Interdisciplinary phenomena and their regional differences in management science

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Abstract. It is of great significance to discuss the interdisciplinary phenomenon and its regional differences for a comprehensive insight into the intersection and integration of disciplines in the field of science and technology. In this study, based on the text information of the National Nature Fund Project, the corpus is constructed by using keyword information, combined with TF-IDF algorithm to improve cosine similarity, and a region-specific measurement method of discipline intersection is proposed. Using this method, the interdisciplinary difference maps of this discipline among provinces, autonomous regions and municipalities directly under the Central Government in China are obtained, and the interdisciplinary and regional differences in this field are analyzed. The results show that management science has small-world characteristics, and there are great differences in the degree of discipline intersection among different regions, which verifies the effectiveness of the construction method of this study.

1. Introduction

As more and more studies involve interdisciplinary, researchers have found that interdisciplinary is likely to achieve greater success in making breakthroughs and producing significant results [1]. The professional knowledge of a certain discipline alone can no longer meet the needs of knowledge innovation [2]. At the same time, the trend of interdisciplinary knowledge integration has become increasingly prominent with the development of science and technology and the dissemination and flow of interdisciplinary knowledge. Interdisciplinary break through the barriers of their respective disciplines, through interdisciplinary knowledge flow to achieve the purpose of knowledge innovation [3]. Since 2015, the national requirements for the development of scientific research institutions have begun to pay attention to interdisciplinary and knowledge innovation, among which the Ministry of Education and the Ministry of Science and Technology have repeatedly stressed the importance of interdisciplinary.

In view of this, the information of the National Natural Science Foundation of China constructs the interdisciplinary network in the field of management science, extracts the interdisciplinary relations within management science disciplines and the differences between regional disciplines from the network, and analyzes their cross phenomena and regional differences, in order to gain a more in-depth understanding of the characteristics of interdisciplinary and regional differences in this field.

2. Literature review
Interdisciplinary research can break through the academic barriers between various disciplines, easily form innovative ideas, and solve complex problems that are difficult or unable to be solved by a single discipline [4]. Brown [5] research shows that continuous cross-cooperation between different disciplines is the only way to promote sustainable development. C.H.Song [6] compares individual research and cooperative research on the phenomenon of knowledge flow within and between disciplines, and finds that the cross-discipline in cooperative research is higher than that in individual research. Tang [7] uses citation relations to analyze the interdiscipline in the field of library and information science, and the results show that the field of library and information science is a highly interdisciplinary field. Chen et al. [8] found that the highly cited papers of Top1% show a higher level of interdisciplinary intersection than other papers.

However, the traditional journal evaluation methods can not well measure cross-disciplines [9], so more and more researchers begin to study how to more accurately measure and evaluate the degree of intersection in a certain field or between disciplines. Generally speaking, scientific research is divided into the following three categories: first, based on statistical indicators, this kind of measurement indicators focus on the diversity of disciplines. Researchers mostly find the situation of interdisciplinary through the analysis of statistics and clustering of indicators, and combined with the corresponding empirical analysis. At the same time, demonstrate the effectiveness of indicators [10-11]. Second, based on the complex network index, the complex network has the characteristic of modularization, and there are some nodes belonging to different modules. Researchers use this feature to try to identify interdisciplinary trends and topics through the disciplinary network. Li Changling [12] and Yu Yang [13] used this method to study the current situation of interdisciplinary intersection in the field of information science. Third, construct multi-index comprehensive measurement. Rao-Stirling [14] index measures the "knowledge integration degree" of interdisciplinary research by combining the three dimensions of discipline richness, discipline distribution uniformity and discipline difference of references, which has a great impact on interdisciplinary research at home and abroad, but its performance is poor in measuring interdisciplinarity [15].

Through the carding of the above research results, it is found that although the interdisciplinary research has been accepted by the academic circles as a whole, the measurement of interdisciplinary research mostly stays in the external characteristics of the research results, the use of the internal characteristics of the research results, that is, the content of the text is very limited, but it has great potential [16]. Based on this, the text-based interdisciplinary measurement method is proposed in this paper to study the interdisciplinary situation in the field of management science and the cross differences in different regions.

3. Research processes and methods
In this paper, the interdisciplinary research is carried out by using text information, and the research and design process is shown in figure 1. First of all, the corresponding text set should be obtained according to the research needs, and then the text should be cleaned to extract the text information needed by the research to obtain the corpus needed for computing interdisciplinary intersection, then the improved cosine similarity is used to measure the similarity between different regions and disciplines.
3.1. Data collection
The intersection of disciplines often occurs in the research with higher academic level[17]. Therefore, this paper selects the projects of the National Natural Science Foundation of China with relatively guaranteed academic quality as the research sample, and uses the Selenium toolkit to climb a total of 2815 completed projects in management science during the five-year period from 2014 to 2018, as shown in Table 1.

