

Data Mining Applied to Music Style Classification

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Abstract — With the increasing growth of online music resources, the development of popular music information retrieval research, and automatic music style classification has become an important field of music information retrieval. Music style represents a music creator's personality, audience preferences for different musical styles also vary, it is difficult to find a particular style of music for all the public alike. In this era of online music, music style classification method based on computer technology is a promising field of research. In this paper, based on knowledge of music theory, from the perspective of data mining technology proposed classification method style of music files, the style of music in the original classification of information as a basis for harmony and melody style classification, the use of data Mining technology for music from the bottom up, segmentation, stratification style classification, and other classifications related test methods were analyzed and compared to give a more satisfactory test results.

Keywords - Music Style Classification, Data Mining, Mining Algorithm, Association Rule

I. INTRODUCTION

With the continuous development of network technology and large-scale database technology, today people have access to contain millions of music online music library via the Internet. However, music has been one of the most important online product, there are hundreds of online music streaming and download service running on the World Wide Web, some of which ran close to the size of the music library Pat million tracks [1-3]. This raises the question of how to search, retrieve and organize music content. Music Information Retrieval in this research project, with the perception of music from across the exchange, communication and cooperation between disciplines, there have been a series of content-based music information retrieval between music psychology, musicology, engineering and computational science experts The methods and techniques.

The music is not only a huge number, but different styles, how to effectively manage the music library, provides help users access and retrieval features, so they can understand from a number of music efficiently find their favorite, is the urgent need to address an important topic. Commonly used method can be distinguished by the iconic music information such as genre, musician's name, region, used musical instruments. But the information is often incomplete, and to add the workload of these iconic information needed by the listener's opinions are too large. More advanced method is the use of signal processing and pattern recognition technology, with the processing power of computers to automatically analyze music files, extract the signature information. In such art, music automatic classification technology to mature [4]. Figure 1 is a musical visualization method of classification of cases.

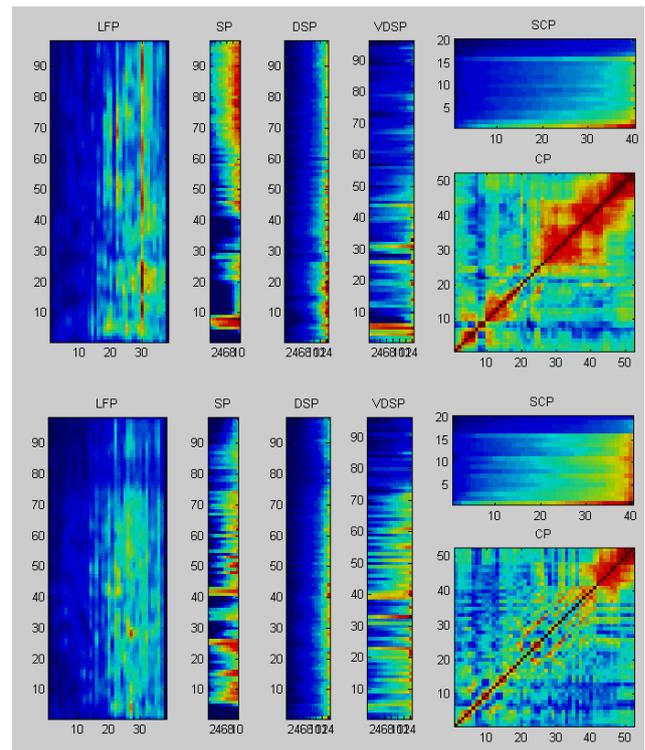


Figure 1. Visualization of music classification Case.

Music style classification task of data processing by the music signal to the music classified as a certain kind of style. Use music style classification system can help users quickly find the relevant style of music, the music database can achieve more effective management. In this paper, the implementation of the music style classification algorithm, background music style classification system and

relate to the basic theory are introduced, focusing on the music feature extraction, feature extraction based on data mining and classification to achieve a style of music classification system and related experiments.

