Research Article

Multivariate Statistical Analysis of Interaction Mechanism and Identity in Multiethnic Community Based on Random Matrix

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At a time when the world is undergoing an unprecedented and dramatic change, strengthening the national spirit of the nation is the key to improving national unity and competitiveness, as well as an important force in unifying the Chinese national spirit. In the course of the development of the Internet, the mechanisms of interethnic interactions among multiple ethnic communities are increasingly enriched and there is a trend towards multidisciplinary and permanent research on ethnic cultural identities, resulting in a constant change in the structure of ethnic interaction and identity networks among ethnic communities. At the same time, the particular perspective and successful application of RMT in the physical realm of reality offers great opportunities for the creation of a complex network of interactions. In this thesis, a matrix of weights is developed for group interaction mechanisms and identity systems of multiple ethnic communities, from which the eigenvalues of the network are identified and matched to the energy spectrum of the random matrix. On this basis, the overall interconnections in real information are investigated in terms of the characteristic spectral density, localized features, and frequency band intervals according to the basic principles of the random matrix. The statistics and analysis of the interaction mechanisms and cognitive concepts of ethnic minority groups in China can visualise and analyse the general ideas, methods, and paths of ethnic cultural identity in China. It can promote communication among ethnic groups, enhance people’s cultural identity, and strengthen China’s cultural cohesion.

1. Introduction

National cultural identity is a dynamic and historical process of national identity and construction [1]. No matter what era, a nation’s cultural identity is the key to a country’s political stability and long-term peace, and in today’s era, it is an important construction and expression space [2]. At present, the international society is undergoing a drastic change and reconstruction. Due to the great changes in the cultural structure, it is difficult for China’s cultural integration to become a complete and historically significant tradition. In addition, although world peace and development are still the main issues of world politics, it is undeniable that countries in the world, through their own economic and political power, have carried out multichannel, continuous, long-term, and hidden efforts to China’s traditional culture. Sexually spread its imperialist violent ideology. From the perspective of globalization, the dilemma of “dual identities” brought about by China’s “objective” and “artificial” arouses scholars’ thinking. The issue of the nation’s cultural identity has been discussed vigorously by critics, with outstanding achievements in various disciplines and fields [3]. Most scholars believe that strengthening China’s national cultural identity is an important national identity and consider it an important national identity. In addition, this paper also conducts a more in-depth discussion on the logic, connotation, ethics, and policy changes of national cultural identity. However, in our country, due to the lack of systematic understanding of the region, most scholars only discuss it within their own professional scope, so it is necessary to carry out statistics and analysis.
In 1928, Wishart [4] conducted a work on the Gatlassian matrix, and the results of the mathematical theory of Hsu et al. showed that under the normality of the Wishart matrix, the combination of the unit and the characteristic root of any matrix is consistent with the mathematical theory [5]. The random matrix method, which is a very important mathematical tool, was born in the mathematical community but is not popular in the academic community [5]. In Wigner [6] (1958), the randomness matrix is used to discuss the spectral resonance problem of heavy nuclei. At greater distances, more precise information on energy levels can be obtained, while in the structural mode of the atom, calculations can only be performed close to the ground state. Wigner [7] provided a new approach to the study of spectroscopy, although statistical principles were used to calculate a single energy level, it could well reflect nonuniform shapes and shapes. Due to the contrast of random multidimensional statistical properties, it reflects random deviations in real data and reflects the overall correlation in real data. Therefore, $T$ has been found in applications such as physics, finance, mathematics, biostatistics, networks, and application [8–12]. On the basis of RMT, the researchers used the RMT method to compare the variation law of the maximum eigenvalue of the US stock market between 1962 and 1997, thus highlighting the characteristics of the US stock market crash in 1987 [114].