Table 1. Number of completed projects in Management Science from 2014 to 2018.

| Year | number of entry |
|------|----------------|
| 2014 | 7              |
| 2015 | 684            |
| 2016 | 756            |
| 2017 | 707            |
| 2018 | 661            |

3.2. Data preprocessing

3.2.1. Discipline corpus. This study directly adopts the discipline classification used by the National Natural Science Foundation of China, in order to reduce the intersection of weak disciplines and pan-disciplines caused by too detailed discipline classification, this paper uses a total of 48 disciplines of the second-level discipline classification of the National Natural Science Foundation of China (such as G0101 management science and the history of management thought) as the discipline classification of this paper. Based on this classification, the project keyword [18] is used as text data to construct the corpus of each discipline.

3.2.2. Regional corpus. This paper uses 34 provinces, autonomous regions and municipalities directly under the Central Government as regional classification. Since the official website of the National Natural Science Foundation of China does not provide the area where the project is located, it is illegal to crawl the regional information of the project directly, but the supporting unit of each project is provided on the official website. the region of the project can be judged according to the region where the supporting unit is located. A total of 341 units are involved. Observation and analysis found that the names of some supporting units have regional information, such as Peking University, so we get the names of 34 provinces, autonomous regions, municipalities directly under the Central Government and prefecture-level cities under each province, and use Python to process the corresponding regional information. The rest of the information can not be extracted directly from the unit name of the use of manual search to determine the region to which it belongs, such as Tsinghua University. Taking the
region as the classification standard, the project keywords are classified and the regional corpus is obtained.

3.3. Research methods

3.3.1. Degree of interdisciplinary intersection. The study uses the method of keyword co-occurrence to judge the degree of interdisciplinary intersection, if the more keywords overlap or the greater the similarity between the two disciplines, then the greater the degree of intersection in the research topic and content between the two disciplines [16].

3.3.2. Intersection of disciplines in the region. In this study, cosine similarity is used as a tool to measure text similarity. The more professional words used in the two corpora, the higher the similarity score. The formula for calculating cosine similarity with word frequency is shown in (1):

$$
\cos(\vec{a}, \vec{d}) = \frac{\sum_{w \in \text{intersection}} tf_{w,r} \times tf_{w,d}}{\sqrt{\sum_{w \in \text{region}} tf_{w,r}^2} \times \sqrt{\sum_{w \in \text{subject}} tf_{w,d}^2}}
$$

Among them, \( r \) represents the regional corpus, \( d \) represents the subject corpus, \( w \) represents the words that appear in both corpora, \( tf_{w,r} \) indicates the frequency of the word \( w \) in the corpus \( r \), and \( tf_{w,d} \) indicates the frequency of the word \( w \) in the corpus \( d \).

In this study, considering the high repetition of some words within the discipline and in the whole corpus, in order to avoid the interference caused by these factors to the interdisciplinary calculation, the text uses the TF-IDF method to weight the cosine similarity. In this study, TF-IDF acts on the discipline level, so that the lexical representation that appears in the less disciplinary corpus provides more disciplinary information. The formula for calculating TF-IDF weighted cosine similarity measure is shown in (2):

$$
\cos(r, d) = \frac{\sum_{w \in \text{intersection}} tf_{w,r} \times tf_{w,d} \times idf_w}{\sqrt{\sum_{w \in \text{region}} (tf_{w,r} \times idf_w)^2} \times \sqrt{\sum_{w \in \text{subject}} (tf_{w,d} \times idf_w)^2}}
$$

Where \( idf_w \) represents the inverse document frequency of the word \( w \), as shown in (3):

$$
idf_w = \log\left(\frac{D}{d_w+1}\right) + 1
$$

Among them, \( D \) represents the total number of disciplines, and \( d_w \) represents the number of subject corpora in which the word \( w \) appears. The \( idf_w \) is calculated using all the funded projects that have been completed in the discipline of management science between 2014 and 2018. The less the subject corpus of vocabulary appears, the higher the weight of \( idf_w \) will be.

Formula (2) is used to measure all projects and each discipline in each region, so as to obtain the intersection of all projects and each discipline in different regions. All the project levels in a region represent the overall level of the region, so the intersection of projects and all disciplines in each region is accumulated to get the interdisciplinary level of the region. the higher the interdisciplinary level, the more frequent the interdisciplinary in the region.

4. Results of the study

4.1. Degree of interdisciplinary intersection

In the data collection, it is found that there are no completed projects in nine disciplines from 2014 to 2018. they are G0112 information systems and management, G0301 macroeconomic management and strategy, G0302 financial management and policy, G0303 fiscal and taxation management and policy, G0310 public safety and crisis management, G0311 employment and social security, G0312 resource and environmental policy and management, G0313 regional development management, G0314 information resource management. In addition, 39 disciplines use Python for keyword co-occurrence processing, and import the results into Gephi software to get the network shown in figure 2.
Figure 2. Discipline keyword co-occurrence network.

