Research on Community Affiliation Based on the Research Interest Similarity Network of Core Authors: A Case Study of the Domestic Information Science Field (Postprint)

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Abstract

[Purpose/Significance] Construct a research interest similarity network of core authors in the field of information science, and investigate the community structure and community affiliation issues of this network. [Method/Process] In the CSSCI database, using the Chinese Library Classification number as the search criterion, download all paper data of this discipline from 1998-2015, and identify core authors through Price's law. Represent author research interests using the bag-of-words model, calculate the cosine similarity of research interests between authors, and thereby construct a core author research interest similarity network. On this basis, conduct community division and identify the research topics of each community, and calculate the authors' affiliation degree and fuzzy entropy to each community. [Results/Conclusion] The study finds that current Chinese information science research can be divided into four areas: information organization and retrieval, bibliometrics and scientific evaluation, competitive intelligence and knowledge management, and overall research on the information science discipline. Most authors' research is not limited to a single area; the boundaries between the competitive intelligence and bibliometrics fields are distinct, with few authors affiliating with the other field as a secondary community.

Full Text

Research on Community Membership Based on the Research Interest Similarity Network of Core Authors: Taking the Domestic Field of Information Science as an Example

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Abstract

[**Purpose/Significance**] This study constructs a research interest similarity network of core authors in the field of information science to investigate the community structure and community membership issues within this network. [**Method/Process**] Using the China Library Classification number as the retrieval criterion in the CSSCI database, we downloaded all paper data for the discipline from 1998 to 2015 and identified core authors through Price's Law. Author research interests were represented using a bag-of-words model, and cosine similarity between authors' research interests was calculated to construct a core author research interest similarity network. On this basis, community division was performed, research themes of each community were identified, and authors' membership degrees to each community and fuzzy entropy were calculated. [**Result/Conclusion**] The study reveals that current information science research in China can be divided into four domains: information organization and retrieval, bibliometrics and scientific evaluation, competitive intelligence and knowledge management, and the overall study of the information science discipline. Most authors' research is not limited to a single domain; the boundaries between competitive intelligence and bibliometrics are distinct, with few authors considering each other as secondary affiliation communities.

Classification Number: G250
Keywords: research interest, network, information science, community, membership degree, similarity

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2 Related Research

2.1 Analysis of Information Science Discipline Structure

Analyzing the structure of the information science field follows two research approaches: qualitative and quantitative. The former relies on authors' macro-level understanding of the discipline's overall situation, focusing on paradigm induction [3], summary of fundamental principles [4], and stage division [5], belonging to speculative research. The latter primarily utilizes bibliometrics and social network analysis methods to deeply mine research themes and community structures from literature data, presenting results through visualization. For instance, Zhang Bin et al. [6] employed co-word analysis to analyze and identify the cognitive structure of library and information science in China, concluding that four main branches exist: digital information organization and management, library science, informetrics and evaluation, and organizational knowledge management. Ma Feicheng et al. [7] used ACA to analyze co-citation patterns among core authors in Chinese information science from 1994 to 2005, identifying five research areas: early researchers, information science theory, information retrieval, library science research, and document resource construction. Qiu Junping [8] analyzed authors of information science research papers during China's 30 years of reform and opening up, dividing research content into eight areas including competitive intelligence, information systems, and bibliometrics. These studies mostly identify community themes from an overall disciplinary level using co-word networks, co-authorship networks, and co-citation networks, with few conducting domain structure identification from the perspective of research interests, and even fewer exploring the micro-level affiliation relationships between scholars and communities.

2.2 Research Interest Related Research

As a psychological activity, interest significantly influences people's cognitive tendencies and practical activities. In scientific research, analyzing core authors' research interests in a field helps grasp its current status and future development direction. Current research on research interests primarily involves representation models and similarity calculation, as well as phenomenon revelation. Regarding representation models and similarity calculation, M. Steyvers et al. [9] modified the original topic model and proposed the Author-Topic model to reveal author research interests, exploring its applications in topic evolution trend analysis, author-topic correlation analysis, and anomalous paper detection. Li Shuqing et al. [10] used the vector space model as the basic interest representation structure and adopted a time-slice oscillation algorithm to discover authors' main research interest characteristics for portable personalized service research. Liu Ping et al. [11] calculated associations between keywords through the vector space model and used the P/Rank algorithm to compute structural similarity between authors' keyword networks. Ba Zhichao et al. [12] introduced the word2vec model for semantic modeling of author keyword matrices, calculating the JS distance between two authors' research interest matrices as their interest similarity and clustering authors with similar research interests into groups through clustering algorithms.

