Music, Mind, and Technology

Assignment 2 & 3

Question A

1. Harmonics

a) Check the file named “BabySharkMelody.wav” in the repo
b) Check the files named “BabySharkMelodyOdd.wav” and “BabySharkMelodyEven.wav” in the repo
c) Perceptual Differences:
    - ❖ First Ten Harmonics: produce a full, rich tone. It enhances the melody's harmonic completeness and complexity.
    - ❖ Odd Harmonics: In comparison to the complete harmonic version, it sounds more hollow, there is a lack of depth in music.
    - ❖ Even Harmonics: In comparison to the odd harmonics version, this version has the same sharpness but feels high pitched, there is also the lack of completeness.

2. Virtual Pitch

a) Check the file named “BabySharkMelody.wav” in the repo
b) Check the file named “BabySharkMelodyWithoutFundamentals.wav” in the repo
c) Check the file named “BabySharkMelodyWithoutFirstAndSecondHarmonics.wav” in the repo
d) Perceptual Differences:
    - ❖ First Ten Harmonics: produce a full, rich tone. It enhances the melody's harmonic completeness and complexity.
    - ❖ Without Fundamental Frequencies: The intended pitch using the harmonic series may seem slightly thinner or less grounded without the fundamental frequency, but the pitch remains recognisable.
    - ❖ Without First and Second Harmonics: Pitch is shaky, absence of these lower harmonics might slightly challenge pitch perception.

Question B

1. Rhythm & Meter

Estimated Tempos

Michael Jackson.mp3 : 138 bpm
Dream_theater.mp3 : 115 bpm
Mozart.mp3 : 125 bpm
Queen.mp3 : 105 bpm
Taylor_swft.mp3 : 67 bpm

MIR Computed Tempos

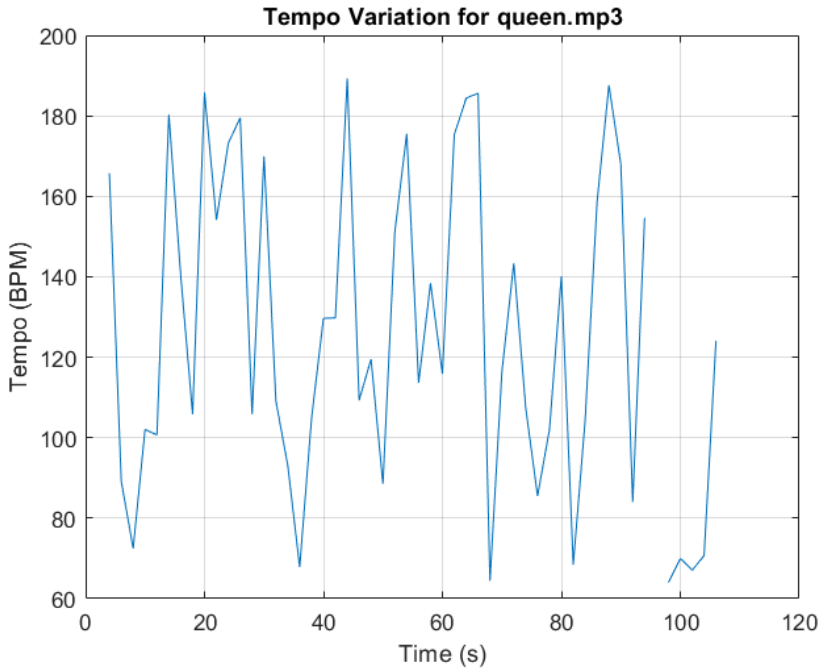
Michael Jackson.mp3 : 185.3 bpm
Dream_theater.mp3 : 97.5 bpm
Mozart.mp3 : 140.87 bpm
Queen.mp3 : 109.4 bpm
Taylor_swft.mp3 : 51 bpm