It can be seen from figure 2 that G0118 project management, G0212 logistics and supply chain management, G0214 service management, G0216 non-profit organization management, G0215 entrepreneurship and small and medium-sized enterprise management, G0213 project management, G0204 organizational behavior and organizational culture, G0202 enterprise theory, G0115 financial engineering are frequently crossed disciplines in the field of management science.

In order to grasp the connection mechanism and characteristics of the cross-integration of different disciplines in the field of management science, the attribute characteristics of the interdisciplinary network shown in figure 2 are measured, and the characteristic indicators are shown in Table 2.

Table 2. Characteristic index of interdisciplinary network.

| Node | Edge | Den | CC  | AP   | Dia |
|------|------|-----|-----|------|-----|
| 39   | 583  | 0.787 | 0.89 | 1.213 | 2   |

Note: Node -- Number of discipline direction nodes; Edge -- The number of edges; Den -- Network density; CC -- clustering coefficient; AP -- average path length; Dia -- Network diameter.

It can be seen from Table 2 that the network density of interdisciplinary network is 0.787, which does not belong to sparse network. The clustering coefficient of the network is 0.89, the average path length is 1.213 and the diameter is 2. The higher clustering coefficient and the lower average path length indicate that the interdisciplinary network accords with the characteristics of the small world network [19], and the association between different discipline directions can be established in no more than 2 steps at most. It shows that the disciplines in this field are very close to each other.

4.2. Regional interdisciplinary

Add the interdisciplinary degree of all projects in each region obtained from the formula (2) to represent the interdisciplinary degree in the field of management science in the region, and use Python for visualization to get figure 3.
Figure 3. Interdisciplinary regional differences in the field of management science.

Figure 3 shows the interdisciplinary situation in the respective studies of 34 provinces, municipalities, autonomous regions and autonomous regions in the field of management science. It can be seen that the interdisciplinary research in the field of management science in China is extremely unbalanced. Interdisciplinary frequently occurs in the eastern or southeastern regions of China, while there is basically no interdisciplinary in this field in the western region. Beijing, Shanghai and Jiangsu, as the three regions with the highest degree of intersection in this field, can find some commonalities between these three regions through analysis: Beijing, as the capital of China, has good learning resources, advanced ideas and excellent talents. It is most likely to cross disciplines; as a mega-city and the center of international economy, finance, trade, shipping and scientific and technological innovation in China, Shanghai is more likely to have academic exchanges; Jiangsu, as a major province of education, the advanced nature of education and teaching is also ranked high, which also provides a good foundation for discipline intersection.

Table 3. The interdisciplinary situation of the three regions with the most frequent intersections.

| Region | Beijing | Shanghai | Jiangsu |
|--------|---------|----------|---------|
| G0308  | G0206   | G0308    |
| G0304  | G0205   | G0109    |
| G0202  | G0306   | G0111    |
| ......  | ......   | ......    |
| G0106  | G0215   | G0108    |
| G0214  | G0113   | G0216    |
| G0216  | G0216   | G0215    |

Table 3 show the interdisciplinary situation in the research work of Beijing, Jiangsu and Hubei, which cross most frequently. Among them, the intersection of G0308 health management and policy, G0304 industrial policy and management and G0202 enterprise management is the most frequent in Beijing area. however, the intersection of G0216 non-profit organization management, G0214 service management and G0106 evaluation theory and method is not significant. In the field of management science, Jiangsu pays more attention to the cross-integration of G0308 health management and policy, G0109 management system engineering and G0111 system reliability and management. however, the intersection of G0215 entrepreneurship and small and medium-sized enterprise management, G0216 non-profit organization management and G0108 management psychology and behavior is not obvious. The most crossed disciplines in Hubei are G0308 health management and policy, G0207 accounting and audit and G0211 enterprise information management. However, G0113 quantitative economy theory and method, G0106 evaluation theory and method and G0215 entrepreneurship and small and
medium-sized enterprise management rarely cross each other. It can be found that G0308 health management and policy intersects most frequently in the areas with the highest degree of intersection of the three disciplines, while the theories and methods of G0216 non-profit organization management and G0106 evaluation appear many times in less interdisciplinary disciplines.

5. Conclusions
Based on the current situation and regional differences of interdisciplinary intersection of text information measurement management science, this paper uses TF-IDF to improve the cosine similarity to construct a regional interdisciplinary measurement model, uses the project of the National Natural Science Foundation of China to carry out experiments, and analyzes the results. The conclusions are as follows: (1) the interdisciplinary intersection in the field of management science has the characteristics of small-world network and high degree of interdisciplinary intersection. (2) there are some differences in the degree of interdisciplinary in different regions, and the interdisciplinary in the southeast is more frequent than that in the northwest. The revelation of the interdisciplinary characteristics and regional differences in domain knowledge will help to establish a more comprehensive and in-depth understanding and identification of the current interdisciplinary research in the field of scientific research. There are also some limitations in the research, the time series dynamic evolution analysis of the interdisciplinary phenomenon in the field has not been involved, and the future research work will further track and analyze the dynamic evolution of the interdisciplinary phenomena. Reveal its dynamic development law more deeply.

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