In terms of research interest phenomenon revelation, Li Gang et al. [13] used the bag-of-words model to represent author research interests and analyzed the frequency distribution patterns of research interest similarity among co-authors across different disciplines and productivity levels. The study found that authors from different disciplines show consistent distribution patterns when seeking collaborators, with the tendency to find partners first increasing and then decreasing as similarity increases, while highly productive authors prefer to co-author with those having more similar research interests. Guan Peng et al. [14] combined lifecycle theory with the author-topic model to analyze the evolution of author research interests in the lithium battery field within the CNKI database, finding that when core authors' research interest evolution trends align with corresponding topic evolution trends, they can lead the development of those research topics.

In summary, current research on research interests mainly involves representation models and similarity calculation, as well as phenomenon revelation. Representation models primarily include topic models, bag-of-words models, keyword networks, and keyword semantic matrices, with similarity calculation methods mainly comprising cosine similarity, JACCARD, P/Rank, and JS distance, depending on the specific representation model. Phenomenon revelation primarily focuses on the relationship between co-authorship and research interest similarity, and the evolution of research interests. This study takes information science as an example, identifies core authors in the field to generate their research interest similarity network, analyzes the network's characteristics, conducts community structure analysis, calculates each author's membership degree to each community, and analyzes associations between communities.

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3 Research Methods

3.1 Research Ideas and Process

As previously discussed, uniquely assigning each node to a single community in community analysis has its limitations. Similarly, in scientific research, researchers' interests are rarely confined to a single domain but simultaneously belong to multiple academic communities to varying degrees. Drawing on the computational approach in reference [1], this study first performs community division on the network and then calculates each author's degree of membership to each community. The specific research process consists of three steps: data acquisition and processing, research interest similarity network construction, and community identification with membership degree calculation, as shown in Figure 1 [Figure 1: see original paper].

3.2 Data Acquisition and Processing

Data acquisition and processing 主要包括以下步骤：数据下载、字段识别、作者消歧、核心作者选择。The data source is the Nanjing University Social Science Citation Index database, with the retrieval criterion "China Library Classification Number = G35." A Java program was used to extract fields such as title, author, author affiliation, journal name, keywords, and journal name from the bibliographic data and store them in a database. To ensure data analysis accuracy, author disambiguation employed a combination of systematic disambiguation and manual verification. Specifically, authors with the same "name + primary affiliation" were identified as the same person, followed by manual case-by-case analysis of authors with identical names but different affiliations for merging. To ensure sufficient keywords for calculating inter-author interest similarity, this study focuses on disciplinary core authors for network construction.

According to Price's Law [15], authors publishing equal to or greater than N papers are considered core authors in a field, with N calculated using formula (1):

$$N = 0.749 \times (\eta_{max})^{1/2}$$

where η_{max} represents the maximum number of articles published by any author in the field. In this dataset, Professor Qiu Junping from Wuhan University has the highest publication count at 198 papers, yielding an N value of 10.384. Consequently, authors with 11 or more publications are considered core authors, totaling 220 individuals.

3.3 Research Interest Similarity Network Construction

The research interest similarity network uses authors as nodes and research interest similarity between authors as edge weights. The construction process 主要包括以下步骤：研究兴趣相似性计算、强相似性筛选、研究兴趣相似性网络构建。This study employs the cosine similarity algorithm using co-authors' private keyword sets as referenced in [16], which effectively eliminates the influence of co-authorship on research interest similarity calculation. Before similarity calculation, the inverse document frequency of each keyword must be computed (see formula (2)), where k_i is a keyword, N_{doc} is the total number of documents, and $df(k_i)$ is the number of documents containing the keyword.