Comparing Computational and Perceptual Estimates

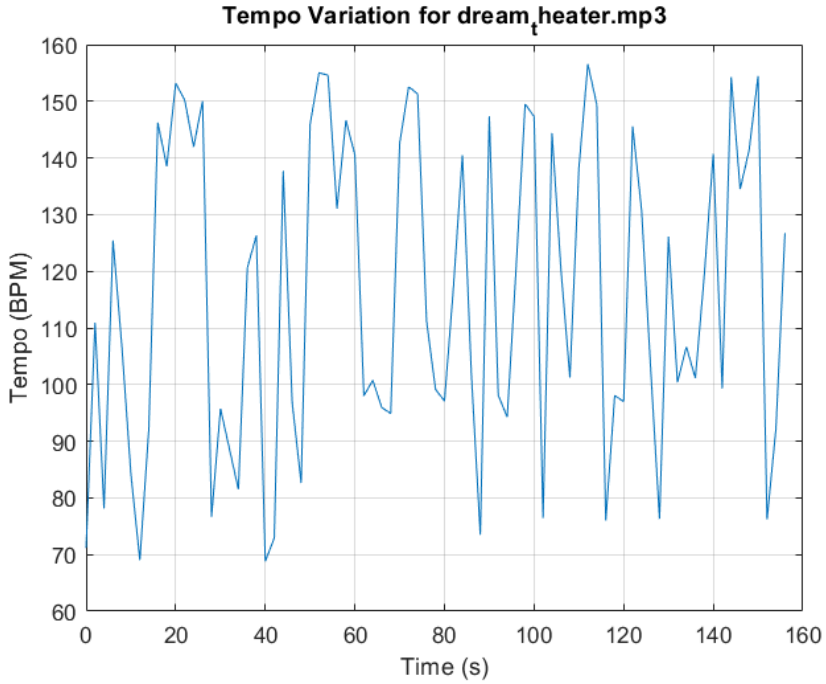
- **Tempo Variability :** Algorithms adjust tempo estimates based on different criteria, such as the most memorable parts of a piece. Depending on their design, they may calculate an average tempo, identify the most prominent tempo, or offer a range of possibilities, resulting in varying estimates.
- **Subdivisions of the Beat :** Sometimes, there can be a discrepancy in identifying the beat's subdivision. While people may tap along with quarter notes, algorithms might detect the primary tempo at the eighth-note level, effectively doubling the perceived Beats Per Minute (BPM).
- **Perception and Analysis :** Individuals often base their tempo perception on the main rhythm they notice, such as vocals or bass lines. In contrast, algorithms analyse factors like overall audio energy or specific features, which may not always align perfectly with human perception.