II. MUSIC CLASSIFICATION ALGORITHM ANALYSIS

Music classification is in accordance with certain standards of existing music into different species to go, while the standard classification is generally based on the subjective perception (especially different style) determined. Involved in the realization of the entire system of music classification framework to music psychology, knowledge of music signal processing, pattern recognition and other disciplines. At present, many researchers have proposed many effective algorithms to achieve music category [5-7]. It is a pattern classification process music category essence, the current majority of music classification algorithms are based on the structure shown below in figure 2.

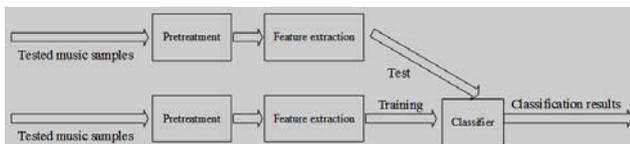


Figure 2. Block diagram showing music classification algorithm.

Seen from the figure, the music classification system to include voice signal preprocessing, feature extraction, classifier training and classification test, and several other functional modules, the following brief description of the function of each module [8]:

1) pre-processing module of the original music signal input processing, which filter out important information and noise, music and the like framing and pre-emphasis processing. 2) feature extraction module is responsible for the acoustic parameter calculation music, and computing features to extract the key characteristic parameter reflects signal characteristics, in order to reduce the dimension and to facilitate subsequent processing. Music classification system common characteristic parameters amplitude, energy, zero-crossing rate, the linear prediction coefficient (LPC), LPC cepstral coefficients (LPCC), line spectrum parameters (LSP), short-term spectrum, formant frequencies, reflecting the human ear Mel Frequency Cepstral auditory characteristics (MFCC) and the like. Feature selection and extraction system construction is the key.

3) In the training phase, select a number of pieces of music composed music category of the training set, using the extracted from each of the first train set features music chosen to train classifiers, to determine the value to be determined classifier structure parameters to obtain specialized music classification for classification problems.

4) During the testing phase, when a new test music arrival, using the above-obtained free music category will test whether the training process preset category one, test the music is correctly classified to that it should belong to class, the overall classification accuracy rate last statistical music classification system.

Classification is part of the essence of music audio processing. The meaning of audio processing is a very broad concept, including audio digital signal processing, psychoacoustics, linguistics, vocal learning and speech signal processing technology, computer technology and multimedia database technology. Audio processing has a long history, and has made certain achievements. Its main areas of voice, speech recognition, IBM's ViaVoice has matured, while the University of Cambridge VMR systems, and Carnegie Mellon University Informedia are very good audio processing system. Few people study generalized sound, research on audio classification techniques began only in recent years even more. Audio technology is the basis for classification of audio depth treatment, which is in audio and video processing systems and other interactive multimedia application systems have a wide range of applications.

III. PROPOSED DATA MINING AND ITS MAIN TECHNICAL

Artificial intelligence, statistical, database technology, data mining technology was born and laid a solid foundation. Artificial Intelligence and Statistics are studies on how to discover knowledge from existing data, and predicted by the existing knowledge of the subject [9]. In these disciplines working knowledge discovery, the statistics are based on a mathematical theory of traditional disciplines, and data mining technology is more dependent on the computer powerful computing capability. The whole process of knowledge discovery is broadly divided into: "data cleansing and integration process", "data transformation and selection process", "data mining process," "model assessment process and knowledge representation", as shown in the figure 3 we can see, the task of data mining process is to find patterns from the target data. Description Mode can usually be divided into two categories and predictive mode [10-11]. Descriptive mode understandable way to describe the current data in the presence of the characteristics and laws, is the use of predictive relationship between the known field and the unknown field by field value known to predict the value of the unknown field.

