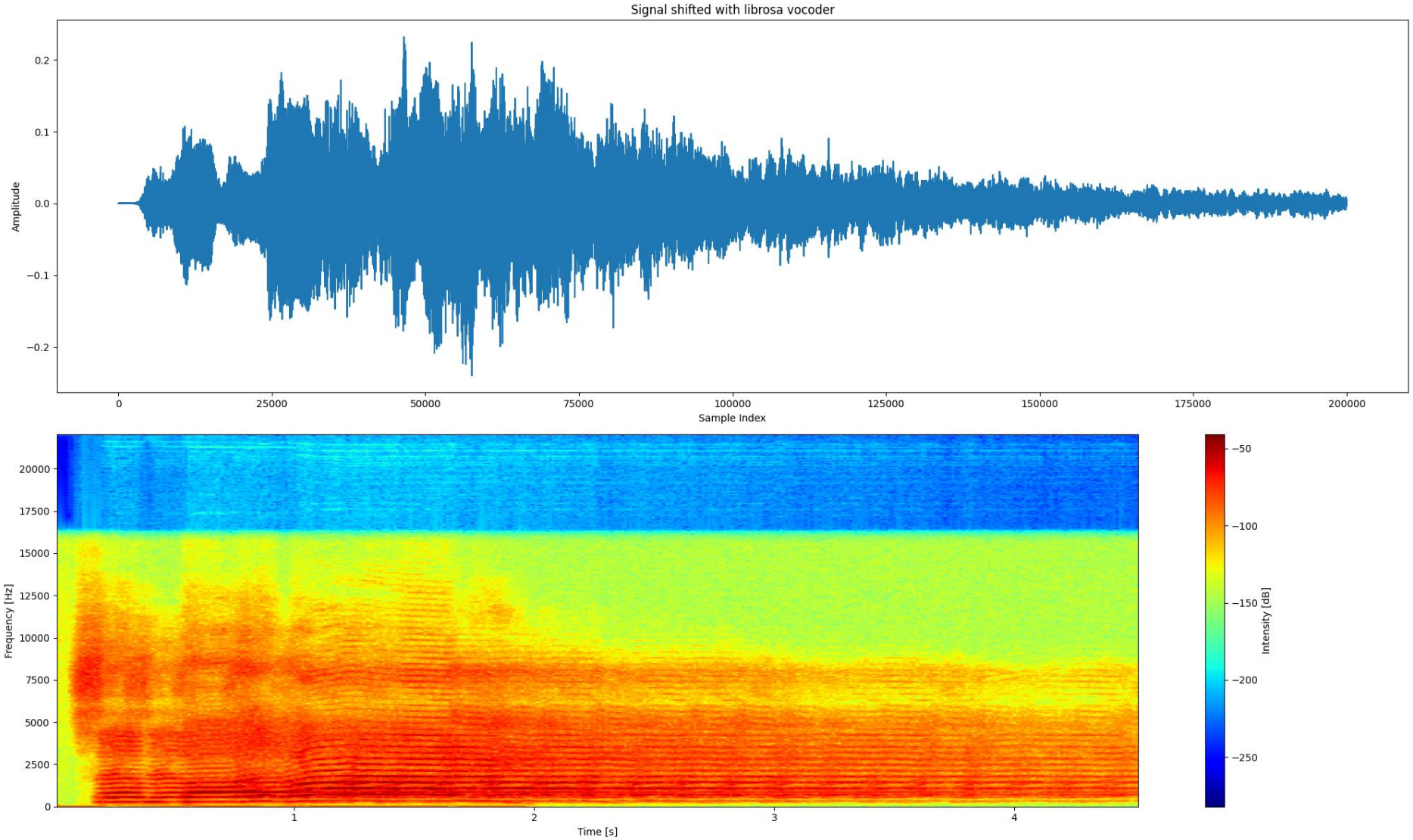
Phase Vocoder





- Librosa is a Python library for analyzing and processing audio, particularly for music and speech tasks.
- It implements a method **librosa.effects.pitch_shift**.
- This function shifts the pitch of an audio signal by a specified number of semitones without affecting its duration.
- It also uses phase vocoder technique.

Librosa


Signal shifted with librosa vocoder
Amplitude
Sample Index
Frequency [Hz]
Time [s]
Intensity [dB]

Thank you for your attention

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