Frame Based Tempo Analysis

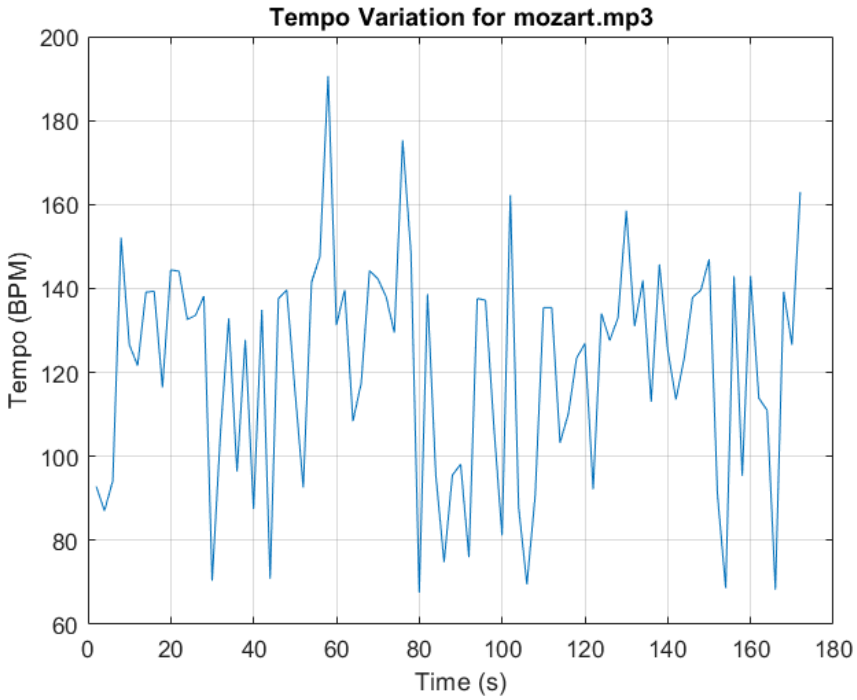
Queen



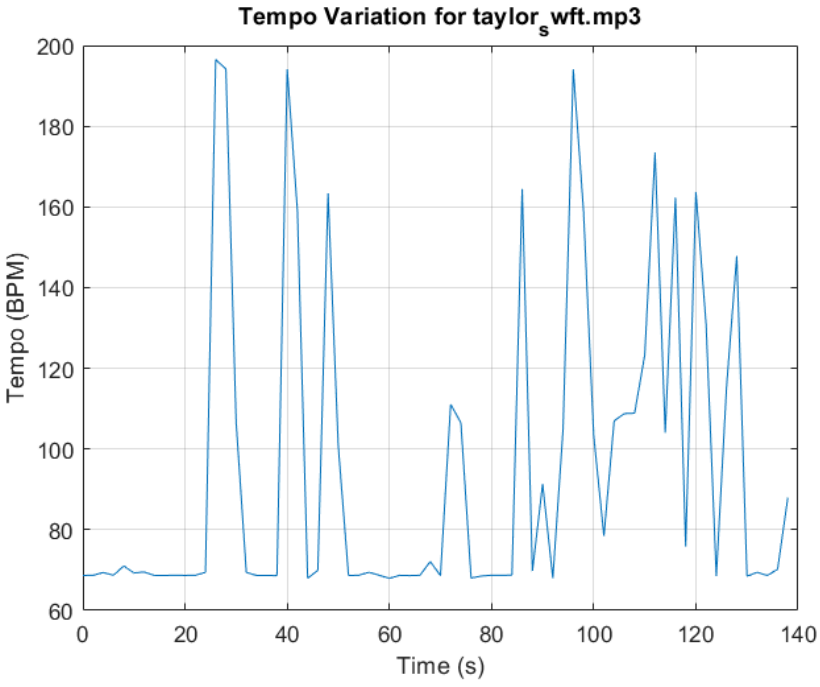
Dream Theatre



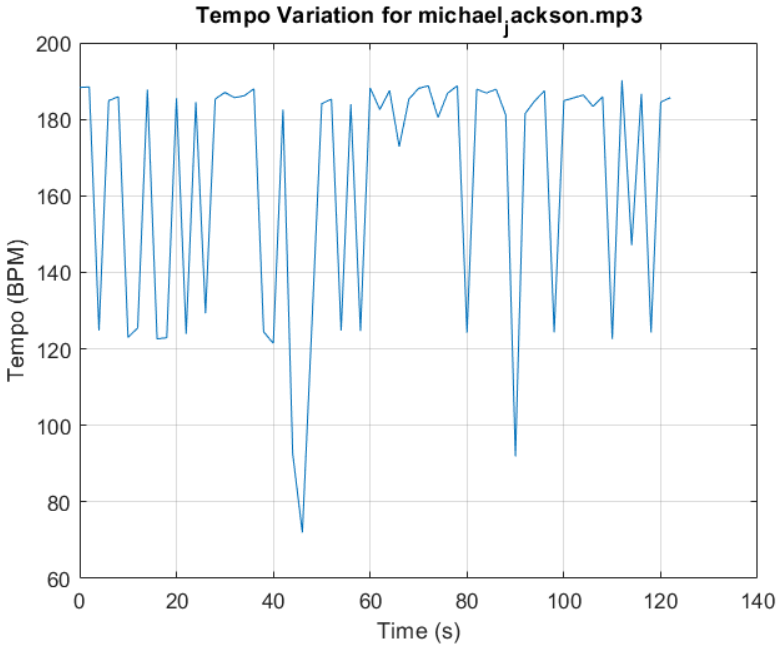
Mozart



Taylor Swift



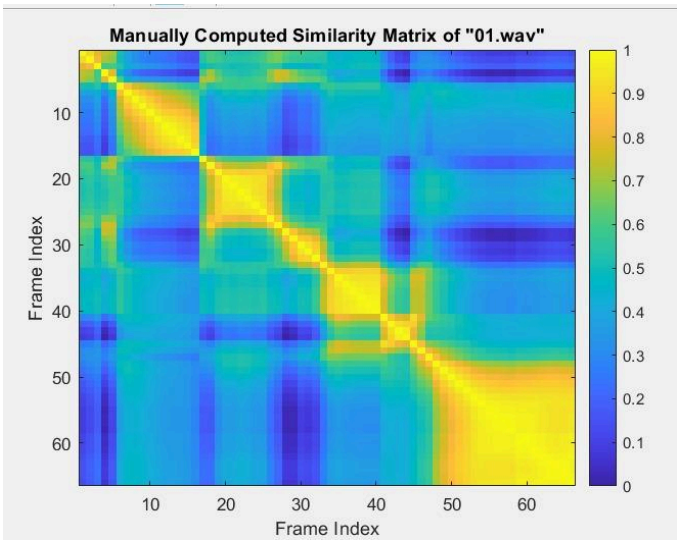
Michael Jackson



The ranges of variation of tempi observed in frame-based analysis offer a detailed view like around 90 to 200 of how tempo evolves within each piece, highlighting both expected and unexpected variations. These ranges and our initial estimates vary, emphasizing the value of detailed tempo analysis for an understanding of rhythm dynamics in music.

2. Repetition in Music

Similarity Matrix for “01.wav”



Link Between Lines and Checkered Rectangles in Similarity Matrix:

- Lines in the similarity matrix represent segments with similar chroma features throughout the song, such as recurring musical phrases, identical melodic or harmonic patterns, or sections with similar chord progressions.
- Checkered rectangles in the similarity matrix indicate self-similarity within a segment, suggesting a section that repeats itself, like a repeated melodic motif or a rhythmic pattern that loops.

Impact of Model Parameters on Results:

Chromagram: Useful for identifying tonal and harmonic repetitions as it focuses on the harmonic content of the music.

MFCC (Mel-frequency cepstral coefficients): Might be more suitable for capturing rhythmic and timbre similarities due to its focus on spectral shape.

Spectrum: Less abstract than chroma or MFCC, it might be less suitable for repetition detection because raw frequency content can be more sensitive to variations.

Choosing the Best Feature:

The best audio feature depends on your specific definition of repetition:

- Tonal and Harmonic Repetitions: Chromagram is a good choice due to its focus on harmonic content.

- Rhythmic or Timbral Repetitions: Experiment with MFCCs to capture spectral shape changes related to rhythm and timbre.

Overall:

