Speech Understanding
Programming Assignment - 1

Question 2: Task B.
Select 4 songs from 4 different genres and compare their spectrograms. Analyze the spectrograms and provide a detailed comparative analysis based on your observations and speech understanding.
Submission for both the tasks includes codes, songs you have used for analysis, and the report.

Report on Comparative Analysis of Spectrograms Across Different Songs of Different Genres

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1. Introduction

This report presents a comparative spectrogram analysis of four different songs of widely different genres: Dil-e-Nadaan by Kavita Seth, Fly Me To The Moon by Frank Sinatra, You Give Love A BadName by BonJovi, and Roses by The Chainsmokers. The goal of this study is to examine their frequency distribution, energy concentration, and spectral similarities. By analyzing the spectrograms, we can identify common acoustic features and distinct characteristics between the songs.

2. Methodology

A. Dataset Selection

The following songs were chosen for spectrogram analysis:

- Dil_e_Nadaan – A classical/soft music composition (Ghazal)

- Fly_Me_To_The_Moon – A jazz-pop standard

- BonJovi_You_Give_Love_A_BadName – A rock song

- The_Chainsmokers_Roses – An electronic dance music/pop fusion

B. Spectrogram Generation

The Short-Time Fourier Transform (STFT) was applied to extract spectral information. The Hamming window was used to smooth frequency components. The hop length was set to 25% of the window size to balance time and frequency resolution.