$$idf(k_i) = \frac{\ln\left(0.5 + \frac{N_{doc}}{df(k_i)}\right)}{\ln(1 + N_{doc})}$$

For two authors A and B, $P(A)$ and $P(B)$ represent their respective publication sets. If A and B have co-authored publications, these are removed from $P(A)$ and $P(B)$ to generate private publication sets $P(A)$ and $P(B)$. Here, K_A is the keyword list from document set $P(A)$, while $N_A(k_i)$ and $N_B(k_i)$ denote the frequency of keyword k_i in K_A and K_B. The final research interest similarity calculation is shown in formula (3):

$$sim(A,B) = \frac{\sum_{k_i \in K_A \cap K_B} W_A(k_i) \times W_B(k_i) \times idf^2(k_i)}{\sqrt{\sum_{k_i \in K_A} (W_A(k_i) \times idf(k_i))^2} \times \sqrt{\sum_{k_i \in K_B} (W_B(k_i) \times idf(k_i))^2}}$$

By pairwise calculation of core authors' research interest similarity, an author similarity matrix is obtained. Visually, even if two authors have only one common word in their publications, their similarity is non-zero, resulting in a necessarily dense network requiring pruning to remove low-weight edges. For subsequent community analysis, the research interest similarity matrix is pruned and saved in Gephi-compatible format.

3.4 Community Identification and Membership Degree Calculation

Upon completing the research interest similarity network construction, network division methods can be applied to partition the disciplinary research fields and calculate authors' community membership degrees. This process 主要包括以下步骤：社群结构识别、作者-社群隶属度计算、基于社群隶属度的模糊熵计算等。This study uses the Louvain algorithm [17] for community division, which can efficiently process networks with hundreds of millions of nodes, employing Gephi software to assign core authors to different communities.

Scholars' membership degrees to different communities can be viewed as a discrete distribution of their research interests. Therefore, entropy can be used to represent the dispersion degree of authors' research interests. The concept of entropy originated in physics and is frequently used in information science to measure information quantity and uncertainty. The fuzzy entropy calculation based on community membership degrees is shown in formula (5):

$$Entropy(A_i) = -\sum_{j=1}^{n} membership(A_i, C_j) \times \log_2(membership(A_i, C_j))$$

where n represents the number of communities (4 in this study). When an author's research interests are evenly distributed across all communities, indicating highly dispersed interests and difficulty in identifying primary research focus, the entropy value is larger.

The membership degree of an author to a community is defined as the normalized result of the author's similarity to each community, calculated using formula (4):

$$membership(A_i, C_j) = \frac{Similarity(A_i, C_j)}{\sum_{k=1}^{n} Similarity(A_i, C_k)}$$

4 Experimental Results

4.1 Raw Data Description

As of the dataset download date, 2016 paper data had not been fully 收录 in the database. Therefore, all 14,530 bibliographic records from 1998-2015 were downloaded. The dataset spans 257 journals, with *Journal of Intelligence*, *Information Science*, *Information Theory and Practice*, *Library and Information Service*, and *Journal of the China Society for Scientific and Technical Information* ranking top five in publication volume. Regarding first-author affiliations, Wuhan University, Nanjing University, Institute of Scientific and Technical Information of China, Jilin University, and Peking University rank top five.

4.2 Research Interest Similarity Network Characteristics Analysis

The core author research interest similarity network comprises authors as nodes and research interest similarity as edge weights. The network contains… [garbled text skipped] …C1 community authors primarily research information processing technologies including information organization, information retrieval, ontology, data mining, visualization, and semantic retrieval. This domain includes 86 authors (approximately 39% of core authors), representing the mainstream research group in information science. This highly technical field intersects significantly with computer science and information systems, constituting one of the most distinctive areas in information science. These methods and technologies remain highly capable of solving problems in today's big data era, and future research in this direction could further integrate artificial intelligence technologies for continuous innovation.

C2 community authors focus primarily on competitive intelligence, a field originating in the 1980s that occupies an important position in information science. Competitive environment, competitors, and competitive strategies constitute the three major elements of competitive intelligence. Current research in this domain concentrates on the relationship between competitive intelligence and knowledge management, counter-intelligence, competitive intelligence technology and systems, and industrial (enterprise) competitive intelligence.

