Network Analysis method of Multi-directional Music influence based on Graph Theory

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Abstract: Nowadays, music plays a more and more important role in enriching human spiritual life. In this paper, we establish a model to quantify the influence of music and capture the interaction between music artists based on music feature data. At the same time, we analyze the differences between artists and genres. In order to better understand the evolution and change trend of music development, we use complex networks to analyze the "influence _ data" data set, and establish a multi-directional network of music influence. After that, through the analysis of network association rules, we can get three parameters of music influence, that is, the followers' ability to inherit music, the followers' ability to derive music, and the influence of influencers on music influence. Through the analysis of network association rules. In the end, we can get the inheritance and derivative relationship between schools. These three parameters are the followers' ability to inherit music, the followers' ability to derive the rate of music variation and the influencers' influence on music.

1. Introduction

Since ancient times, music has become not only an important part of human social life, but also an important part of cultural heritage. Nowadays, because people are eager to understand the role of music in human collective experience, it is imperative to develop a method to quantify the development of music. However, when creating new music, there are many factors that affect artists. Therefore, we need to understand and measure the impact of previously produced music on new music and music artists [1].

In this paper, we create (multiple) direction networks of music influence based on data sets. And connect the influencer to the follower and develop parameters that can capture the "music influence" in the network. For the first time, we created and described a direct influence network to explore a subset of music influence.

2. The data processing

Step1. Summary genre
By analyzing the "influence_data" data set, we found that there are 20 genres as follows:

genre	num	genre	num
Avant-Garde	11	Latin	229
Blues	101	New Age	38
Children's	4	Pop/Rock	2808
Classical	28	R&B	677
Comedy/Spoken	46	Reggae	141
Country	403	Religious	89
Easy Listening	23	Stage & Screen	50
Electronic	208	Unknown	3
Folk	95	Vocal	162
Jazz	406	International	81

Step2. Data protocol

Based on the "influence_data" data set, construct the "source", "target", and "weight" data sets. For the "weight" data set, if the "influencer" and its "followers" have the same genre, the weight W is 1, otherwise w=0.

3. Construct a directed network graph

According to the different data storage structure, the network representation method can usually be divided into two types, namely: the adjacency matrix form and the adjacency table form. This article uses the adjacency matrix form of the network [2]. For the network G(V, E), the adjacency matrix is an n*n square matrix (n is the number of nodes), denoted by A. For any $v_i \in V$, $v_j \in V$, its definition is as follows [3]:

$$A_{ij} = \begin{cases} 1, if(v_i, v_j) \in E \\ 0, \text{otherwise} \end{cases} \tag{1}$$

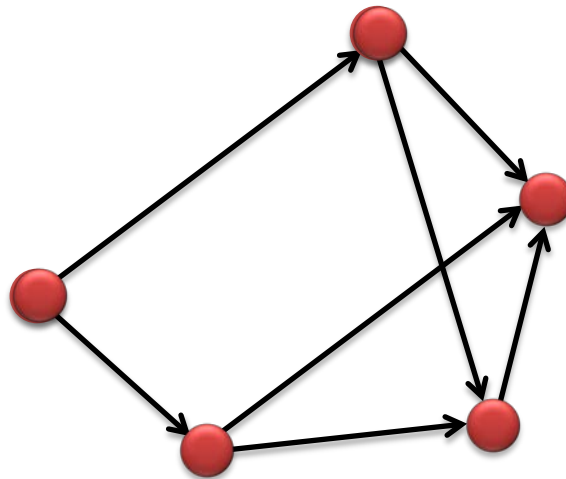That is, when $v_i \in E$ and $v_j \in E$ are related, A_{ij}=1, otherwise A_{ij}=0.

Figure 1: Conceptual diagram of directed network

3.1 Construct a directed network graph

In this paper, we use the "Influence_Data" dataset to create a targeted network of music influence, connecting influential people with followers. But every influential person is associated with a lot of people. If you draw directed networks, it is difficult to see the relationship between them. Therefore, we simplify it and draw a relational network diagram for conceptual guidance (as shown in figure 1).

Through the network diagram, we can find that most influencers and followers are in a many-to-many relationship. We can capture the three main parameters of music influence: the influencer's ability to "inherit _ create" music, the derivative ability of influencer to music "variation _ creation", and the influence of influencer's "influence". If an influencer has many followers, and the more followers belong to the same type as the influencer, the greater the "inheritance" of the influencer. On the contrary, the greater the degree of "variation" of the influencer. If an influential person can influence more followers, then his musical influence should be greater.

