A Study of Musical Influence Networks and Genre Evolution Based on the Pagerank Approach

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Abstract. The aim of this study is to investigate the definition of musical influence networks and the construction of multilayer directed networks. By analyzing the provided dataset, the parameters of an artist's musical influence were evaluated and a musical influence network was constructed using the Pagerank method. The study also extends the single-layer network parameters to a multilayer network and proposes a centrality measure based on node degree. In terms of genre analysis, the musical eigenvalues of each genre were calculated using MATLAB software and evaluated by a similarity comparison model and an influence comparison model. The results showed that there was a high degree of similarity between certain genres, and the influence of pop/rock music was the most significant. In addition, the changes and relationships of different genres over time were analyzed through multiple spatio-temporal networks, and the results showed that new musical genres have emerged over time, some of which have similar musical characteristics to existing genres.

Keywords: Musical influence networks, multilayered directed networks, genre analysis.

1. Introduction

This study explores important topics in the field of music, namely music influence networks and genre analysis [1-2]. The study of music industry and cultural influences has become increasingly important in modern society with the rapid development of digital technology. In this paper, based on an influence dataset containing 5854 artists over the last 90 years, we propose a music influence model based on multilayer directed networks. First, an assessment model is built by defining the parameters of an artist's musical influence. Then, the relationships between artists are modeled using a multilayer network structure, and the similarities and influences between different genres are explored. Finally, the evolution and relationships between different music genres are revealed through an analysis of music genres over time. This study will contribute to a deeper understanding of the trends in the music industry and the evolution of cultural influence [3-4].

2. Music influence networks based on the Pagerank methodology

2.1. Definition of musical influences

The provided dataset influence data contains influencers and followers of 5854 artists over the last 90 years. From this data, it is possible to obtain how many followers an influencer has and how long the influencer has put in the effort. Therefore, the parameters for evaluating an artist's musical influence can be defined as equation (1):

$$w_i = \theta_1 n_i + \theta_2 t_i \tag{1}$$

where n_i is the number of followers of the influencer, and t_i is the time of influence counted from the beginning of the influencer's musical career. θ_1 and θ_2 are the adjustment coefficients, which were determined to be 0.7 and 0.3, respectively, in this study.

2.2. Construction of multilayer directed networks

In single-layer networks, there are a number of well-known parameters that measure the structural relevance of each node, including node degree, closeness, median, class eigenvector centrality, and PageRank centrality. Below, we discuss extending these measures to multilayer networks. A primary centrality measure is per-node degree: the more links a node has, the more relevant it is [5-6]. The order of a multiplexed network with node i ∈ X， M = (g , c) is the vector.

$$k_i = \left(k_i^{[1]}, \ldots, k_i^{[M]}\right) \tag{2}$$

where $k_i^{[\alpha]}$ is the degree of node i in layer α, i.e.

$$k_i^{[\alpha]} = \sum_j a_{ij}^{[\alpha]} \tag{3}$$

This vector type of node degree is a natural extension of the network defined by the node degrees already established in the single layer. One of the main goals of an any centrality metric is to generate an ordered list of vertices by ordering the nodes according to their relevance in the structure. However, since the degree of a node in a multiplexed network is a vector, there is no clear order in $\mathbb{R}^M$ that can produce such a ranking. In fact, we can define many complete orders in $\mathbb{R}^M$, so we should clarify which of them are relevant. Once the vector type degree of a node has been computed, it is possible to aggregate this information and define the overlap degree of a node i ∈ X i.e., ∈ 1 ∈ 1(3). Indeed, many other aggregation measures f (k_i can be used to compute degree centrality, e.g., $k_i^{[1]}, \ldots, k_i^{[M]}$, of convex combinations or any norm. To facilitate the computation of the adjacency matrix, the artists are arranged in 1, 2, and 3. In the music-influenced multidirectional network, it is defined that each artist is represented at each layer by a node that is connected to the corresponding follower. The most crucial point in the process of obtaining a multiplicity of structures is the creation of links connecting the artists' representations at each layer. Influencers with more followers have darker colors. Figure 1 shows the whole network and a part of the network for a better visualization[7].

