Analysis of Drum Patterns From Different Genres using Distance Metrics

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I. INTRODUCTION AND BACKGROUND

In the world of music, we are blessed to enjoy a wide variety of music from different genres, from the mainstream pop and EDM to the likes of rock and metal and everything in between[1]. Drums are one of the oldest instruments to ever exist. Mankind has used drums or percussion instruments for various purposes that are limited not only for musical shows but also for various rituals and religious events. These instruments are ingrained in the history of our people. With modern innovation that comes into play, technology has allowed us to create electrical drum kits or E-drum kits, which boasts features of portability and ease of use.

Any musical genre's rhythmic foundation is greatly influenced by its drum patterns, which also add to the energy, dynamics, and general feel of the genre.

A. *Genres*

- ROCK

The "four-on-the-floor" beat is a term used to describe the most basic drum beat in rock music. Usually, the hi-hat or ride cymbal keeps an even eighth-note pulse while the kick drum plays on downbeats 1, 2, 3, and 4. The snare drum hits on beats 2 and 4.

- JAZZ

Jazz drumming is an extremely expressive and sophisticated type of percussion that is essential in creating the complex, improvisational style of jazz music. Jazz drummers are renowned for their technical mastery, artistic flair, and capacity for impromptu, dynamic interaction with other musicians.

- FUNK

Drumming is a key component in creating the catchy and danceable grooves that characterise funk music, which is widely recognised for its infectious beats. Funk drummers are known for their tightness, precision, and capacity to produce syncopated patterns that compel listeners to move.

- METAL

The intense, aggressive, and complex instrumentation of metal music is well-known, and the genre's potent sound is largely driven by the drumming. Metal drummers are known for their technical proficiency, quickness, and accuracy.

- EDM or Electronic Dance Music

Electronic dance music, or EDM, is a broad category that includes many different genres and styles, each with distinctive drum patterns and features. Synthesised sounds, electronic beats, and rhythmic components intended to get people dancing are frequently the driving forces behind EDM.

B. *Musical Instrument Digital Interface*

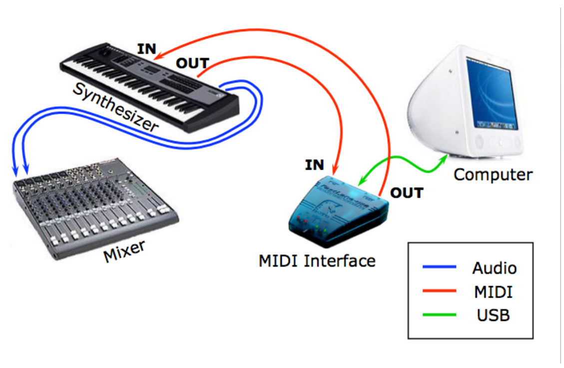

Fig. 1. The MIDI Standard

MIDI is a specification for a digital music device's communications system. Like all human-made products, it has advantages and disadvantages. Its impact on the music industry has garnered greater attention than its network capabilities.

With the development of MIDI (Musical Instrument Digital Interface),we can transmit music through using MIDI notes that have information such as musical note, timing and pitch and so on. Using this technology, recorded music can be reproduced with midi notes, allowing analysis to be easier, because different musical gears and instruments can finally transmit information to each other in a common language.

MIDI was initially designed and developed by a group of commercial synthesizer manufacturers, over a period of a few years, originally as to connect these synthesizers and share information such as gestures, and also to find a way to achieve hardware extensibility, achieve interfacing with a digital computer and to prevent its technology from dying out. It is important at the outset to say that MIDI is designed as an event-based network, not a sample- based one. What MIDI communicates is not sampled waveforms, but indications about pressed keys and switches, turned knobs and pedals-in other words-human gestural control information[2].

MIDI uses up less storage space but cannot store vocal lines or samples. MIDI is also dependent on the sound card used in the synthesizer, affecting quality. On the other hand, MIDI has thrived and is currently the accepted industry standard. It is fairly functional for a range of tasks despite its limitations. Its standard status contributes significantly to its usefulness despite its drawbacks. MIDI is highly accepted and used because of ease of communication and for the purpose of analysing patterns, making it a much more effective format of music. Due to its popularity, there is now interest in creating additional standards for fields like editing and music databases, as well as in expanding or replacing the MIDI standard.

C. *MIDI Toolbox*

A collection of Matlab functions provided by MIDI Toolbox provide all the tools required to analyse and visualise MIDI data. The creation of the Toolbox has been a component of continuing research on musical data mining, music perception modelling, and data decomposition for and from perceptual experiments. Even though MIDI data isn't always a good representation of music overall, it's sufficient for a lot of research questions that address ideas like pulse finding, tonality, and melodic contour. These ideas are fascinating. The perspective on how music is perceived and the representation selected have a significant impact on how these issues can be approached[3].

The toolbox has functions for managing various MIDI event kinds. Pitch bend, control change, note-on and note-off events, and other events are included in this. MIDI sequences allow users to add, remove, or alter events as needed.

The toolbox facilitates the seamless integration of MIDI data analysis with MATLAB's signal processing capabilities. This makes it possible to process, extract features from, and analyse MIDI sequences in a more sophisticated way using the MATLAB environment.

Plotting functions and other visualisation tools in MATLAB can be used to visualise MIDI data. This is especially helpful when analysing the pitch and timing characteristics of MIDI sequences.

The timing and synchronisation of MIDI data can be managed with MIDI Toolbox. Timing data can be used by users to synchronise MIDI events with other data or external devices and to create exact musical sequences.