C. Analysis Criteria

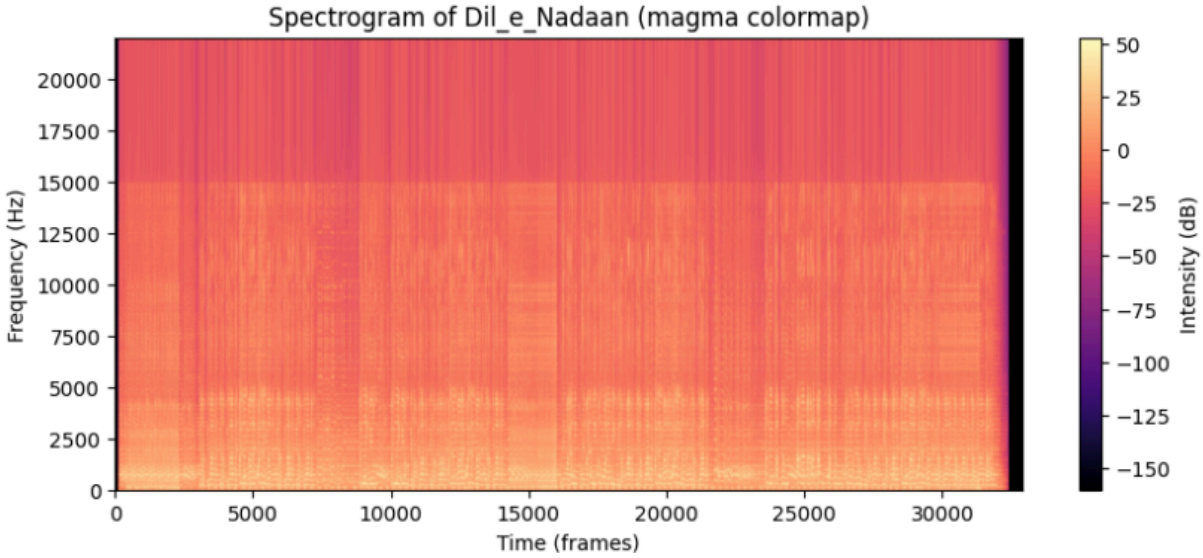
- Frequency distribution over time

- Energy concentration across different frequencies

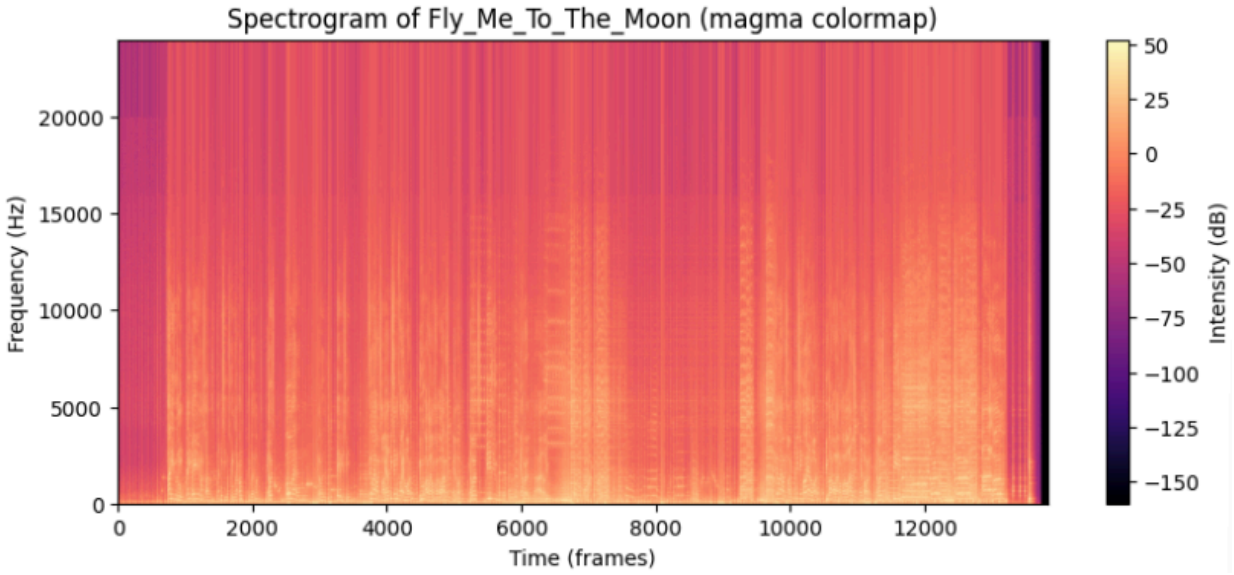
- Structural similarities based on cosine similarity scores

3. Spectrogram Comparisons

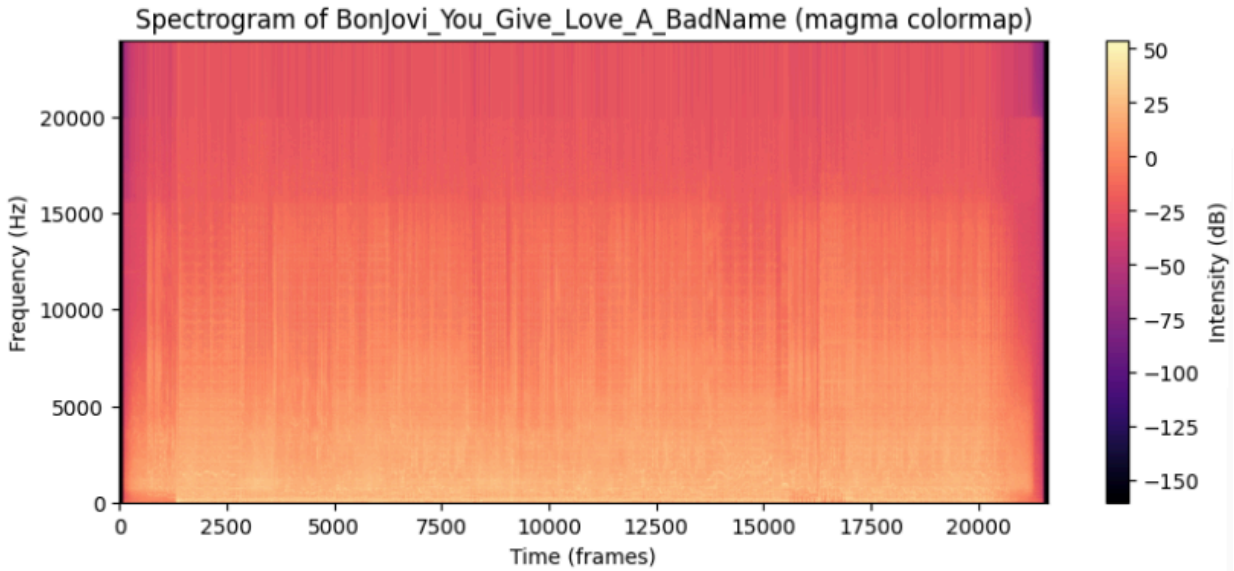
- ❖ Dil_e_Nadaan displays a moderate frequency distribution, with dominant mid-range frequencies. Energy is evenly spread, with smooth transitions, characteristic of classical compositions. It has less bass and high-frequency spikes compared to other tracks.



