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(检索日期: 2011-03-28, 检索责任人: 贺艳菊)

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发表论文单位: Wuhan Univ, Ctr Studies

检索要求: 胡吉明发表的论文被 SCI 收录情况

检索时段: 2011 年

检索结果

数据库	论文收录
Science Citation Index Expanded (SCI-EXPANDED)	1 篇

详情见附件 (已经委托人确认)。

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二〇一一年三月二十八日

检索报告附件:

SCI 收录 1 篇

显示 1 条, 共 1 条

作者: Hu, CP (Hu, Chang-Ping); Hu, JM (Hu, Ji-Ming); Gao, Y (Gao, Yan); Zhang, YK (Zhang, Yao-Kun)

标题: A journal co-citation analysis of library and information science in China

来源出版物: SCIENTOMETRICS, 86 (3): 657-670 MAR 2011

语言: English

文献类型: Article

作者关键词: China; LIS journals; Journal co-citation; Multivariate statistical analysis

KeyWords Plus: INTELLECTUAL SPACE; CITATION

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引用的参考文献数: 21

被引频次: 0

出版商: SPRINGER

出版商地址: VAN GODEWIJCKSTRAAT 30, 3311 GZ DORDRECHT, NETHERLANDS

ISSN: 0138-9130

DOI: 10.1007/s11192-010-0313-6

29 字符的来源出版物名称缩写: SCIENTOMETRICS

ISO 来源文献出版物名称缩写: Scientometrics

来源文献页码计数: 14

学科类别: Computer Science, Interdisciplinary Applications; Information Science & Library Science

ISI 文献传递号: 711YF

Volume 86 ■ Number 3 ■ March

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Volume 86, Number 3, 2011

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A journal co-citation analysis of library and information science in China

Chang-Ping Hu · Ji-Ming Hu · Yan Gao · Yao-Kun Zhang

Received: 2 June 2010 / Published online: 9 November 2010
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Abstract This paper aims to reveal the relationship and structure of library and information science (LIS) journals in China. 24 core LIS journals in China are selected and the relevant data of journal co-citation are retrieved from Chinese Journal Full-Text Database constructed by China National Knowledge Infrastructure during the period of 1999–2009. By calculating mean co-citation frequencies and correlation coefficients, we find that there is a strong relationship among LIS journals in China. Utilizing the methods of cluster analysis, multidimensional scaling analysis and factor analysis, we analyze the data of journal co-citation. LIS journals in China are divided into four clusters. The relatedness among journals is shown manifestly through their locations in the two-dimensional map. A three-factor solution is obtained with the factor loading of each journal. Finally, we interpret and discuss the results to get some conclusions and also expect to describe the network characters of journal co-citation in future research.

Keywords China · LIS journals · Journal co-citation · Multivariate statistical analysis

Introduction

During recent years, Library and Information Science (LIS) in China has being changed dramatically along with the reform and opening policy of China and the rapid growth of Chinese economy (Wu and Yuan 1994). LIS in China has achieved remarkable advances with several research branches emerging at present, namely: basic theories and methods of information science, bibliometrics, digital library, information service, information resource management, document index, information retrieval theory and competitive intelligence, etc. (Ma et al. 2009). As the important carrier of research achievement, LIS core journals in China are selected respectively by “Guide to the Chinese Core Journals” of Peking University Library and Chinese Social Science Citation Index (CSSCI: <http://cssci.nju.edu.cn/lyk2010/tq.htm>) of Nanjing University every year. “Chinese Journal

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Highly cited Indicators” published by Chinese Scientific and Technical Information Institute and Wanfang Data Co., Ltd. demonstrates the basic status of LIS journals in China through the number of published articles, the cited frequencies, impact factor, etc. These works only reveal the properties of individual journal; meanwhile, until now few articles focus on the relationship and structure of LIS journals in China. This paper aims to use journal co-citation analysis (JCA) to identify the relationship and structure of LIS in China.