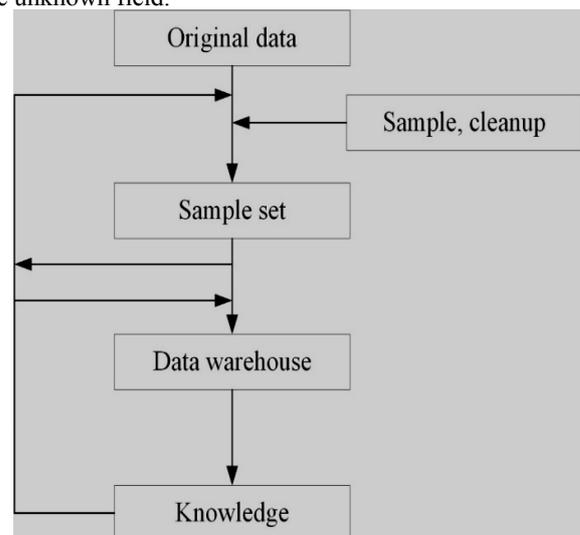


Figure 3. The basic process of data mining.

Data mining process is not a simple data → model → results apply simple formula, but a cycle repeated, stepwise refinement process. The process mining from large databases or data warehouse previously unknown, effective, practical information, and use this information to make decisions or knowledgeable. Step general data mining mainly includes the following interrelated: problem definition and theme analysis, data preparation, data mining, results analysis and assimilation of knowledge, shown in Figure 4.

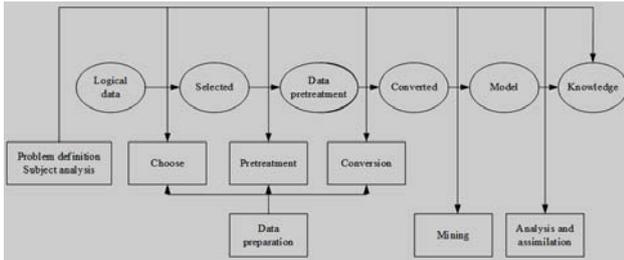


Figure 4. The detailed process of data mining.

Problem definition and thematic analysis: data mining, we must first analyze applications, including knowledge and application objectives, problem definition to understand the application fields of the relevant circumstances, understanding of user needs and business issues, the precise definition of the problem to be solved, in determining the After the user to solve the problem, to deal with the existing resources be evaluated to determine whether the data mining technology to solve the needs of users, data mining will not automatically discover knowledge in the absence of guidance, and therefore, data mining also need to have a clear The topic destination, the topic of data mining objective decision thereafter various operations.

Data Preparation: determining theme, you need to prepare the data mining data processing required. Data preparation is the data integration and data from multiple data sources need from mining, to ensure the quality and timeliness of data. Take advantage of useful data, clear false useless data is data mining technology base. Data preparation includes data selection, data preprocessing and data conversion steps.

Data conversion includes Content that: the property into several discrete intervals, generate some new variables from the raw data as a predictor variables, transition variables, changing format.

Data Mining: select the appropriate algorithm according to the characteristics of the type of data and functions, and data on the purification and the converted data set for data mining. The purpose is to generate data mining module can be shown, according to the meaning of their act of knowledge, which is the establishment of a realistic model of the world.

Results analysis: Data mining is pattern there may be no real meaning and value, there may not reflect the true significance of the data, even in some cases with facts not consistent, so the need for data mining results interpretation and evaluation, mining results to determine whether the

correct and effective, and ultimately converted into knowledge can ultimately be understood user.

Knowledge management: data mining for the purpose of the application, after confirming the results of data mining, the discovery of knowledge into the business system, business systems further validates this knowledge, and effective management of knowledge to knowledge share and use.

IV. PROPOSED ASSOCIATION RULE OF MINING ALGORITHM

One of the main mode of data mining association rules, its main focus on in order to determine the relationship between the data between different regions, as well as to identify the inter-domain satisfy a given condition dependencies. Data mining association rules are generally large databases or data systems, the rule generally expressed formula: $A_1 \wedge A_2 \wedge \dots \wedge A_m \Rightarrow B_1 \wedge B_2 \wedge \dots \wedge B_n$, which, A_k ($k = 1, 2, \dots, m$), B_j ($j = 1, 2, \dots, n$) is a data item in the database. There are support (Support) both transaction also includes A, the percentage of B, that is, the probability, expressed as a formula $Support(A \Rightarrow B) = P(A \cup B)$; Confidence (confidence) is included A transaction while the percentage of B contains, i.e. the conditional probability, $Confidence(A \Rightarrow B) = P(A | B)$. Correlation between data items are called data association, appears in an event, we can draw some inference other items will also appear in the same incident, according to some specific data items. Dig out hidden in the correlation between the data analysis is the purpose of association [12].

