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## Mining Potential Institutional Collaborative Relationships Based on Self-Described Research Interest Similarity Networks: A Case Study of Library, Information and Archive Management Education Institutions in China (Postprint)

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### Abstract

[ Purpose / Significance ] This study quantitatively describes the research landscape of the Library, Information and Archives Management discipline, provides decision support for establishing cooperative relationships among institutions, and thereby promotes the development of cross-institutional collaboration.

[ Method / Process ] Employing the LDA topic model and network analysis methods, and taking 67 domestic Library, Information and Archives Management education institutions as an example, this study constructs an institutional similarity network through topic clustering of faculty self-reported research interest texts, and conducts community detection and mining of potential cooperative relationships.

[ Results / Conclusions ] Currently, the research interests of domestic Library, Information and Archives Management faculty mainly involve 11 topics, including information resource management, informetrics and competitive intelligence, information services and users, etc. The sample institutions can be divided into 7 communities, containing 457 pairs of potential cooperative relationships. In the future, besides disciplinary integration along five pathways, the Library, Information and Archives Management discipline can also fully develop cross-institutional collaboration in research and educational practice across different fields.

## Full Text

### Introduction

#### Background and Significance

The “Six Excellence and One Top” Plan 2.0, jointly launched by China’s Ministry of Education, the Central Political and Legal Affairs Commission, the Ministry of Science and Technology, and ten other departments, aims to comprehensively advance the construction of new liberal arts, which places greater emphasis on inheritance and innovation in disciplinary development, interdisciplinary integration, and multi-institutional collaboration and sharing compared with traditional liberal arts. Against the backdrop of rapid development in big data, cloud computing, artificial intelligence, and other emerging technologies, alongside evolving societal information needs, the discipline of library, information, and archives management (LIAM) has demonstrated increasingly prominent interdisciplinary characteristics. This multidirectional development has generated greater demand for research collaboration across organizational systems. Inter-institutional cooperation can fully leverage research resources on the basis of information sharing, forming effective approaches to solving complex research problems. Consequently, how to mine potential cooperative relationships between institutions and enhance the efficiency of inter-institutional collaboration has become an important issue in scientific research.

#### Literature Review

It is generally believed that entities with more similar research content exhibit higher potential for cooperation. Relevant studies have primarily obtained or indirectly identified research themes from scholars’ academic outputs and employed network analysis methods to calculate similarity or conduct community analysis of research entities from different perspectives. However, this research trajectory rarely utilizes publicly available self-reported data from the internet. Current studies using self-reported data mainly focus on content analysis of thematic distribution, while methods based on topic modeling have been somewhat absent. Generally, scholars’ self-reported research interests, while concise, contain rich semantic content. When timeliness is ensured, they can effectively reduce the impact of long publication cycles and low correlation with scholars’ actual research interests. Therefore, it is necessary to pay due attention to scholars’ self-reported materials.

To promote potential research collaboration and improve research efficiency, scholars have explored similarity between research entities. X. Kong et al. constructed a collaborator recommendation model by calculating cosine similarity between scholars based on a dynamic research interest matrix revealed by the LDA topic model. An Lu et al. measured research field similarity between Chinese and American LIAM research institutions using self-organizing maps based on an “institution-document category” matrix. Lin Yuan et al. analyzed potential cooperative relationships between universities using improved Katz and cosine

similarity indicators based on “university-cooperation” and “university-topic” matrices. E. Yan et al. performed link prediction on collaboration networks at scholar, institution, and country levels using the SimRank model. Overall, at the institutional similarity measurement level, relevant studies primarily utilize institutional topic models and existing cooperation networks, with cosine similarity being widely applied in the former. This study takes LIAM education institutions in China as an example, employing LDA topic modeling to mine themes from full-time faculty’ s self-reported research interests, thereby constructing institutional topic vector models and cosine similarity networks to detect and analyze potential cooperative relationships.