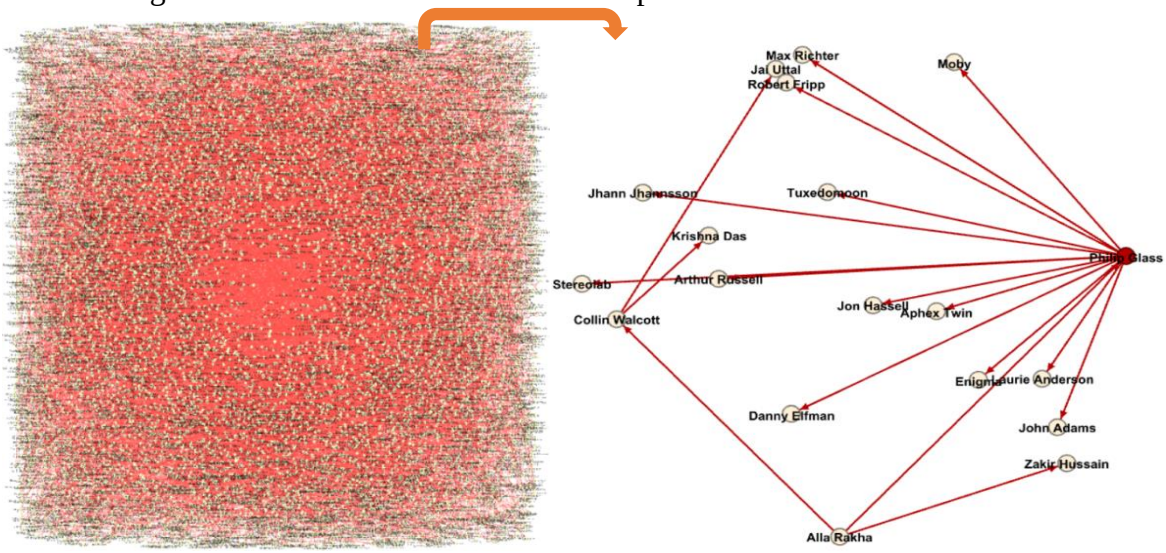


Figure 1. Directed Music Influence Network

3. Genre analysis model

3.1. Similarity Comparison Model

There are 20 genres in the dataset, and each genre has a corresponding artist. According to the simplified data, the values of F1,F2,F3,F4,F5 of each artist are calculated in MATLAB2020b

software, and on the basis of the similarity evaluation model mentioned above, the similarity between different genres is calculated.

It can be concluded that there is a high degree of similarity between the genres of avant-garde, classical, electronic, international, Latin, pop/rock, R&B, reggae, and religious. Blues is most relevant to country music; children's music is most relevant to blues; classical music is most relevant to reggae; comedy/spoken word has little similarity to the other genres; country music is most relevant to blues; easy listening is most relevant to jazz; folk music is most relevant to new age; international music is most relevant to Latin music; jazz is most relevant to vocal music; R&B is most relevant to Latin music; Latin music is most relevant to international music; stage and screen is most relevant to blues; and vocal music is most relevant to easy listening[8-9].

3.2. Comparative modeling of influences

Considering the 'musical impact' and the dataset provided, the impact of genres can be evaluated by 3 factors: popularity, number of artists, and duration of creation.

The impact evaluation model of the genre can be expressed in equation (4)

$$I_j = P_j + N_j + T_j \tag{4}$$

where P_j is the sum of artists' popularity in the genre; N_j is the number of artists in the genre; and T_j is the total development time of the genre's existence. Note that the data used in this model is normalized by the min-max method[10].

Based on the above model, the impact of each genre was calculated using MATLAB software and the results are shown in Table 1.

