Music Identification through Audio Fingerprinting

Yashraj Kakkad - AU1841036
Prayag Savsani - AU1841035
Harshil Mehta - AU1841010
Yashil Depani - AU1841005

Guided by: Prof. Ashok Ranade

Ahmedabad University

October 18, 2019

Objective

- Extract small chunks of each song and fingerprint them.
- Store the chunks in an appropriate database schema.
- Fingerprint a 5 second audio given by user and identify the song being played.
- IMAGE

Sampling

- Music is typically sampled at 44100 kHz.
- This is because of a theorem by Nyquist and Shannon which requires $f_d \geq 2f_{max}$.
- Maximum sound frequency is of course 20 kHz which leads our sampling rate to be 44100 kHz.

Problems with sampling rate

- Performing Fast Fourier Transform on a few hundred songs takes days at such a high sampling rate.
- Therefore we downsample the audio by a factor of 4.
- And as a result, the maximum sound frequency in our audio sample changes to 5 kHz.
- Would it cause any issues??

The song is not the same

- Turns out that the most important part of a song (to us) is below 5 kHz.
- Therefore, for the sake of Fast Fourier Transform, we may simply ignore the higher frequencies.

Aliasing

- We need to filter the higher frequencies in order to avoid aliasing.
- Aliasing: Distortion that results when a signal reconstructed from samples is different from the original continuous signal.
- We achieve the same by filtering the signal before downsampling (using a low pass butterworth filter)
- IMAGE OF A LOW PASS FILTER

Discrete Fourier Transform

- Gives us the frequency spectrum.
- Formula:

$$X(n) = \sum_{k=0}^{N-1} x[k] e^{-j(2\pi kn/N)}$$

- To obtain frequencies of each small part of the song for spectral analysis, we have to apply DFT on each small part of the song by appropriately dividing the song.
- This small part of the song can be seen as a window of N samples on which the DFT is performed.

Fast Fourier Transform

- Discrete Fourier Transform requires $\mathcal{O}(N^2)$ computations where N is the number of samples.
- Today's Fast Fourier Transform implementations are $\mathcal{O}(NlogN)$, which is a huge improvement.