C3 community authors research bibliometrics and scientific evaluation. This field has evolved through stages including bibliographic statistics, bibliometrics, informetrics, and webometrics [8]. Bibliometrics represents crucial quantitative research in information science with a long developmental history, successively producing bibliometrics, scientometrics, informetrics, webometrics, and knowledge metrics—collectively termed the "five metrics." Currently, altmetrics represents a hot topic in international metrology, now receiving widespread attention from domestic scholars.

C4 community authors take the information science discipline as their research object, focusing on information science theory, disciplinary boundaries, and development, identifying connections between this discipline and related fields such as information science and library science. Meanwhile, this community's keywords include high-frequency terms from other communities like bibliometrics, information retrieval, and competitive intelligence, indicating that these sub-domains are closely related to the discipline's overall research.

Table 1 presents basic descriptive statistics for community identification, including network node counts, strong similarity edge counts, density, and representative authors for each community.

Community	Strong Similarity Edges	Density	Representative Authors (Publications)
C1	0.192	0.719	Bi Qiang (57), Lu Wei (40), Zhang Xiaolin (40), Gan Liren (40), Zhou Ning (35), Jia Junzhi (35)
C2	0.358	0.783	Zhang Yufeng (88), Li Gang (64), Zheng Yanning (59), Wang Yuefen (44), Peng Jingli (42), Jing Jipeng (40)
C3	0.189	-	Qiu Junping (198), Zhu Qinghua (74), Leng Fuhai (69), Su Xinning (57), Sun Jianjun (53), Zhao Rongying (49)
C4	-	-	Wang Zhijin (129), Lai Maosheng (52), Ma Feicheng (45), Ma Haiqun (43), Cheng Ying (33), Liang Zhanping (30)

As shown in Table 1, the density of each community's internal research interest similarity network exceeds the average density, with C1 showing relatively lower density, indicating broader research scope and more interdisciplinary connections. The identified four communities are not completely isolated but rather permeate and learn from each other.

4.4 Core Author Community Membership Analysis

As previously established, authors and communities do not have a one-to-one correspondence; an author's research interests may change across different research stages. Therefore, this study introduces the concept of membership degree to calculate the affiliation relationship between authors and communities, and subsequently computes fuzzy entropy to reflect interest dispersion. Partial author-community memberships are shown in **Table 2** .

Name	C1 Membership	C2 Membership	C3 Membership	C4 Membership	Fuzzy Entropy
Qiu Junping	0.12	0.06	0.74	0.08	1.43
Wang Zhijin	0.12	0.05	0.09	0.74	1.45
Zhang Yufeng	0.24	0.52	0.09	0.15	1.90

Each row in Table 2 corresponds to an author's membership degrees to different communities and their fuzzy entropy. The community with the highest membership degree for all 220 core authors aligns completely with the community division results. Fuzzy entropy based on community membership reflects the dispersion degree of authors' research interests. Among all authors in this study, Wang Xianwen from Dalian University of Technology has the minimum fuzzy entropy of 1.39, with 80% membership in C3, focusing primarily on bibliometrics and scientific evaluation. Chu Jiewang from Anhui University has the maximum fuzzy entropy of 2.05, with only 36.4% membership in his primary community C1, extensively covering competitive intelligence, bibliometrics, and other fields. Additionally, we plotted the frequency distribution of fuzzy entropy for 220 core authors, shown in **Figure 8** [**Figure 8: see original paper**].

As **Figure 8** [**Figure 8: see original paper**] illustrates, core authors' interest membership fuzzy entropy concentrates between 1.6-2, indicating most researchers span multiple domains. This may result from two factors: (1) scholars' research interests evolve with scientific progress, and (2) increasingly more research requires multi-disciplinary collaboration, necessitating authors' engagement with multiple fields. Grouping core authors by fuzzy entropy magnitude yields average publication counts per group shown in **Figure 9** [**Figure 9: see original paper**].

Figure 9 [**Figure 9: see original paper**] demonstrates a positive correlation between average publication count and fuzzy entropy, suggesting highly productive authors generally have broader research interests and more dispersed research directions. The average membership degrees of community members to each community are shown in **Figure 10** [**Figure 10: see original paper**].