Table 1. Impact of genres

Avant-garde	0.1107	Jazz	0.1771
Blues	0.1205	Latin	0.1714
Children's music	0.1000	New Age	0.1099
Classical	0.1046	Pop/Rock	1.0000
Comedy/Recitation	0.1090	Rhythm and Blues	0.3083
Country Music	0.2137	Reggae	0.1429
Light Music	0.1032	Religious	0.1259
Electronic	0.1759	Stage & Screen	0.1120
Folk Song	0.1195	Vocal	0.1000
International	0.1200	Unknown	0.1278

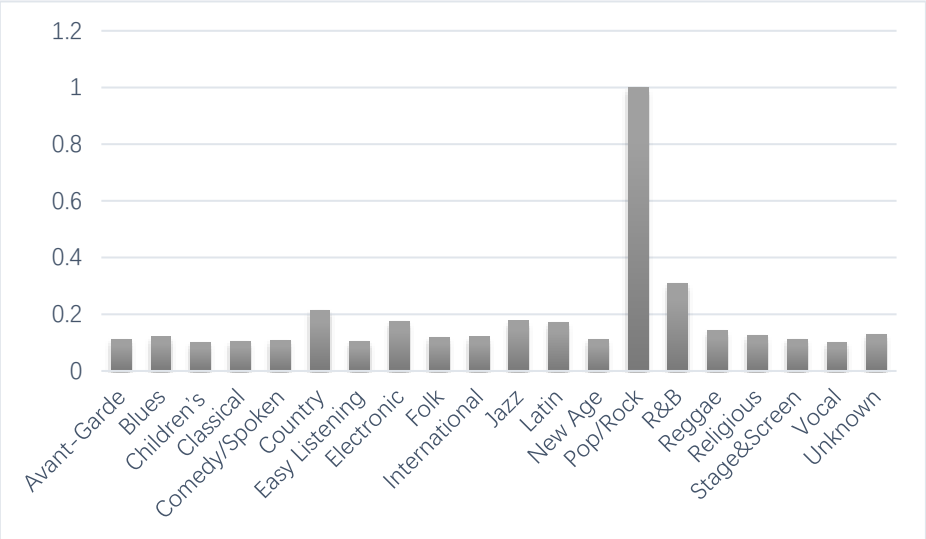
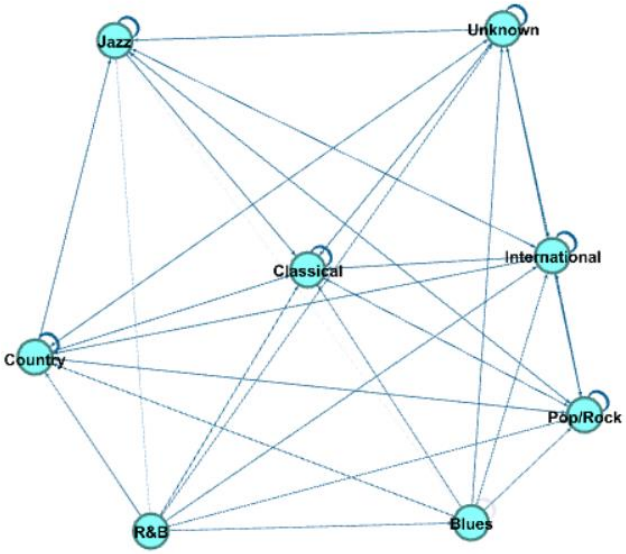


Figure 2. Impact of each genre

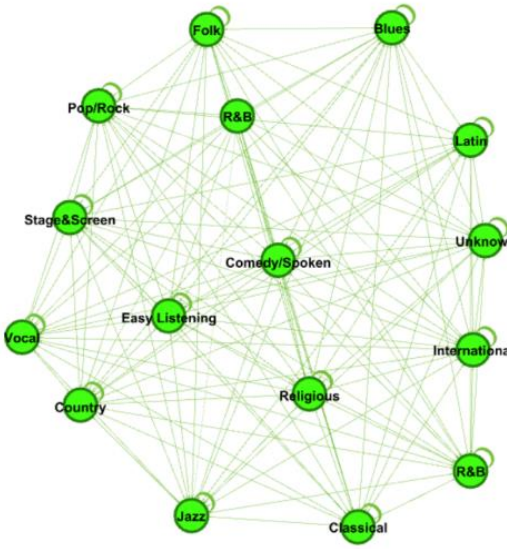
As can be seen in Figure 2, the combined effect of pop/rock is the most significant of the 20 genres, while children's and vocal music have smaller effects.