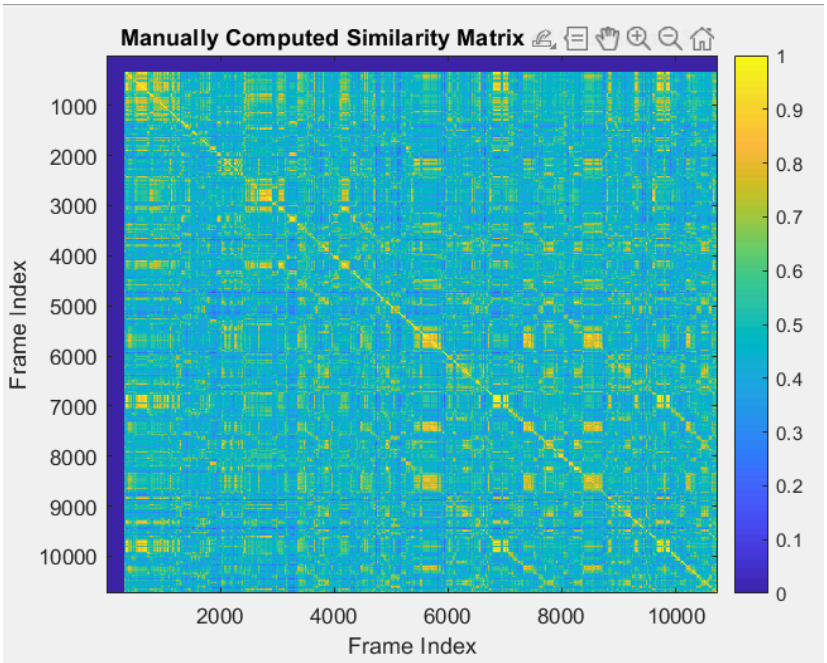
Mel-frequency cepstral coefficients, or MFCCs, are coefficients that are used to analyze the audio signal's short-term power spectrum in order to capture the timbre aspects of sound. They act as a model for the spectral envelope.

Repetition: MFCCs are especially good at identifying timbral repeats and variations; they are also good at identifying situations in which the same sounds return, regardless of changes in melody.

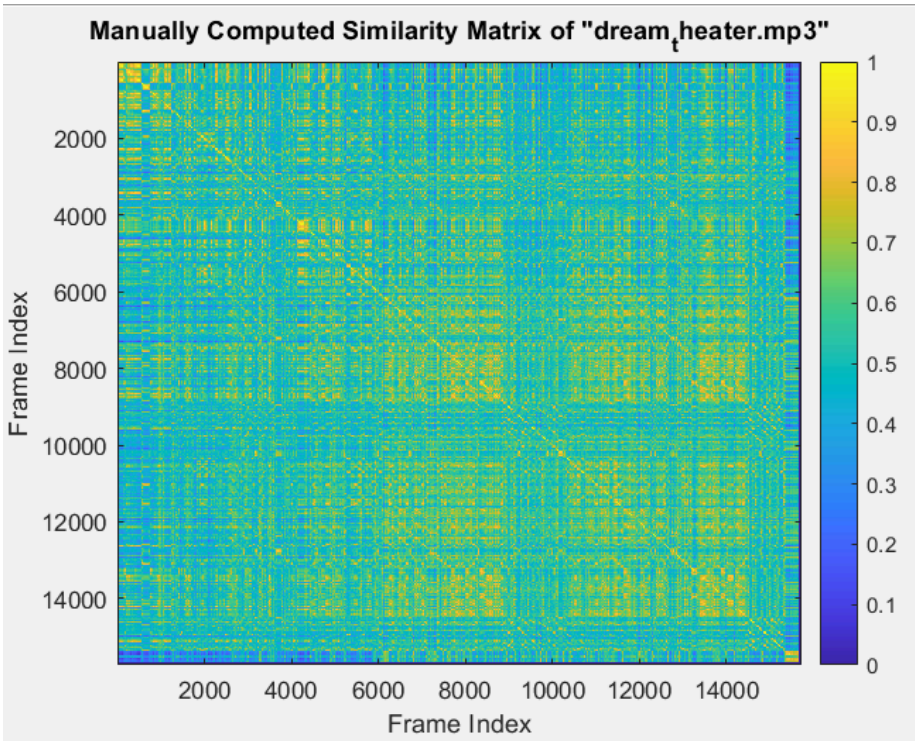
I have used Chromagram to analyze the samples.