## Data and Methods

This study primarily employs web survey, LDA topic clustering, and network analysis methods, completing the following research pathway in the R language and Gephi software environment (see [Figure 1: see original paper]): Data acquisition and preprocessing. Faculty personal profiles were collected through official websites of sample institutions. After text data cleaning and segmentation, a “faculty-term” Document Term Matrix (DTM) was constructed. Faculty self-reported research interest topic discovery. Basic parameters of the LDA topic model were determined, and topics were identified based on the “topic-term” distribution. Institutional similarity network analysis. Based on institutional topic vector models, similarity between institutions was calculated to construct an institutional similarity network, perform community division, and identify institution groups with potential cooperative relationships.

### Data Collection and Preprocessing

Following an investigation of the official website development status of LIAM education institutions in China, 67 institutions were selected as data sources (for convenience, only the names of the universities or research units to which the institutions belong are used in the following text). Faculty personal profiles were collected through official websites, covering name, affiliation, and self-reported research interests. Data collection was conducted from November 16 to November 29, 2020, yielding 1,289 faculty members after cleaning, with research interests mentioned 3,599 times.

Segmentation and matrix construction were primarily completed using the Rwordseg and tm packages in R. First, due to multilingual sources in the sample, English descriptions were translated into Chinese. Second, to delete meaningless words, segmentation stopword lists were constructed using the Harbin Institute of Technology stopword list and the Sichuan University Machine Intelligence Laboratory stopword library. Finally, 20% of the sample was extracted for pre-segmentation experiments, and a custom dictionary was supplemented based on actual conditions, mainly involving proper nouns such as discipline names. After these operations, a 1289 $\times$ 14179 “faculty-term” DTM matrix was obtained.

## LDA Topic Model

To analyze the distribution of research interest themes among LIAM faculty in China, it is necessary to determine the basic parameters of the LDA topic model. The construction of the LDA topic model was mainly implemented using the `lda`, `Rmpfr`, `topicmodels`, and `LDavis` packages in R. The Gibbs sampling algorithm was employed to solve the global topic and term distribution, requiring the setting of three hyperparameters:  $\alpha$ ,  $\beta$ , and the optimal number of topics  $K$ . Parameters  $\alpha$  and  $\beta$  are generally set to default values and can be adjusted based on actual effects. The optimal number of topics can be determined based on how perplexity or likelihood estimation values change with the number of topics, with the number of topics at which the likelihood estimation reaches its maximum being the optimal solution. Based on the “topic-term” probability distribution matrix obtained from model training, several terms with high significance in each topic were extracted as the basis for topic identification. Additionally, based on the “faculty-topic” probability distribution matrix, the probability and proportion of all faculty members’ research interests involving a certain topic were calculated to obtain the topic’ s strength as a metric of topic attention.

## Similarity Calculation and Analysis

Based on the institutional topic vector model, cosine similarity was selected as the indicator for measuring inter-institutional similarity. First, according to the “faculty-topic” probability distribution matrix obtained from LDA topic model training, each faculty’ s topic vector model  $iFV$  can be obtained, calculated as shown in formula (1):

formula (1)

where  $P_{i,j}$  is the probability that faculty  $F_i$ ’ s research interest text belongs to topic  $T_j$ , and  $K$  is the optimal number of topics. By calculating the sum of topic probability distributions for all faculty  $F_{x,i}$  belonging to institution  $I_x$ , the topic vector model  $V_{I_x}$  for each institution can be constructed, as calculated in formula (2):

formula (2)

where  $n$  is the total number of faculty in institution  $I_x$ . Therefore, the cosine similarity between institutions  $I_a$  and  $I_b$  can be expressed as shown in formula (3):

formula (3)

Obviously,  $\text{Sim}(I_a, I_b) \in [0,1]$ , and when  $a=b$ ,  $\text{Sim}(I_a, I_b)=1$ . On the one hand, the similarity matrix between institutions can be constructed accordingly. Since

the network generated based on this matrix is a connected graph, for subsequent analysis convenience, an appropriate threshold  $\lambda$  needs to be set for pruning to eliminate elements with low weights. Referring to the Pareto principle, only the top 20% of elements with high weights were retained. The similarity network between institutions was constructed using Gephi software, with the built-in Louvain algorithm employed for community division. In this network, nodes represent institutions, and the weight of edges connecting nodes Ia and Ib is  $\text{Sim}(Ia, Ib)$ , representing the similarity between institutions. On the other hand, the topic sets with strength exceeding 10% for an institution and its most similar institution can be obtained respectively, and their intersection can be calculated to identify potential cooperative research fields.