3.3. Genre changes and relationships over time.

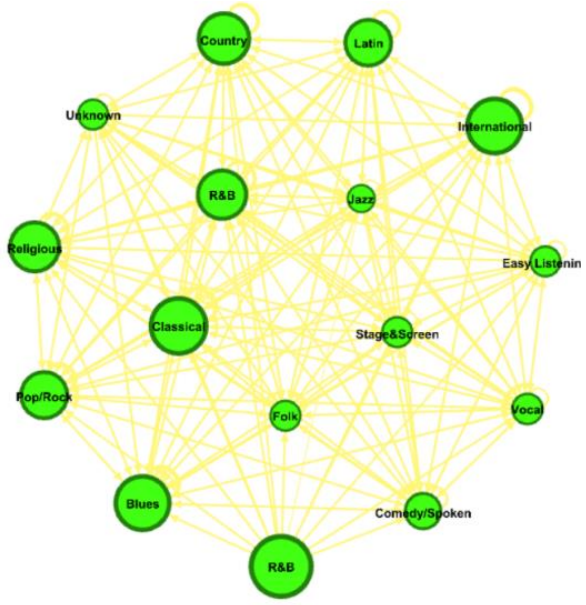
In order to clarify the changes in genres and the relationship between genres between 1920 and 2020, this paper uses a multiple temporally oriented network for analysis. Based on the data provided and modeled, Figure 3 provides a better illustration of how genres change over time.