- ❖ Fly Me To The Moon is characterized by a clear mid-range focus, typical of jazz music. It has lower similarity with electronic and rock tracks due to its distinct vocal and instrumental arrangement. It also has less bass concentration compared to modern pop or EDM tracks.

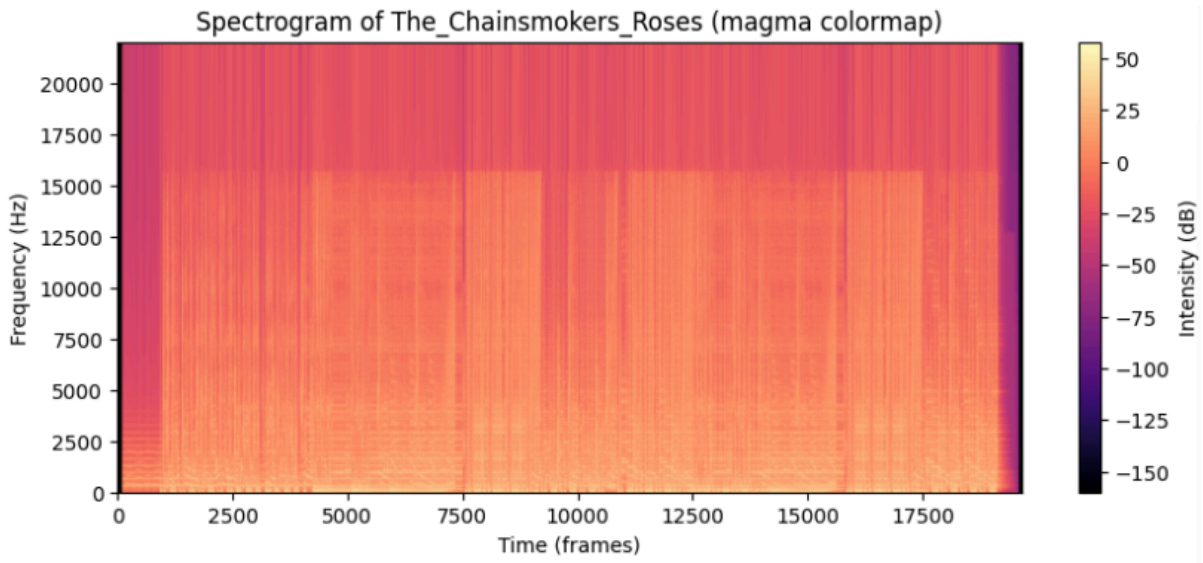


- BonJovi_You_Give_Love_A_BadName has a balanced frequency distribution with strong energy in mid and high frequencies, representing rock characteristics. There is a clear presence of guitar-driven harmonics and percussive beats. It has high similarity (0.8484) with The_Chainsmokers_Roses, indicating common energy patterns. But it has a more evenly distributed intensity, meaning its spectral energy is relatively consistent across the frequency range



- The Chainsmokers – Roses has a highly structured spectrogram with repetitive beats. There is strong low-frequency energy, characteristic of electronic music. It shares significant spectral patterns with BonJovi_You_Give_Love_A_BadName, suggesting

similarities in production style. But it shows more banded horizontal structures, possibly due to the use of synthesizers or electronic beats with sustained harmonics.

