Mapping musical notes to socio-political events

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1 Introduction

Musical genres are labels created to characterize different types of music. In the past, categorising using musical genres was carried out manually by humans. Nowadays these may be replaced by automatic musical genre classification replacing the manual procedure. This is a topic which has seen an increased interest recently as one of the cornerstones of the general area of Music Information Retrieval. It is also certain that music has a significant commercial, cultural and political impact on real-world events bringing positive change and unity into the commercial, cultural and political world.

In this paper, a neural and fuzzy technique is investigated for two main aims: (1) automatic musical genre classification and (2) mapping music notes to socio-political events. The validation of the algorithm is studied by using historical data.

Section 2 provides some basic methods for audio features extraction. Section 3 introduces briefly the neuro-fuzzy modelling of this study. Section 4 examines the genre classification and section 5 examines the mapping of musical pieces to one socio-political event. Some early conclusions are drawn.

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2 Audio features extraction

Audio data are time series where the vertical axis corresponds to the current amplitude of a loudspeaker?s membrane and the horizontal axis corresponds to time. In order to obtain high accuracy for classification and segmentation, it is important to select specific features of audio files. Generally, audio file analysis is based on the nature of the waveform. Therefore, the features are selected on the basis of their numerical values. In this paper volume and aero-crossing rate are the two main features extracted in the numerical studies.The definitions for these two features are provided below.

Volume is one feature which represents the level of sound of the audio signal. This is represented by the amplitude and is also referred to as energy or intensity of audio signals.

$$V = \sum_{i=1}^{n} |S_i| \tag{1}$$

where V is the volume and S_i is the amplitude of frame i assuming the signal is subdivided into n frames.

The zero-crossing rate is the rate of sign-changes along a signal, i.e., the rate at which the signal changes from positive to negative or vice versa. This feature has been used in both speech recognition and music information retrieval.

The typical mathematical tool used in treating a signal is the Fast Fourier Transform of it from time domain to frequency domain.

3 Neuro-fuzzy modelling

Neural networks are good at recognising patterns but poor at explaining the decision making process. On the other hand fuzzy logic systems are good at explaining their decisions. However, they are unable to automatically acquire the rules and membership functions. A combination of these two systems generates a useful tool which overcomes the weaknesses.

A neuro-fuzzy system is a neural network which is functionally equivalent to a fuzzy inference system. Without any prior knowledge of rules and membership function it can be trained to develop fuzzy rules [1] and determine membership functions for the input and output variables of the system [2].

This modelling approach can be used to (1) build a model that can predict the behaviour of the underlying system and (2) control the system.

In this paper the Adaptive Neuro-Fuzzy Inference System (ANFIS) proposed by Jang [3] is adopted for the computational tests. This is one of the specific approaches of neuro-fuzzy systems in which a fuzzy system is implemented in the framework of an adaptive network. The ANFIS is similar to a multi-layer neural network with five layers. The first layer is an input layer implementing the first-order Takagi Sugeno inference system with two inputs and one output. It is referred to as the fuzzification layer and is used to determine the membership grades. The membership function used in the system can be any continuous and piecewise differentiable function such as the bell shaped trapezium, triangular, or Gaussian distribution. The second and third layers contain fixed nodes that provide the antecedent parts in each rule. The fourth layer contains nodes that are adaptive and computes the first-order Takagi-Sugeno rule output for each fuzzy rule. The fifth output layer computes the weighted global output of the system.

4 Music genre classification model

The authors implemented fuzzy neural techniques based on the ANFIS system described above in order to classify a song or a short sound clip into its corresponding music genre. Our algorithms have two phases: (1) feature extraction and (2) model implementations.

In feature extraction, six features have been used, including Short Time Energy (the energy of the signal in each analysis frame/window), Spectral Centroid (centre of gravity of the magnitude spectrum of the Fourier transform), Zero-crossing (Mean of zero crossings across time frames in the texture window), Spectral Flux (the squared difference between the normalized magnitudes of successive spectral distributions), and Spectral Rolloff (the frequency below 85% of the magnitude distribution).

In the validation process five types of music, namely, blues, classical, country, disco and pop were used to examine the automatic music genre classification methods described above. A total of 125 songs along the horizontal axis as shown in Figure 1 was used. The vertical axis uses the genres 1, 3, 5, 7 and 9 to represent blues, classical, country, disco and pop, respectively. For each genre there are 25 songs. The model is used to predict the genres provided by the songs. Note that the predictions (red plus) are in

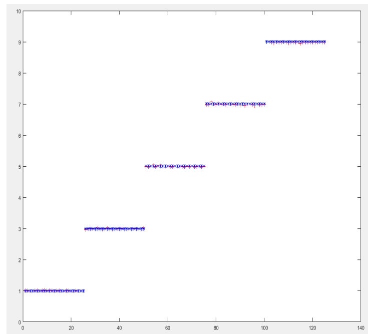

Figure 1: Genre classification results: Comparison between model prediction (red plus) and historical data (blue star).

good agreement with the experimental data (blue star). As such the model is ready to be used to classify the genres of any song provided.

5 Predication of one political event using popular music

A correlation between the popular music prior to election and the outcome of the election possibly exists. This indicates a dependency of the election results on the popular music. A model was developed for the purpose of validating the prediction. Training data which maps the election results to the popular music using the music features. This has been done using the above fuzzy neural network techniques. Data on the popular music hit list one year prior to the election and also data on the election results from June 1970 to May 2010 were collected.

In the validation process 26 songs from the hit list were used to check the model. Figure 2 shows the prediction (red star) of the election results in comparison with the historical data (blue circle). Along the vertical axis 1 represents the labour party and 0 represents the conservative party winning an election and the horizontal axis represents the hit songs. It can be seen the model predictions show good agreement with the historical data. Only a limited amount of data was available on the songs and larger data set would produce better and reliable prediction.

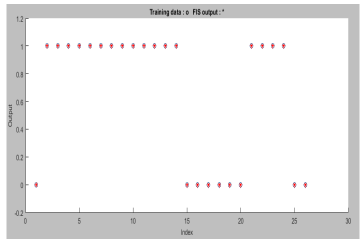

Figure 2: General election results: Comparison between model prediction (red plus) and historical data (blue star).

6 Conclusion

First, five types of music, including, blues, classical, country, disco and pop were used to automate music genre classification. A total of 125 songs were used in the experiments. The model developed is used to predict the genres provided the songs. Computational results demonstrated that the predictions are in good agreement with the experimental data. The model may now be used to classify the genres of any song provided.

Second, a correlation between the popular music prior to election and the outcome of the election is assumed. This could mean a dependency of the election results on the popular music. Therefore, a model is developed using a set of training data to map the election results to the popular music. This is done using neural and fuzzy network techniques. Data related to the popular music one year prior to the election and also data on the election results were collected for the study. A total of 26 songs from the hit list was used to check the model. The prediction of the election results in comparison with the historical data is well with the party winning the election matching the prediction. The model predictions show good agreement with the historical data.

Only a limited amount of data was available on the songs used in the above computational experiments. More data would allow for more reliable prediction. Future work includes refining the model for the political event prediction to become more sophisticated by adapting other machine learning techniques with a large amount of data. This technique described is suitable for understanding the correlation of music and political events.

References

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