II. Methodology and Implementation

My main aim is to conduct an analysis of different prominent drum patterns that have emerged from different genres. Drums are inherently monophonic, since they do not produce harmonies, and as such, are easy to analyse and understand, as well as making them easy to manipulate[4] Here is a flowchart below:

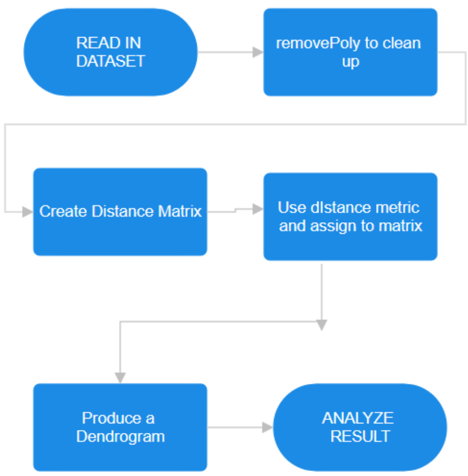

Fig. 2. Flowchart of the methodology

A. *Dataset*

We shall first talk about the sourcing of our dataset. For the purpose of this experiment, we are going to consider five different drum patterns from five different distinct genres that we have already talked about in the background section of this report. The midi Files hence used in this experiment are sourced online and are referenced in this report. We have picked a randomized set of files that contain midi files with varying drum patterns of different tempo and size. This is the basis on which we conduct our assignment.

Once we read in the dataset, we clean it up and remove data redundancy to further make our program efficient. Next step is to discuss our choice of our distance metric. Here, we are using the euclidean distance metric

B. *Distance Metric*

The Euclidean distance matrix is widely used in data analysis, clustering, and pattern recognition, among other areas. In a multi-dimensional space, the straight-line distance between two points is expressed as the Euclidean distance. When analysing MIDI files or using feature vectors in other applications[5]

Since numerical data is frequently represented as vectors, the Euclidean distance is especially appropriate for this type of data. Since MIDI files are transformed into numerical data when feature vectors are processed, the Euclidean distance is an obvious choice for calculating dissimilarity. The metric characteristics necessary for a distance measure, including non-negativity, identity of indiscernibles, symmetry, and the triangle inequality, are satisfied by euclidean distance. These characteristics guarantee that, in statistical and mathematical analyses, the distance metric performs as predicted.

In clustering algorithms like k-means and hierarchical clustering, Euclidean distance is a common option for distance metrics. When evaluating the similarity between feature vectors in classification tasks, it is also widely utilised.

C. *Clustering and Dendrogram*

Hierarchical clustering is carried out by first generating a distance matrix from pairwise distances between MIDI files, and then the results are visualised as a dendrogram. The dendrogram sheds light on the MIDI files' hierarchical structure by illustrating how they are grouped together according to their similarities and differences[6].

When using hierarchical clustering, a dendrogram is an effective tool for comprehending the data's hierarchical structure. It offers flexibility in exploring clusters at different granularities by providing a visual representation of how data points are grouped into clusters at varying levels of similarity[7].

Usually, the dendrogram is shown as a vertical tree structure. The linkage distances or differences between individual data points or clusters are shown on the vertical axis. The actual data points or clusters are shown on the horizontal axis. The dendrogram's various patterns shed light on the data's structure. Long vertical branches imply dissimilarity, whereas tight clusters with short vertical branches show high similarity. The relationships between various data points or clusters can be interpreted with the aid of the branches' position and length.

III. EXPERIMENTATION AND RESULTS

Using the tools provided in the MIDI toolbox, we first read in the input directory that contains our dataset. This is where we have stored our midi files. Using 'removePoly' function, we clean up the midi files and process them for easier analysis and preventing any potential errors, basically yields a list of the processed MIDI file names after removing any unwanted or polynomial trends from the MIDI files.

After categorically analysing and organzing the data, we perform a paired comparison between the data using the 'meldistance' function, which uses a distance measure and a user-defined representation (different distributions or melodic contour) to determine the distance (or similarity) between two notematrices. In this particular assignment we use the euclidean distance metric to undergo this procedure.

In the next section, we move on to creating a distance matrix and undergo hierarchical clustering. By creating a symmetric distance matrix, we can deal with our distance matrix by allowing us to avoid redundancy. Using the 'average' linkage method, we form a Hierarchical clustering tree, and the linkage information is stored. Finally, we plot the dendrogram, and we can analyze and draw conclusions based on the output.

IV. DISCUSSION AND CONCLUSION

Once we have setup and run the program, we get figure 3

Looking at the figure, we have realized and we can come to the conclusion of the following:

- We can understand that with the low linkage heights, there's a great value of similarity between two files, with an even bigger value of dissimilarity between them and the third file.
- Considering the different lengths and tempo, these kinds of inconsistencies can lead to some of the files to not have a dendrogram generated.
- We can improve upon these results by revising the distance metric used, providing more data in the data set, including more genres, making sure the files are consistent, maybe even categorising them into subsets based on tempo and size of the file by time. These results only prove to be improved upon.
- We can conclude that with some finer tuning and improved dataset, we can achieve more accurate results. We have gained an understanding regarding hierarchical clustering and distance metrics.

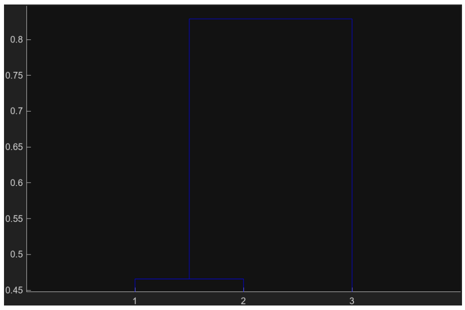

Fig. 3. Dendrogram generated

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