Using a random matrix approach, group identities and interactions of multiple ethnic minority groups were statistically and analytically analysed. Based on the rasterised information of the community population, the matrix-type distribution of interrelationships between different ethnic groups and communities is compared, and the statistical analysis of the random matrix is used to explore the study of ethnic cultural identity from multiple perspectives, thus making some efforts to strengthen the ethnic cultural confidence of the ethnic groups [13–17].

### 2. Principle of Random Matrix Theory

The random matrix method is a new doctrine developed from atomic nuclear physics. The method statistically treats the energy spectrum and eigenstates of complex systems to obtain the randomness of the real data, thus reflecting the overall correlation in the real data. In the topological domain, local features are used for analysis, while local properties are better suited to analysis in the spectral region. It is clear that in the topological domain the graphs are expressed in terms of nodes and edges, whereas in the spectral region they are expressed in terms of their eigenvalues and eigenvectors. Therefore, each graph can be represented using a matrix, and the characteristic system is a good way to do this. The reset consisting of all the eigenvalues in the graph and its multiple quantities is also called the density of states. On this basis, statistics on the order of energy levels of an arbitrary matrix are presented, including spectral density, participation rate and structural entropy, energy level rise and fall statistics, spectral stiffness, and nearest neighbour spacing.

### 3. Data Sources and Model Building

#### 3.1. Data Sources

Multiethnicity is the result of the permanent settlement and exchange of different ethnic groups in different geographical areas, which in turn give rise to different ethnic groups. The components of a multi-ethnic community are multiethnic, geographic, social systems, and organisations. According to the history of interactions between the ethnic groups in the community, multiethnic communities can be divided into three main categories: traditional multiethnic communities, identifying multiethnic communities, and building multiethnic communities.

The concept of national identity and national identity is the identification and alignment of a national people with their natural and cultural tendencies. The identity orientation of national ties refers to a particular ethnic group, the identity belonging to that group, which has its roots in the boundaries between that group and other ethnic groups; the cultural identity of the nation is the development of a multiethnic community where the members of each ethnic group come from all over and are not familiar with each other. They are usually a particular group, so their work is very clear and they make their own contributions to their communities. This study is based on information about interactions between communities within a multiethnic community in one region and includes the total number of participants as well as the total number of participants. Interaction is the act of exchanging information in relation to an engineering product. The interaction construct of an interacting body is in fact a composite networking, and the corresponding networking can be used to describe and analyse a composite system that emerges from the process of exchange between many different ethnicities. A net is the abstraction of many human interactions into a whole composed of points to surfaces.

Any kind of complex net can be depicted by a set $G = (V, E)$, where $E$ represents a set of points of the net and $E$ represents a set of faces of the net. Each part of $E$ has a set in $V$, and $E$ is a set of edges that connects two elements in $V$. The number of points in the set of notation points $V$ is $N$ and on the set of edges of $E$ is $L$. In the set of edges $E$, an edge is an undirected net if $(i, j)$ is the same as $(j, i)$, and conversely, a directed net; if either of these is the case, it is said to be a net without authority, or a weighted net. This thesis focuses on undirected nets in depth.

In carrying out the analysis, a matrix is generally used in the form of $N$ nodes corresponding to $N$ level nodes A, i.e., the connections between the nodes of node $i$ and node $j$ on that network. In practice, any kind of network can be expressed in terms of some kind of matrix, but not necessarily all of them are one.

In describing the connections between the nodes of a network, their interaction is adequately represented by the use of an adjacency matrix. The adjacency matrix provides a complete picture of the properties of a network, and the eigenvalues and eigenvectors that the adjacency matrix has are related to many of the underlying topological non-parameters in the network, such as network diameter and robustness. The eigenfrequencies of the adjacency matrix can be used to better analyse its topology and dynamic performance.
3.2. Interaction Structure Model. Multiethnic communities will inevitably increase and decrease projects, the number of community users will change, and the scope of community activities will also change. Therefore, the nodes and number of social networks will also change accordingly. As the community grows and develops, the number of community members increases and the communication network of the interactors becomes more complex. In human society, the communication between people is very crucial. Only by understanding the communication between people, we can better understand the development mode and rules of society.