Mining association rules is rules based on support and confidence itemset process, under normal circumstances, this may be too ingredient is extract frequent itemsets mining rules to achieve.

In two steps association rule mining, the extraction of frequent itemsets is key to the entire mining process, is to evaluate the quality standards associated with the rule during the operation requires a lot of I / O operations. According frequent itemsets found digging out strong rules with high confidence can be calculated by the formula

$$C(X \rightarrow Y) = \frac{\sigma(X \cup Y)}{\sigma(X)}$$

obtained. Until now most of the association rule algorithms are resolved to extract frequent itemsets. The specific process may have the following Figure 5 shows. D input data set, the user identify the threshold based on support from D all the frequent item sets, then tap the rules, according to the credibility threshold dig out all of the strong centralized rule in frequent item, all the final strong set of rules. You can use the support and confidence threshold rules guide the mining process, but also timely to assess the threshold be adjusted according to the rules of the association, to reach the desired effect.

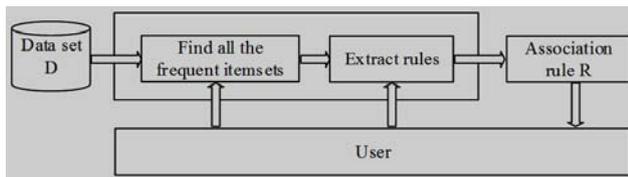


Figure 5. Association rule model.

Apriori algorithm found that all item (set), support less than the minimum support. The ratio of the number of transactions to support the general set of projects, including projects set total number of transactions. Set to meet the minimum support constraint is called frequently set. The algorithm requires a plurality of through the data. In the first pass, supporting individual projects. In this passage, frequent decisions. In each subsequent pass, a seed set found frequently in previously generated by a new set of frequently used, called a candidate set. They are supported by actual statistics after. Finally, those who gather to meet the minimum support constraint, that is. OK, frequent set, these seeds of the future through. Repeat this process until no new frequent sets.

The proposed work implements the task of mining association rules in a distributed fashion. Following is the pseudo-code for the proposed distributed approach of Apriori Algorithm:

1. Generate valid user credentials. (These are required in a grid environment for making secure communications)
2. Request the server to start generating association rules in a distributed fashion.
3. Prepare the transactional matrix. (Transactional matrix is a representation of the entire database and is prepared by scanning the database once)
4. Distribute the transactional matrix's data equally among available grid nodes using Reliable File Transfer service. The data is partitioned horizontally.
5. On each grid node, do the following: a. Calculate the local candidates b. Generate frequent local item-sets by pruning the non-frequent itemsets c. Mine frequent local association rules d. Send mined rules back to server
6. Receive the data from all the grid nodes and generate the global association rules
7. Send the mined global association rules to the client.

The implementation of the above steps in grid environment is shown graphically in Figure 6 below.

Effective methods first need to generate the user credentials association rule mining. Generate credentials server acts as the certificate authority, or as a rule mining mesh nodes. Distributed Apriori web service creation and deployment on the server, and each grid node involved in the work performed. Once the server accepts the request, the distribution of Apriori web service calls.

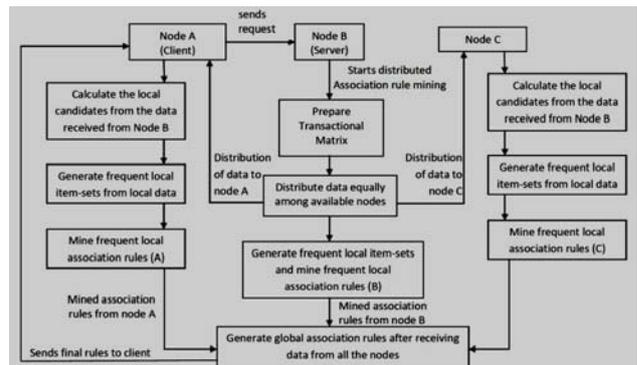


Figure 6. Working of proposed Distributed Apriori Algorithm.