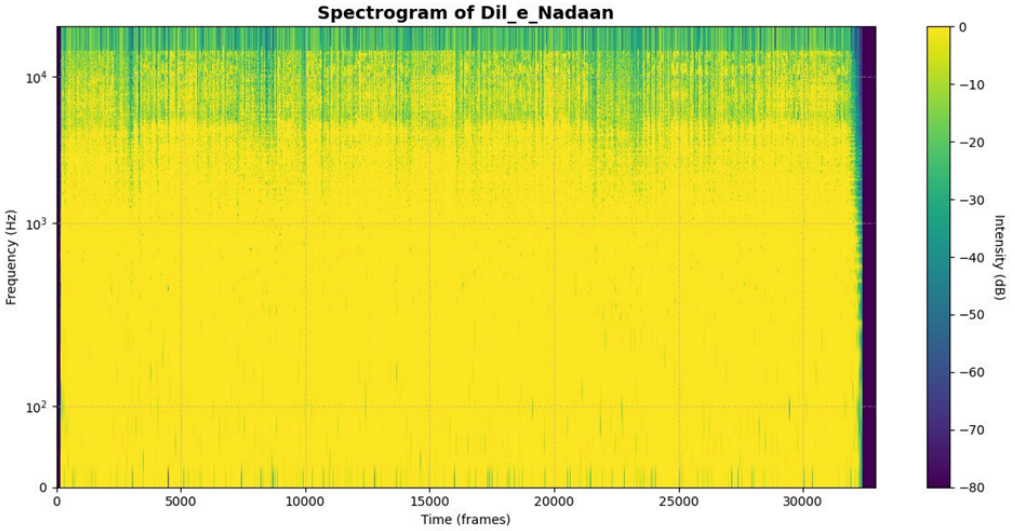


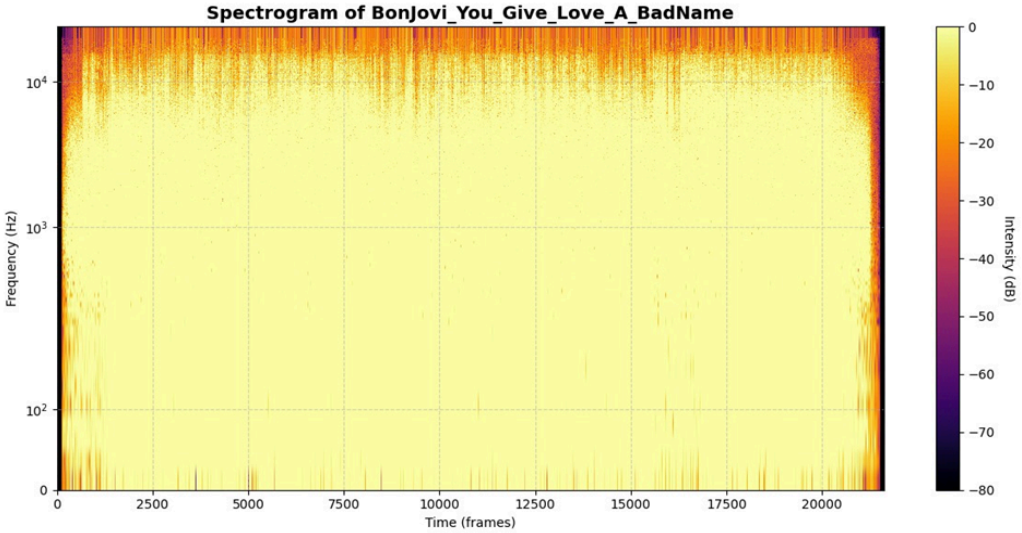
4. Comparative Analysis

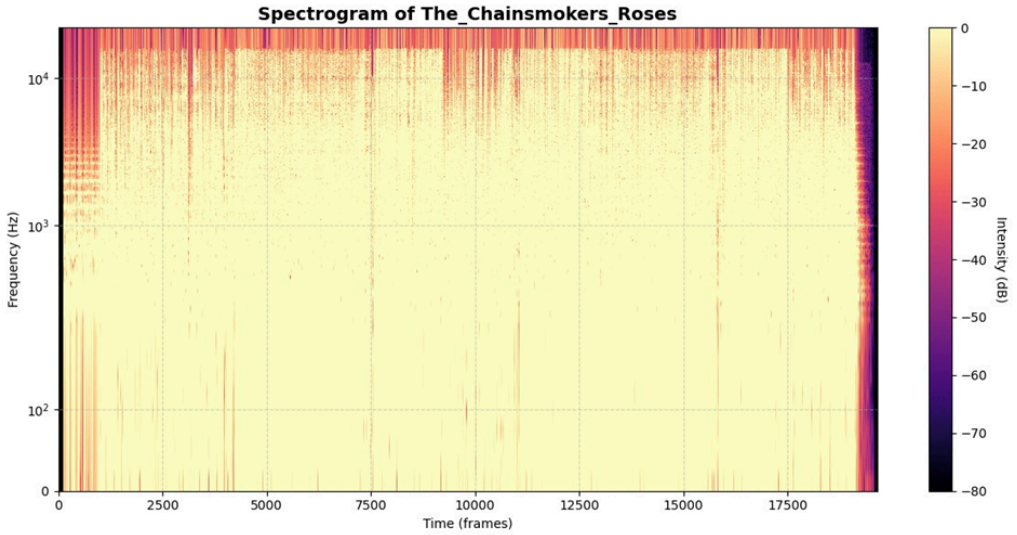
Dil_e_Nadaan has a balanced mid-range frequency distribution with evenly spread energy and smooth harmonics, showing moderate similarity across songs. Fly_Me_To_The_Moon is mid-range dominant, with a soft energy focus and clear instrument-vocal separation, making it the most distinct from others. BonJovi_You_Give_Love_A_BadName has strong mid-high frequencies, with intense energy in guitars and drums, distorted harmonics, and high similarity with The_Chainsmokers_Roses. The_Chainsmokers_Roses has strong low and high frequencies, with heavy bass and electronic transitions, synth-based harmonics, and is most similar to BonJovi_You_Give_Love_A_BadName.