This paper uses a multiethnic community in a region as a sample, and the types of materials cover different cultural identities and interaction methods. The six years from 2016 to the first quarter of 2021 are divided into two groups.

As shown in Figure 1, we can easily see how the number of interactions in this group has changed over time. From the first quarter of 2016 to the first five months of 2021, the number of exchanges in this group continued to increase steadily. However, in the second half of 2020, the total number of exchanges dropped sharply by around 700, and the number of exchange users recovered in the first half of 2021.

The change in the total number of interactions in this group over time can be easily seen in Figure 2. The trend curve for the overall number of interactions is more complex when compared to the number of participants. The total number of interactions declined in the second half of 2016, the second half of 2018, the second half of 2020, and the first half of 2021, with the number of interactions in particular declining by more than 50% in the second half of 2020 over the first half of 2021, a change closely linked to the number of interactions over this period together.

4. Theoretical Analysis of Random Matrix of Interactive Structure Weight Matrix

The weight matrix can reflect both the presence or absence of connections between individuals, as well as the differences between individuals and the continuity of connections and can better reflect the true picture of the system. Therefore, it is of great interest to delve into the weight matrix of interaction relationships.

4.1. Eigenspectral Analysis of Weight Matrix. In Figure 3, we can clearly see that the difference between the largest and smallest eigenvalues in the weighted matrix of the interactive structure is very large because the differences in the network make some of the elements in the weights more, but most of them are 0, which causes some eigenvectors to have a greater impact on some feature vectors, which causes the extreme value distribution of each eigenvalue to be unbalanced. 4.2 Characteristic spectral density distribution.

4.2. Characteristic Spectral Density Distribution. In the interaction structure, although the weighted matrix of the interaction relationship has a large amount of information, the spectral density of its characteristic values is not affected by the Wegener semicircle. At each stage, the spectral density distribution of the weight characteristic values of the interaction relationship is basically the same; that is, the number of members of the 11 interaction relationships in Figure 4 will change significantly at different times, and the frequency of interaction will also change greatly, but the composition of the community group is relatively stable. The eigenvalues of the weighted matrices range widely, with the maximum peak at zero eigenvalues being higher and the trailing at large eigenvalues.

4.3. Expanded Spectrum Cumulative Distribution Curve. Figure 5 shows the cumulative distribution of the characteristic spectrum of the interactive structure after
Figure 3: Weight matrix eigenvalues.

Figure 4: Continued.
Figure 4: Continued.
“expanding” at different stages, in which the blue circle represents the cumulative distribution of the initial characteristic spectrum, and the polynomial fitting method is used to analyse the “expanded” characteristic spectrum. Statistical analysis. The cumulative distribution diagram of the characteristic spectrum of the interactive structure weighting matrix after “expanding” is basically in a steep S-shape. The distribution graph is steeper and has a larger difference from the smooth random net sigmoid curve.

4.4. Localization Properties of Weight Matrix. Just like the discussion of the local characteristics of complex networks, when recognizing the local properties of complex networks, we must first recognize the local properties of their complexity, which are usually quantified by the participation ratio; then, using the structural entropy value, the probability distribution function and the most basic step relationship is studied in depth. Local characteristic parameters of each time period in the weight matrix of the interactive structure are shown in Table 1.

As the participation ratio of the communication architecture weighting matrix changes over a period of time, as shown in Figure 6.

The participation rate of the interaction behavior changes with the increase of the number of interactions, and the degree of activity of the interaction behavior shows a fluctuating and undulating nature, and the participation rate is between I/N and 1 (I/N is the full localization of the system, 1 is full diffuse). Studies have shown that the participation obtained using the averaging method describes the weighted matrix more closely to the local region. In the case of absolute domainization, the system of weighted matrices is a constantly changing system, and the interaction structure weight matrix participation rate change graph is shown in Figure 6, and the result coincides with the Boolean matrix network.