## Results

### Faculty Self-Reported Research Interest Topic Discovery

First, following the method for determining basic parameters of the LDA topic model, the optimal number of topics for clustering was determined. As shown in [Figure 2: see original paper], when the number of topics is 11, the likelihood estimation reaches its maximum, indicating good model performance and effective topic discrimination. Therefore, the optimal number of topics  $K=11$  was set. After running the topic discovery model and obtaining the “topic-term” probability distribution results, topics were identified based on the six terms with the highest significance under each topic (see ). Currently, the research interests of LIAM faculty in China can be mainly summarized into 11 major themes, including e-commerce and strategic management, information services and users, and library science and book cultural history.

As mentioned above, based on the “faculty-topic” probability distribution matrix obtained from LDA topic discovery, the proportion of a certain topic in the overall corpus can be calculated to obtain the topic’s strength. To some extent, topic strength can reflect the attention of current LIAM faculty to different research interests, as shown in [Figure 3: see original paper]. Information resource management (T8), informetrics and competitive intelligence (T7), and information services and users (T2) are the three most concerned topics among the sample faculty, each with a topic strength exceeding 10%. This indicates that within the current time window, Chinese LIAM faculty have formed preliminary consensus on the discipline’s core and collectively demonstrate a sense of mission oriented toward national strategy, social development, and user needs. The research interests also reflect a high degree of technological involvement and broad disciplinary application scenarios. E-commerce and strategic management (T1), data mining and big data technology (T11), and government information management (T9) show relatively high topic strength. In addition, publishing and cultural industry (T5), interdisciplinary information application (T4), and library science and book cultural history (T3) are the three topics with relatively lower attention, mainly influenced by the construction scale of corresponding disciplines and the number of faculty in sample institutions.

## Institutional Similarity Network Analysis

After obtaining the institutional topic vector models, cosine similarity between institutions can be calculated. According to the Pareto principle, edges between institutions were pruned, with the weight threshold  $\lambda=0.72$ , meaning that when  $\text{Sim}(I_a, I_b) \geq 0.72$ , institutions  $I_a$  and  $I_b$  are considered highly similar. Based on this, the similarity network of Chinese LIAM education institutions can be obtained (see [Figure 4: see original paper]), containing 67 nodes and 457 edges. Node size represents the number of faculty, and node color represents different community categories, denoted by letters A-G.

Community A primarily consists of institutions with archives or information resource management as their main specialty, including Renmin University of China, Shanghai University, Xiangtan University, and Zhengzhou University (23 institutions in total). Archives management theory and methods, government information management, and information resource management are the three topics of greater concern in Community A, with a combined strength of 56.6%.

Community B comprises institutions with more comprehensive disciplinary backgrounds, forming the main part of the network together with Community A, including Wuhan University, Nanjing University, Peking University, and Sun Yat-sen University (19 institutions in total). The topic probability distribution within Community B is relatively balanced, with information resource management, information services and users, informetrics and competitive intelligence, and data mining and big data technology being the four topics of greater concern, each exceeding 10% in strength.

Community C mainly consists of institutions with economics and management backgrounds, mostly established under schools or faculties of economics or management, including 10 institutions such as Hebei University, Shandong University, Shanxi University, and Southeast University. The two topics with higher strength are e-commerce and strategic management and management science and engineering, both exceeding 20%.

Community D includes nine institutions such as the Institute of Scientific and Technical Information of China, University of Chinese Academy of Sciences, Jiangsu University, and Shandong University of Technology, which mainly rely on institutional libraries or documentation and information centers for disciplinary construction. Informetrics and competitive intelligence has the highest strength in this community, reaching 43.4%. Faculty with professional library and documentation titles account for approximately 64.3% of the total faculty in the community, mostly conducting research in directions such as scientific evaluation, science and technology strategy, and patent intelligence analysis.