In this paper, we believe that even if there is no direct influence relationship between artists and artists, artists and artists can have a certain degree of influence through intermediaries. With the increase in the number of artists separated from each other, the degree of influence is getting smaller and smaller. The formula for calculating its weight is as follows [4]:

$$t_i = \frac{1}{2^i} (i = 0,1,2. n) \tag{2}$$

Where N represents the depth of influential people and followers
The calculation method of "Inheritanc_vate" of influencer a:

$$Inheritance_a = \frac{\sum_{i=1}^{n} W_i \times t_i}{\sum_{i=1}^{n} t_i} \tag{3}$$

Alculation method of "variation_rate" of influencer a:

$$variation_a = 1 - Inheritance_a \tag{4}$$

The calculation method of "influence" of influencer a:

$$influence_a = \sum_{i=1}^{n} W_i \times t_i \tag{5}$$

3.2 Calculation results of musical influence parameters

Through calculation, we can get the top five "artist_id" in music influence and their three music influence parameters

Table 2: Influence parameter table

Artist_id	inheritance	variation	influence
754032	0.679548	0.320452	1100.985
66915	0.651346	0.348654	1020.036
120521	0.646113	0.353887	936.8556
128099	0.14661	0.85339	927.0103
894465	0.694359	0.305641	925.4893

3.3 Describe the subnet

In this paper, the Association rules we use is $A \Rightarrow B$.

Among them, an and B represent two mutually exclusive events, an is called pre-event and B is

called result event. The above association rules indicate that A will lead to B. Specifically, in this article, it means that class A derives from class B, and the strength of association rules can use their support and confidence:

$$S(A \Rightarrow B) = P(AB) \tag{6}$$

$$C(A \Rightarrow B) = P(B \mid A) = \frac{P(AB)}{P(A)} \tag{7}$$

Mining association rules from the "influence_data" dataset, the following results can be obtained:
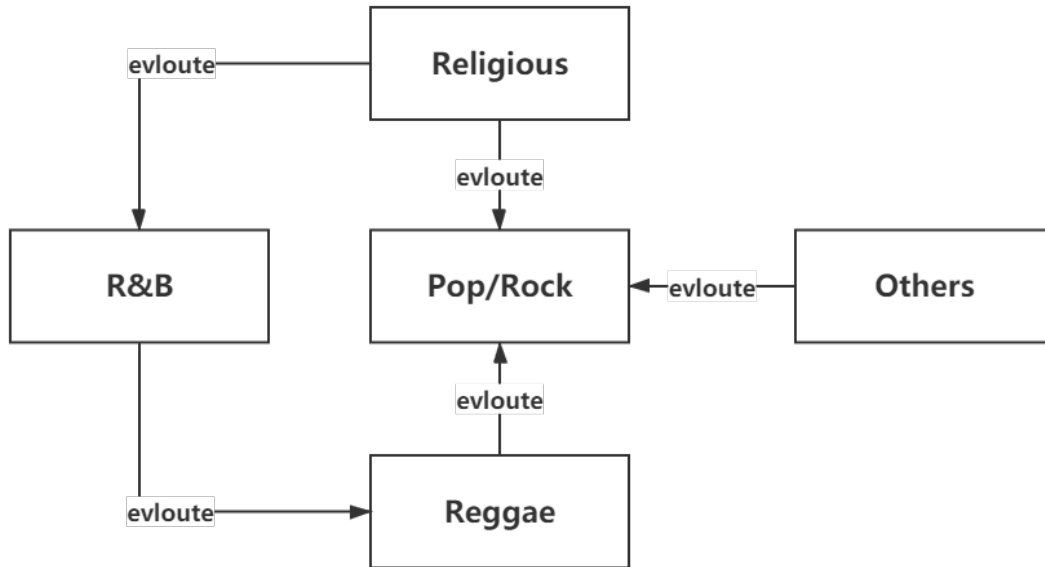

Figure 2: Music genre evolution chart

4. Conclusion

In this paper, we established a music influence (multiple) direction network based on a dataset. It also connects influencers with followers, and develops parameters that can capture the "music influence" on the Internet. We created and described a direct influence network for the first time to explore a subset of musical influence.

References

[1] Miwa N. The Necessity of Communication through Music in the Growth Process of Human Beings (I) [J]. Journal of the Faculty of Global Communication Siebold University of Nagasaki, 2005, 6: 165-174.
[2] Ma Haiying, Xiao Yuzhi, Zhao Haixing, Wu Huan, Luo Haixiu. Three-layer complex network model construction and characteristic analysis [J]. Complex Systems and Complexity Science, 2020, 17(04): 16-29.
[3] Diestel R. Graph Theory [J]. Mathematical Gazette, 2000, 173(502): 67-128.
[4] Awerbuch B, Shavitt Y. Topology aggregation for directed graph [C] // IEEE Symposium on Computers & Communications. IEEE, 1998.