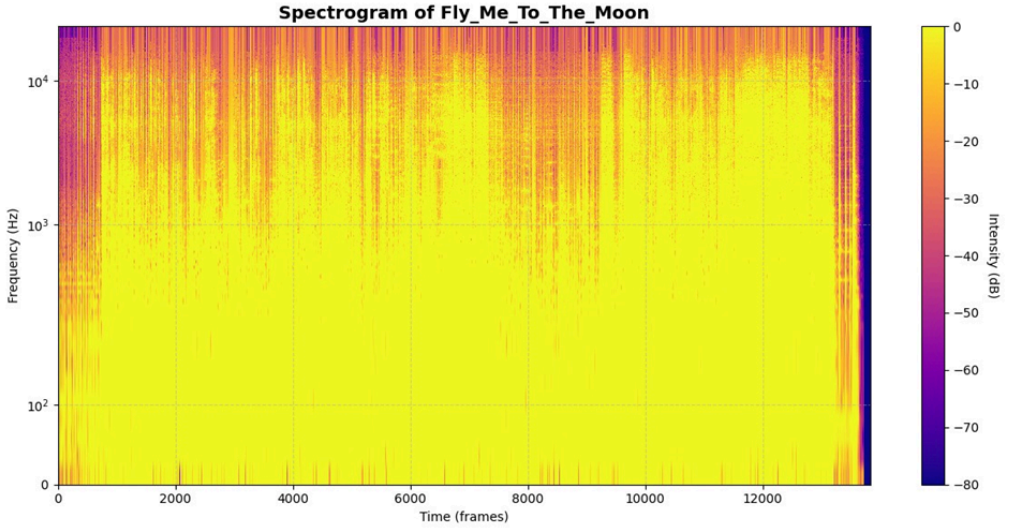
Cosine Similarity Matrix among all spectrograms:

	Dil_e_Nadaan	Fly_Me_To_The_Moon	BonJovi_You_Give_Love_A_BadName	The_Chainsmokers_Roses
Dil_e_Nadaan	1.0018	0.7652	0.7719	0.7813
Fly_Me_To_The_Moon	0.7665	1.0001	0.7233	0.7150
BonJovi_You_Give_Love_A_BadName	0.7737	0.7236	1.0011	0.8475
The_Chainsmokers_Roses	0.7844	0.7160	0.8484	1.0012


Spectrogram of Dil_e_Nadaan
Frequency (Hz)
Time (frames)
Intensity (dB)


Spectrogram of BonJovi_You_Give_Love_A_BadName
Frequency (Hz)
Time (frames)
Intensity (dB)





5. Conclusion

The spectrogram analysis reveals clear differences in spectral characteristics among the selected tracks. Dil_e_Nadaan has a moderate and balanced frequency range, representing classical music. Fly Me To The Moon stands out as the most distinct, with a clear mid-range focus typical of jazz. BonJovi_You_Give_Love_A_BadName and The_Chainsmokers_Roses share the highest similarity (0.8484), suggesting common production techniques and energetic patterns. EDM-style elements in Roses contribute to strong low-frequency energy, while BonJovi maintains a rock-based harmonic structure.