Communities E, F, and G have relatively few institutions and show almost no significant similarity with other communities. Community E includes three institutions—China Medical University, Shanxi Medical University, and Central South University—all with medical or biological backgrounds, with interdisci-

plinary information application topic strength as high as 65.4%. Community F includes Fudan University and the China Academy of Chinese Medical Sciences. Although like Community D they rely on library and documentation centers for construction, they place greater emphasis on historical philology and ancient book preservation, with library science and book cultural history topic strength at 38.2%, significantly higher than Community D' s 1.1%. Community G includes only Shandong University of Science and Technology as an isolated node, unconnected with the other 66 institutions. This is mainly due to its strong computer science and technology background, with data mining and big data technology topic strength as high as 68.0%, while the highest strength of this topic in other institutions is less than 20%.

Based on the 457 pairs of potential cooperative relationships identified above, the most similar institutions for each institution were identified, and their potential cooperative research fields were recognized, which is of great significance for promoting inter-institutional cooperation. This study defines the topic sets with strength exceeding 10% for an institution and its most similar institution as potential research fields. shows partial calculation results. In terms of similarity values, the similarity between Southeast University and Hohai University is the highest, reaching 0.98, with both institutions showing high attention to data mining and big data technology and management science and engineering. The most similar institution for the China Academy of Chinese Medical Sciences is Fudan University, with a similarity of 0.76, and their potential cooperative fields are informetrics and competitive intelligence and library science and book cultural history, respectively. Additionally, shows the situations of institutions with top-ranked disciplinary construction levels. For example, Nanjing University can cooperate with Wuhan University in fields such as information services and users, data mining and big data technology, and publishing and cultural industry, while Renmin University of China can cooperate with Beijing Union University in fields such as information resource management, government information management, and archives management theory and methods.

## Discussion

### **Interdisciplinary Integration Paths of Library, Information and Archives Management**

As an applied discipline, LIAM exhibits obvious interdisciplinary characteristics in its development. Scholars' interdisciplinary research activities are generally considered important manifestations and drivers of its interdisciplinary nature. Based on the previous topic discovery of Chinese faculty research interests and community division of education institutions, this study summarizes the interdisciplinary integration paths of LIAM (see [Figure 5: see original paper]).

On the one hand, LIAM should closely develop around the disciplinary core of information resource management. Every discipline has its own discourse system and rules, and it is necessary to clarify and adhere to its core content

in the process of integrating with other disciplines. The core knowledge of LIAM is based on the education and research of the entire lifecycle management of information resources, involving the recording, preservation, organization, retrieval, acquisition, analysis, and development and utilization of data, information, and knowledge, with significant service characteristics. Through the previous topic discovery, information resource management has the highest topic strength among Chinese faculty research interests. With the continuous development of the information society and the support of emerging information technologies such as big data and artificial intelligence, application scenarios are constantly expanding and deepening. In the 2021 draft of the new discipline and specialty catalog, the first-level discipline of “library, information, and archives management” is proposed to be renamed “information resource management,” which has further triggered discussions on the discipline’s core knowledge. This action fully reflects the value shift of China’s LIAM first-level discipline. In addition, topics such as informetrics and competitive intelligence, information services and users, e-commerce and strategic management, and data mining and big data technology that connect various levels of the “data-information-knowledge-wisdom” (DIKW) system also have relatively high strength, fully reflecting that the overall connection within the LIAM discipline is becoming closer. Researchers and educators in the sub-disciplines of library science, information science, and archival science should establish a disciplinary community consciousness, strengthen the discipline’s social service function on the basis of focusing on the information resource management core, and promote social innovation and progress.

On the other hand, LIAM can promote in-depth disciplinary development and enhance its disciplinary status and competitiveness through intersection and integration with other disciplines. With the increasingly significant trend of disciplinary integration in contemporary science, LIAM, which already has relatively strong interdisciplinary attributes, has achieved different degrees of integration with at least five categories of disciplines outside the information resource management discipline group while integrating its sub-disciplines and consolidating its first-level discipline core. Specifically: integration with basic humanities such as history and literature to support research in book cultural history and digital humanities; integration with basic natural sciences such as medicine and biology to use LIAM methods to organize literature and knowledge; integration with computer science and technology to enhance the efficiency of LIAM research work with emerging information technologies; integration with management science and engineering to provide management decision support for various industries or fields; and integration with public management to promote the development of government information management and public cultural directions. In the future, LIAM can continue to deepen integration and cooperation with other disciplines and strengthen disciplinary construction more openly, daring to speak, compete, and lead in interdisciplinary research.

