Musical Chord Recognition

Ashish Ekka(160010011)
Shreyash Tripathi(160010013)
Shivangi Sharma(160020011)
Team 6

November 25,2018

1 Introduction and Overview

Chord Recognition is the automated process of assigning musical chords[5] to segments of a music piece.It is an important task in the analysis of western music and music transcription in general, and it can contribute to applications such as key detection, structural segmentation, music similarity measures, and other semantic analysis tasks. The first step of the chord recognition (CR) is the extraction of a meaningful descriptor that enhances the contribution of every note at each instant. One of the main strategies of doing Chord Recognition is based on the comparison of vectors of the extracted descriptor with a set of chords templates by means of a distance measure. This method, due to the interaction of many instruments with different timbral characteristics, is very influenced by the noise of the descriptor itself and, for this reason, can be ineffective. In this project, we worked on a method for Chord Recognition based on machine learning techniques. These techniques are designed to automatically learn the complicated relations that link an input observation to the corresponding class making use of probabilistic theory.

Related work

Chroma features, also known as Pitch Class Profiles (PCP)[4], have been used as front end to chord and songs recognition systems from audio recorded queries. Method based on machine learning techniques have better results , for chord recognition ,than the methods that uses signal processing techniques in order to obtain the best possible 12-bin PCP vectors, and then perform pattern matching [1, 2].The reason for this is that that it is very difficult to obtain a perfect 12-bin PCP vector which highlights only the main notes of a chord. Indeed, each instrument brings new harmonics, and the dynamic of the musician, among other parameters, adds noise to the PCP chords recognition.Machine learning techniques learns a suitable model encapsulating all these parameters.

2 Methods

Classification of chords of live music is performed using Naive Bayes Classifier[3]. In a context where we have a set of classes *(namely the chords)* $c_j \in \mathcal{C}$

$$\mathcal{C} = \{c_1, c_2, ..., c_{|C|}\}$$

and a melody x*(now represented as a vector)* is assigned to the class c_j with maximum a posteriori probability, in order to minimize the probability of error:

$$P(c_j|x) = \frac{P(c_j)P(x|c_j)}{P(x)} \tag{1}$$

where P(c_j) is the a priori probability of class c_j , P(x|c_j) is the probability of x being generated by class c_j, and
P(x) = $\sum_{j=1}^{j=|C|} P$(c$_j$)P(x|c_j).
Our classifier is based on the Naive Bayes assumption, i.e. it assumes that all notes in a melody are independent of each other, and also independent of the order they are generated.

3 Experimental Analyses

The raw audio file needs to be processed into machine recognizable format. There are signal processing libraries that estimate audio files into its features (like frequency, timber, zero crossing rate, midi number) . The Chromatic feature vector which classifies every piece of music into 12 bins is the best-suited for our purpose. Every Digital audio file has been sampled down to get discrete values. In our case, the files were recorded at 44,100 Hz (samples/sec). Now for the feature-detection, we need a bunch of such samples to estimate the values. So, every audio file is divided into smaller frames each having 512 samples. This is the most optimal framesize which fits our dataset. We have about 25,000 such frames for guitar and approximately 1 million for piano chords. Each such frame has 12 features and a label associated with it.

Datasets

The dataset has 2 categories. One for the guitar and one for the piano. For the guitar, the dataset was manually compiled and labeled. For the piano, there is an existing dataset (UMA Piano Chords Database) from which about one-tenth part was used which had over 15,000 audio files. The overall dataset consists of all such feature vector generated into 24 distinct files (one for each chord). This dataset was analyzed before using any classifier. Firstly, we analyzed the dataset by plotting boxplots[8] and implementing clustering algorithms. Each data point is a 12-bin vector with its corresponding chord label. Using boxplot, we observed that there is some correlation between the different data points of a chord which was desired. K-Means clustering[9], on the other hand, failed to give satisfactory results. The reason behind it was that similar notes appeared in different chords, and notes are the features for this classification. Also, there are factors like noise and acoustics which create an impact on the feature vector.

Results

On a random test data with true labels, the guitar chord classifier produced an accuracy of about 70%, and the piano chord classifier showed an accuracy of about 25%. For the piano, it was not a good classifier. For real-time tests the guitar classifier was optimal and the results were favorable. The piano, on the other hand, had an irregularity in its performance.

4 Discussion and Future Directions

It is known that music is the presentation of art which consists of infinite combinations of musical notes and time. In order to implement chord recognition intelligently, we tried to establish a classifier. Among various Artificial Intelligence methods , we chose Naive Bayes Classifier for classification of chords of guitar audio file. Similar approach can applied for classification of chords of a song but no real labelled chords database seems to be publicly available (to our knowledge) to build such a model. Other methods such as Neural Networks , Logistic Regression [6, 7] etc can also be applied for classification of chords.The results can compared among the different approaches.

References

[1] J. Osmalskyj, J-J. Embrechts, S. Pierard, M. Van Droogenbroeck *NEURAL NETWORKS FOR MUSICAL CHORDS RECOGNITION*.

[2] Xinquan Zhou Alexander Lerch *CHORD DETECTION USING DEEP LEARNING*.

[3] Naive Bayes Classifier *https://towardsdatascience.com/naive-bayes-classifier-81d512f50a7c*

[4] Chroma feature *https://en.wikipedia.org/wiki/Chroma_feature*

[5] Chords *https://en.wikipedia.org/wiki/Chord_(music)*

[6] Neural Network *https://towardsdatascience.com/how-to-build-your-own-neural-network-from-scratch-in-python-68998a08e4f6*

[7] Logistic Regression *https://towardsdatascience.com/logistic-regression-detailed-overview-46c4da4303bc*

[8] Box Plot *https://chartio.com/resources/tutorials/what-is-a-box-plot/*

[9] K Means *https://www.datascience.com/blog/k-means-clustering*