Figure 10 [**Figure 10: see original paper**] reveals that authors' average membership to their own communities ranges between 0.5-0.6, while average membership to other communities ranges between 0.1-0.2. The average fuzzy entropy across communities falls between 1.8-1.9, indicating relatively consistent interest dispersion across communities with minimal variation.

4.5 Author Secondary Affiliation Community Analysis

As established, authors belong to communities with certain membership degrees, allowing ranking of overlapping communities for individual authors. Here, an author's secondary affiliation community is defined as the community with the second-highest membership degree. This section focuses on secondary affiliation distributions across different communities to identify inter-community relationships, shown in **Table 3** .

Primary Community	Secondary Affiliation Distribution
C1	C4 (41%), C3 (33%), C2 (26%)
C2	C4 (59%), C1 (26%), C3 (15%)
C3	C4 (46%), C1 (41%), C2 (13%)
C4	C3 (39%), C1 (32%), C2 (29%)

Table 3 shows that C1 and C3 community authors both select C4 community research themes as their secondary affiliation. As previously noted, C1 focuses on information organization and retrieval, C2 on competitive intelligence, and C3 on bibliometrics and scientific evaluation. These three research domains in information science have distinct methods and paradigms with clear boundaries, while C4 examines information science at the disciplinary level with a higher perspective and 层次, maintaining close connections with the other three communities. Notably, C2 and C3 community authors rarely consider each other as secondary affiliation communities. Competitive intelligence research emphasizes theory-practice integration with strong practical value, while bibliometrics and scientific evaluation focus more on academic research problems, emphasizing data analysis methods and experimental results. These differences lead to lower inter-community association and fewer cross-domain interactions, consistent with the visualization in **Figure 5** [**Figure 5: see original paper**] where C2 and C3 communities appear distant from each other.

Conclusion and Future Directions

Research on overlapping communities has attracted widespread academic attention. This study constructs a research interest similarity network for the information science field, identifies four major research domains through community detection algorithms, and determines each community's research themes using high-frequency term co-occurrence mapping. Subsequently, we calculate authors' community membership degrees and fuzzy entropy, group authors by fuzzy entropy, and count group sizes and average publications. Finally, we analyze secondary affiliation distributions across communities. Key findings include: (1) Edge weights in the information science core author research interest similarity network follow a power-law distribution; (2) Chinese information science research divides into four domains: information organization and retrieval, bibliometrics and scientific evaluation, competitive intelligence and knowledge management, and overall information science discipline research; (3) Most domain authors' research interests are not limited to a single field but distributed across multiple research areas, with higher fuzzy entropy correlating with greater publication output; (4) C1, C2, and C3 community authors all select C4 as their secondary affiliation, indicating close relationships and cross-domain interactions; (5) C2 and C3 authors rarely select each other as secondary affiliations, suggesting substantial differences in research paradigms and limited mutual exchange.

Several limitations should be noted: data sources are constrained by CSSCI 收录 scope, and author disambiguation and selection methods have remaining issues. Future research will pursue: (1) Improving existing research interest similarity calculation methods by incorporating semantic relationships between keywords and merging synonymous terms; (2) Incorporating temporal factors to analyze dynamic evolution of research interest similarity networks; (3) Exploring more accurate community identification methods to analyze information exchange and cooperation across multiple communities, expanding application scope; (4) Investigating inter-community exchange and cooperation from citation and co-authorship perspectives.

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Author Contributions

Xu Jian: Paper writing; **Mao Jin:** Paper revision; **Ye Guanghui:** Data collection and organization; **Ba Zhichao:** Research framework design and guidance; **Li Gang:** Paper topic and idea design.

English Abstract

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[Result/conclusion] We discover that the domestic information science discipline has four research field: information organization and retrieval, bibliometrics and scientific evaluation, competitive intelligence and knowledge management, and the information science. Most authors' research isn't limited to one field. Finally, the authors in C2 and C3 merely take each other as secondary membership community, and it implies that the boundary between competitive intelligence and bibliometrics is very obvious.

Keywords: research interest, network, information science, community, membership degree, similarity

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