## Inter-institutional Cooperation in the Context of New Liberal Arts Construction

Institutional collaboration and information sharing are important aspects emphasized in new liberal arts construction. On the basis of multidisciplinary cross-integration, institutions can promote their own transformation through inter-institutional research and education cooperation and build a disciplinary community of shared future. Based on the cosine similarity network of faculty self-reported research interest texts, this study divided Chinese LIAM education institutions into seven communities and detected the most similar potential cooperative institutions and research fields for each institution. The results show that most institutions' potential cooperative institutions are within the same community, and institutions in different communities rely on various types of education and research resources to form different research focuses and distinctive characteristics. For example, institutions with economics and management backgrounds have absolute advantages in e-commerce and strategic management and management science and engineering, while institutions relying on institutional libraries or documentation and information centers for disciplinary construction mostly focus on informetrics and competitive intelligence research. With decreasing barriers to information exchange, Chinese LIAM schools can communicate, share, and cooperate with similar institutions on the same topics in many scenarios such as education and research.

Based on the most significant potential institutional cooperative relationships derived from the distribution of research topics in this study, five cross-community combinations were identified: "Fudan University–Shaanxi University of Technology," "Hebei University–Wuhan University," "East China Normal University–Nanjing University," "Jishou University–Changchun Normal University," and "Nankai University–Sun Yat-sen University." This indicates to some extent that the seven identified communities are not completely isolated and have possibilities for mutual penetration and learning. In this process, institutions at community edges play important bridging roles, often possessing composite community characteristics that can effectively promote communication and cooperation within the LIAM discipline, such as Hebei University, Tianjin Normal University, Shandong University, Nankai University, and Sichuan University. In the future, while leveraging institutions with larger faculty sizes to lead disciplinary development, attention should also be paid to the role of typical institutions in research and education practice cooperation. Additionally, due to the varying number of institutions in each community, and even the emergence of Shandong University of Science and Technology as an isolated node relying on computer science and technology, attention should be paid to the division of research content and topics in specific cooperation processes to maximize the internal cohesion of the LIAM discipline and jointly promote the improvement of cooperation efficiency and the transformation of research results.

## Conclusion

Based on Chinese LIAM education institutions' faculty self-reported research interest texts, this study thematically clustered the current research interests of relevant faculty in China and constructed an institutional research interest similarity network to identify potential cooperative institutions and research fields for each institution. For China' s LIAM discipline, the study found that:

Faculty research interests mainly involve 11 topics, including information resource management, informetrics and competitive intelligence, and information services and users; Sample institutions can be divided into seven communities, containing 457 pairs of potential cooperative relationships. Based on these findings, this study emphasizes the importance of multidisciplinary integration and inter-institutional cooperation: The interdisciplinary integration path of LIAM should actively integrate with management science and engineering, public management, computer science and technology, and other disciplines while adhering to the core of information resource management; The important role of community-edge institutions in inter-institutional cooperation should be fully leveraged to promote multi-faceted and in-depth cooperation between institutions. This study can assist institutions in seeking peer institutions similar to themselves and promote the development of inter-institutional cooperation to a certain extent by mining potential cooperative relationships.

It should be noted that the research interest text data in this study mainly come from institutional official websites, which may be outdated or not updated in a timely manner, potentially affecting the analysis results. In the future, multi-source materials such as institutional websites and academic output bibliographic information can be integrated to optimize data quality for comprehensive analysis. Additionally, comparisons between potential cooperative relationships and actual cooperation status, as well as investigations of institutional potential cooperative relationships on a global scale, are also worthy of further research.

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#### Author Contributions

Hu Zhiwei: Collected, processed, and analyzed data, and wrote the paper;  
Pei Lei: Guided the research ideas, checked the paper content, and provided revision suggestions.

*Note: Figure translations are in progress. See original paper for figures.*

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