V. BASED ON DATA MINING MUSIC STYLE CLASSIFICATION

Music style classification method based on computer technology is a promising area of research. In today's emerging style of music, study of musical styles has become a focus of research in the field of musicology. In this paper, data mining techniques combined with theoretical knowledge of music, the style of music in the original classification of harmony and melody style classification of information as a basis for the use of data mining technology for music style classification, the structure shown in Figure 7.

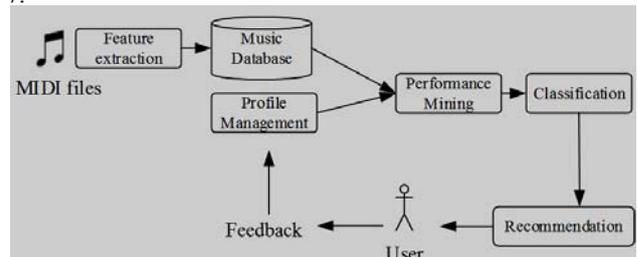


Figure 7. Architecture of music genre classification system.

Music is not just entertainment and fun, but was used for various purposes because of their social and physiological effects. The early 21st century, the world is facing the growing online music information, authorized by the penetration of the Internet into their daily lives. Efficient and accurate automatic music information processing (especially access and retrieval) will be a very important issue, it has been enjoying more and more attention. Music can be divided based on their style and the style have a hierarchy. The current hot topic in the automatic music information retrieval problem is to organize, classify, describe the online music content. Such efforts can be found, such as mp3.com and Napster online music database. An important aspect of the genre structure in these online database type is specified by a human expert and amateur (such as the user), the label process is time-consuming and expensive. Currently music genre classification is mainly done by hand, because give a precise definition of a musical genre is extremely difficult, and in addition, a lot of music sounds sit boundaries between types. These difficulties are due to the fact that: the development of an art of music, performers and composers

has been the subject of other genres of music. However, it has been observed that certain characteristics of the audio signal (digital or analog) of the same type of music sharing, since they are made similar instruments, have a similar rhythm patterns, similar to the pitch profile. This shows the feasibility of automatic genre classification.

Classification of us here meant by automatic music genre is the most stringent form of the problem, namely. Classification of the music signal to a unique musical characterization analysis based computing class. Automatic music genre classification is a fundamental part of the music information retrieval system. We put music genre classification process is divided into two steps: feature extraction and multi-classification. In the feature extraction step, we extract the music signal information represents the music. Feature extraction should be comprehensive (on behalf of the music is very good), (a small amount of memory) compact, efficient extraction (does not require much computing). It must be designed to meet the first requirement of such low-level and high-level information, including music. In the second step, we have established a mechanism (an algorithm and / or mathematical model) identification tag indicates music sounds on their properties.

We have a lot of work in the speech recognition feature extraction and music-speech discrimination, but less work has been reported in descriptive characteristic development specifically for musical signals. To our knowledge, currently the most influential direct modeling method to automatically classify the type of music signal is due Tsanetakis and cook, texture field timbre, rhythm and pitch content is characterized by explicit development. The accuracy of classification based on these characteristics, however, only 61% to ten-genre sound data sets. This raises the question: Are there different characteristics, more useful music category and whether to use statistical and machine learning techniques (such as discriminant analysis and support vector machine.) You can improve accuracy. The main purpose of this paper is to solve these two problems.

VI. EXPERIMENT

Specific examples will show more clearly assumed mining method based on data characteristics and advantages. In Figure 8, left to right and top to bottom, ten music sounds are characterized by different genres from ten-genre dataset. We observed a distinct feature to characterize different music genres. For example, several decomposition characteristics, the corresponding function from 20-30, is obviously different countries and discos. The difference is very consistent with human perception of music. Figures 9 and 10 show characteristic blues and one thousand and one ten years respectively, from the sounds of classical music dataset based on data mining. We observed similar characteristics exists in a musical genre. If our observations are correct, a unique DWCHs function mode exists in every genre of music, we can assume that the use of data mining would increase music genre classification.