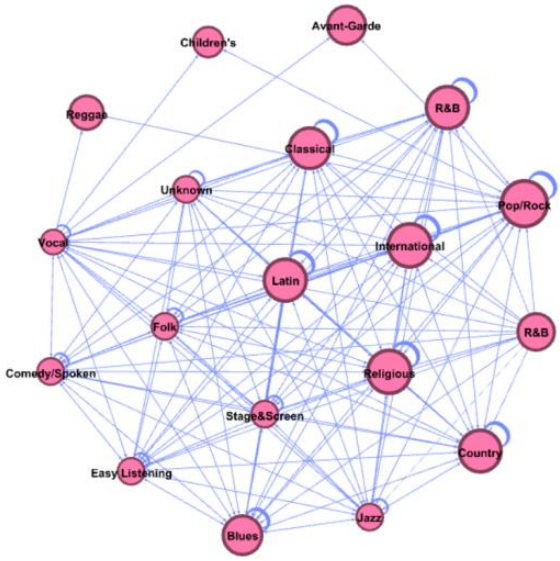
1920-1930



1930-1940



1940-1950



1950-1960

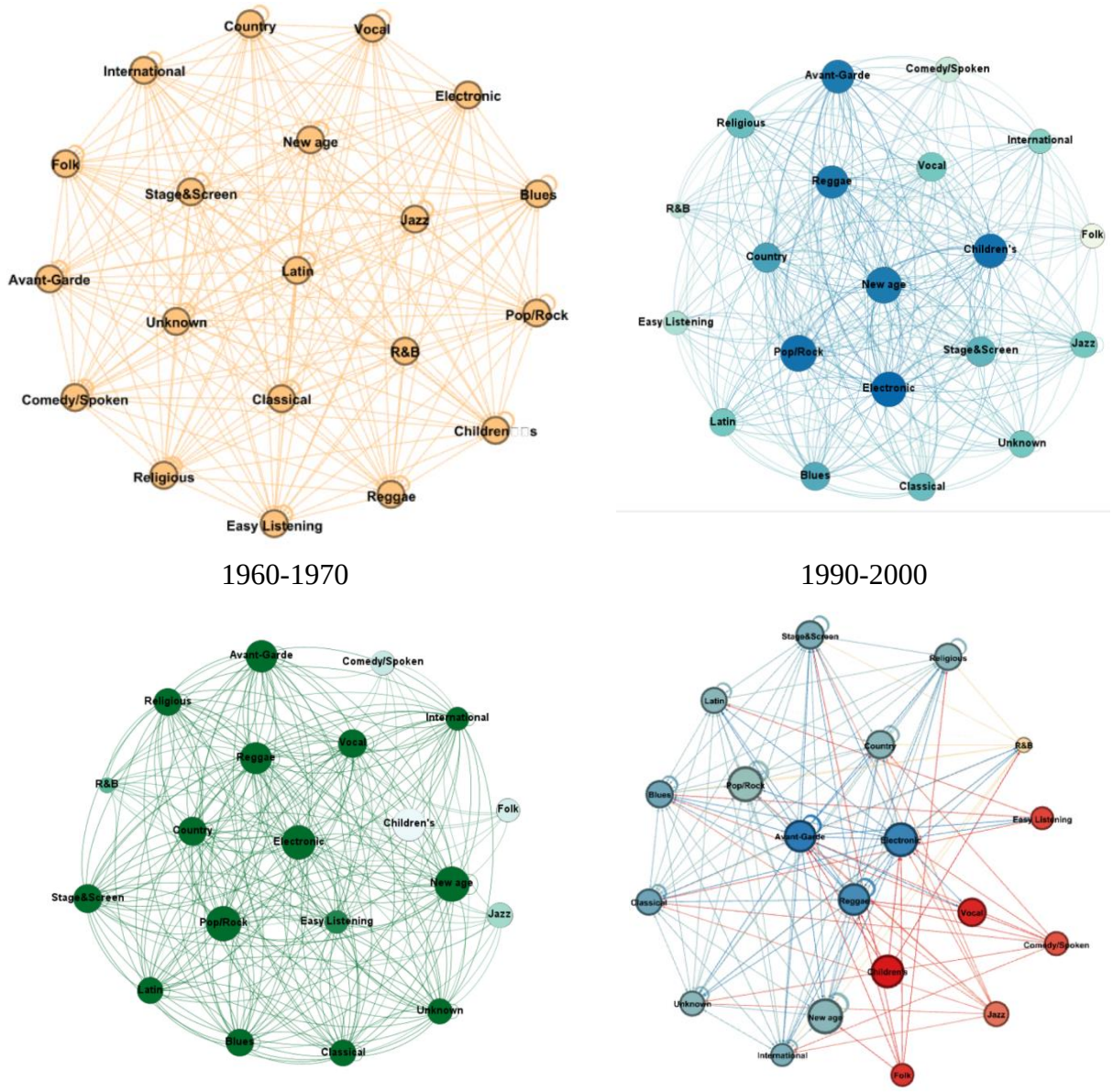


Figure 3. Dynamic multi-temporal network

In the network, the weight of the line between two nodes depends on the similarity between the two genres, with the bold line indicating a higher correlation between the two genres. In addition, the larger size of the node indicates that the genre has more influence on other genres. The conclusions are as follows:

(1) A genre has its own unique musical characteristics, and similar genres can be distinguished by using Principal Component Analysis (PCA) to reduce features F1,F2,F3,F4,F5 to compute similarity based on Mahalanobis distance.

(2) In 1920, there were only a few genres of music such as classical, jazz, country, R&B, blues, international and pop/rock. Some genres influenced others. As time went on, more and more new genres were created, some of whose musical characteristics were very similar to those of the existing musical genres.

4. Conclusions

This study reveals the relationships between artists and the interactions between different musical genres in the field of music through an in-depth study of musical influence networks and genre

analysis. First, we define the parameters of artists' musical influence and establish an assessment model. Second, the relationships between artists were modeled using a multilayer directed network structure to explore the similarities and influences between different genres. Finally, the evolution and relationships between different musical genres were revealed through an analysis of musical genres over time. Our findings provide an important reference for further understanding the development trend of the music industry and the evolution of cultural influence. This is of great significance to music industry practitioners, researchers, and music enthusiasts, helping to guide them to make more informed decisions when creating, promoting, and consuming music.

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