The following graph shows the entropy of the interaction structure weighting matrix changing over time.

In the structural entropy portrayal in Figure 7, the probability distribution function deviates from the most basic step relationship at the structural point. It can be seen that the structural entropy of most of the interacting structural weighting matrices falls within the interval of 0.3 to 0.7. Overall, the overall variation in the structural entropy of the probability of occurrence of each node in the weighting matrix network is small and the degree of deviation at the same time period is relatively small. The results show that the magnitude of deviation of the probability distribution function at the network construction points of the weighted matrix in different time periods is smaller, at 0.7 in the first half of 2018, and has the smallest deviation from other time periods.

Most of the networks available in practice are small, and the expressions for the energy levels are often not directly available and can only be approximated with a smaller amount of information. The original frequency band and the corresponding cumulative distribution function are first normalised using an “unfolding” approach, and then a smoothed segment of the extended frequency band is derived using a higher order fit to obtain its nearest neighbour distance. The smoothed results are very slightly different from the actual results after fitting a large amount of information to the entitled case, where each edge value varies considerably, and the results are therefore satisfactory.

4.5. Discussion of Results. The weight matrix in the interactive construction can reflect the interaction between each node in the interactive construction and also has a small feature quantity. The characteristic spectrum of the method is studied, and the results show that the zero eigenvalue of this method is relatively high, and the phenomenon of “drag” exists under the large eigenvalue. At the same time, its characteristic spectrum cumulative distribution is relatively steep S-shaped. From an average point of view, the localized characteristics of the weight matrix fluctuate between absolute localization and absolute diffusion states. In different
Figure 5: Continued.
Figure 5: Characteristic spectrum cumulative distribution curve: (a) 201601, (b) 201602, (c) 201701, (d) 201702, (e) 201801, (f) 201802, (g) 201901, (h) 201902, (i) 202001, (j) 202002, and (k) 202101.
periods, the probability distribution curve of the probability distribution has a small deviation in each period, and the deviation of the probability distribution is the smallest in the first half of 2018.

5. Conclusion

By means of random matrix analysis, the group interaction and the overall dynamic process of the group in the multicomunity were analysed. In current academic circles, there is a normative discussion of the cultural identity of the country. Starting from the cultural identity of the nation, the cultural soft ability of our country has been explored, and a lot of results have been achieved. There are many research results in sociology, ethnology, philosophy, literature, history, economics, and so on. This paper explores multietnic communities from a new perspective, which can enable us to better understand the characteristics of the social information interaction structure in the Internet society, provide a useful reference for the reality of the mass production mode, and provide a useful reference for the development of multietnic groups. It plays an important guiding role in the future social development. However, this paper is only a preliminary discussion on the mechanism of its dynamic evolution and the role of the open source community communication network.

At present, the world is facing unprecedented and dramatic changes and is faced with both opportunities and severe tests. The cultural identity of the nation is an important part of our national spirit. In this new stage of history, we must continue to expand our national cultural identity and maintain a strategic position in the process of heritage and innovation. In view of the above, this paper has the following points to make regarding the future exploration of issues related to the cultural identity of the nation.

A multidisciplinary academic community is established. It is important to break down traditional disciplinary barriers and combine the fields of socialist theory with Chinese characteristics, sociology, literature, history, and statistics to produce representative and high-quality cutting-edge results.

The exploration of theory and practice is deepened in the new situation. At present, due to the negative impact of the New Coronavirus, the global economic downturn, the global economic regression, the country’s victory over poverty, and the overall prosperity of all ethnic groups, it is worthwhile to
explore how to enhance the cultural identity of the Chinese nation from a fresh perspective. Researchers must keep abreast of the times and discover new ideas based on a new historical period in order to promote cultural epistemology and practical research in China.

Data Availability

The dataset used in this paper is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

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