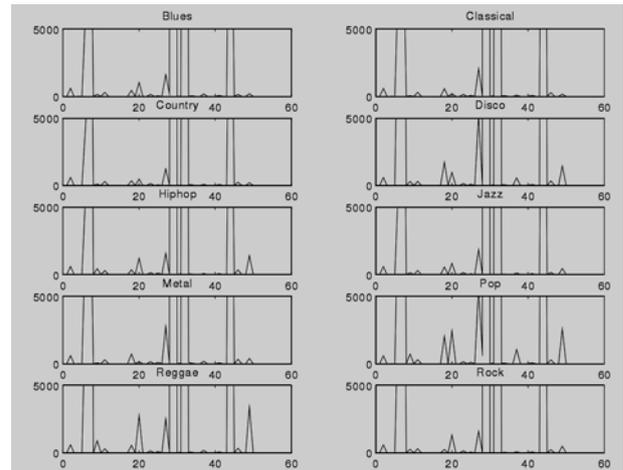


Figure 8. 10 music signals in different genre.

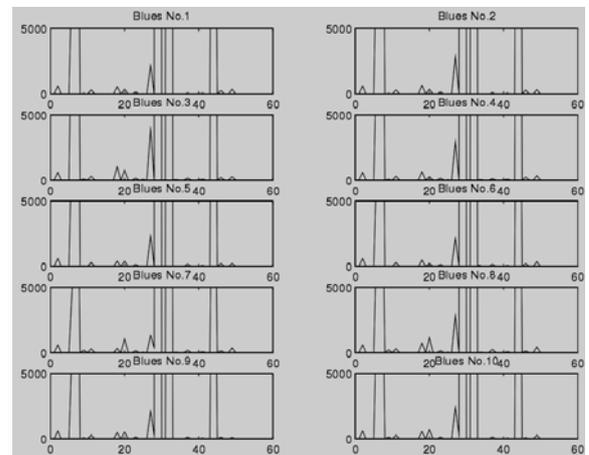


Figure 9. Data mining based musical genre of ten blues songs.

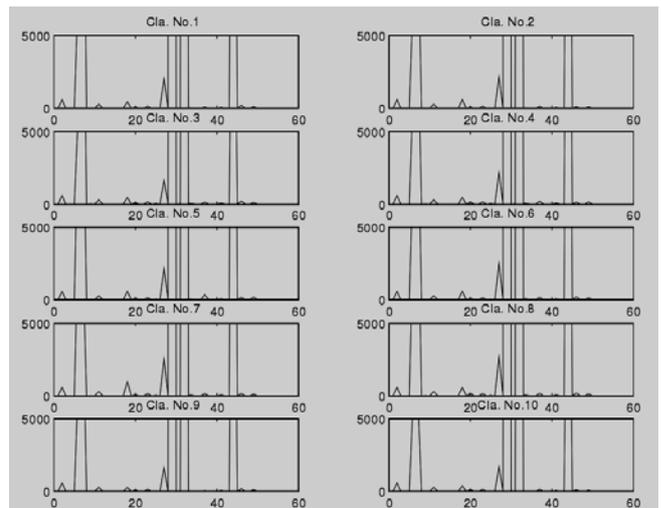


Figure 10. Data mining based musical genre of ten classical songs.

VII. CONCLUSION

With the explosive growth of online music resources, the development of popular music information retrieval research, and automatic music style classification has become an important field of music information retrieval. Music is a stick used to send an inner feelings of people very important art form, and emotional expression of specific music style varies depending. Music style classification method based on computer technology is a promising area of research. In today's emerging style of music, study of musical styles has become a focus of research in the field of musicology. In this paper, data mining techniques combined with theoretical knowledge of music, the style of music in the original classification of information as a basis for harmony and melody style classification, the use of data mining technology for music from the bottom up, segmentation, stratification style classification, and other classifications related test methods were analyzed and compared to give a more satisfactory test results.

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