Similarity Matrices For Sample Files

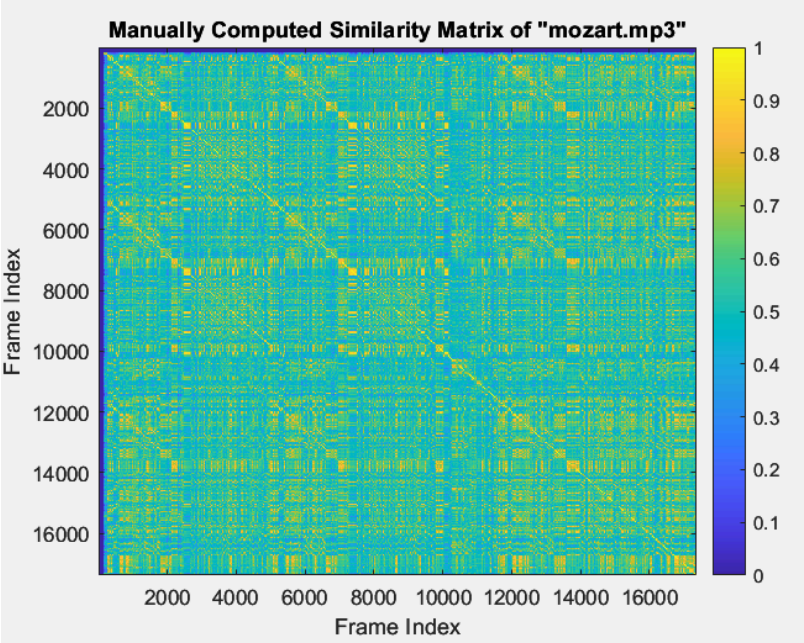
Queen



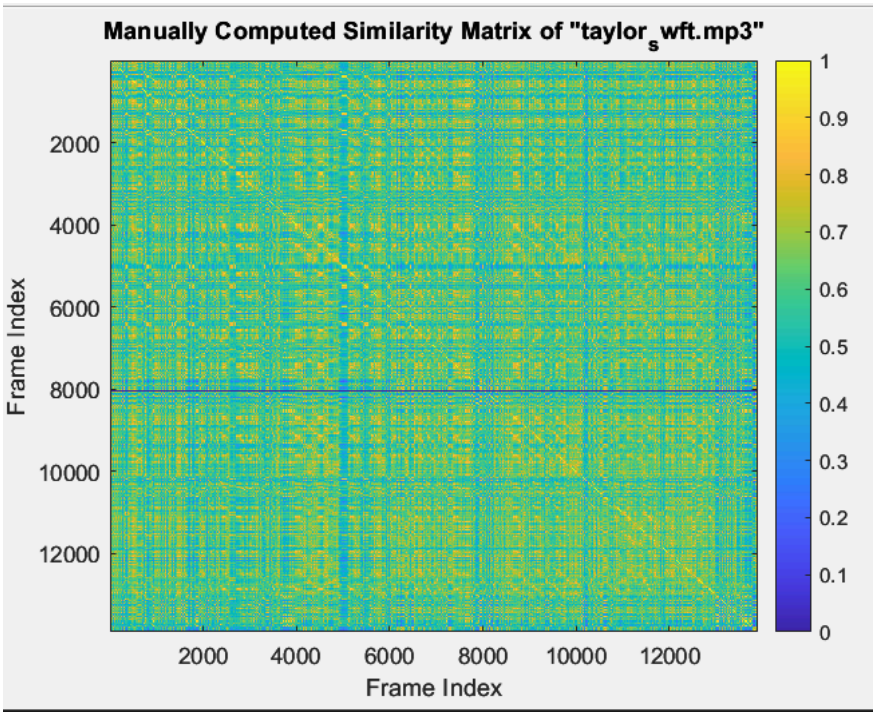
Dream Theatre



Mozart



Taylor Swift



Michael Jackson