Co-citation means that two items (documents, authors and journals, etc.) are cited when they are listed in a citing item’s reference list. The basic assumption of co-citation analysis is that the more frequently two items are co-cited, the more closely they are linked together. Co-citation analysis was first presented by Small (1973) in the early 1970s to examine the relationship and structure of an academic field, and proved to be an effective method to analyze the communication patterns through the published literatures (Small and Griffith 1974). Since then, co-citation analysis has been widely used to reveal the relationship and structure of an academic field in terms of authors, articles, journals or keywords (e.g., McCain 1990; Ma et al. 2009; Zhao et al. 2009; Liu 2005b; Zitt et al. 2003). McCain (1991) first attempted to utilize journal co-citation analysis and manifested that journal co-citation analysis could produce clear, coherent and reasonable results to help the researchers to study the structure of an academic field in which scholarly journals are a major means of communication. Among related studies, it has been shown that journal co-citation analysis can be used as an operational indicator for the discipline organization of the sciences, such as: information retrieval (Ding et al. 2000), semi-conductor (Tsay et al. 2003), urban studies (Liu 2005b), etc. Furthermore, social network analysis (SNA) is applied in journal co-citation to show the network structure of journals (Yue and Liu 2008).

At present, scholars usually cluster analysis, multidimensional scaling analysis and factor analysis to conduct co-citation analysis. Compared to the scholars’ traditional qualitative analysis (including individual induction, interviews and other subjective methods), co-citation analysis is more scientific, objective and effective (Liu 2005a).

By applying JCA, We manage to map the intellectual structure of LIS in China during the time period of 1999–2009, mainly including the status of any two journals co-cited, the relationship among journals and the subject areas that journals cover, and the reasonable interpretation according to actual situation of journals. The results of the study will help us to understand the scholarly communication in the field of LIS in China and benefit LIS scholars and researchers in terms of grasping the intellectual structure as reflected in its published journals. Additionally, the results may also guide information providers to collect and manage the related academic journals in LIS.

Method and data collection

The study followed the steps outlined by McCain (1991). Firstly, respective journals are selected and paired with other journals in the journal set. The co-citation frequencies of the paired journals are retrieved from the citation database and put into the square symmetric journal co-citation matrix with the data in the diagonal cells treated as missing data. Afterwards, the co-citation frequencies matrix is converted into a matrix of correlation coefficients, served as the measure of similarity. Then, the correlation matrix is analyzed using the statistical procedures of cluster analysis, multidimensional scaling analysis and factor analysis. Finally, the results are interpreted and confirmed.

Journal selection

We select 24 journals from “Chinese Journal Highlycited Indictors (CJHI)” (impact factor greater than 0.6) (Zeng 2009). The list of those journals and their general citation information acquired from CJHI are presented in Table 1. These 24 journals are capable of representing the major scholarly communication and collaboration patterns of LIS research in China.

Data collection of journal co-citation

Chinese Journal Full-Text Database (CJFTD) is the biggest Chinese journal full-text database and is updated continuously and dynamically every day. CJFTD embraces all Chinese LIS journals with the retrieval function for journal co-citation. Therefore, we

Table 1 24 LIS journals in China and their citation information in recent 5 years

No.	Journal title	Abbreviation	Number of published papers in 5 years	Cited frequencies in 5 years	Impact factor in 5 years
1	Journal of Academic Libraries	JAL	619	1,606	2.595
2	Journal of Library Science in China	JLSC	727	1,490	2.050
3	Journal of the China Society for Scientific and Technical Information	JCSSTI	608	1,087	1.788
4	Library Tribune	LT	2,091	3,265	1.561
5	Library Work and Study	LWS	1,040	1,474	1.417
6	Library Development	LD	1,281	1,713	1.337
7	Document; Information & Knowledge	DIK	872	1,144	1.312
8	Library Journal	LJ	1,258	1,549	1.231
9	Library and Information Service	LIS	1,981	2,381	1.202
10	Information Studies: Theory & Application	ISTA	968	1,140	1.178
11	Journal of the National Library of China	JNLC	387	445	1.150
12	Library Work in Colleges and Universities	LWCU	937	1,001	1.068
13	Information and Documentation Services	IDS	841	898	1.068
14	Information Science	IS	2,014	1,906	0.946
15	New Technology of Library and Information Service	NTLIS	1,254	1,150	0.917
16	Library Theory and Practice	LTP	1,588	1,431	0.901
17	Library and Information	LI	872	764	0.876
18	Researches in Library Science	RLS	1,865	1,550	0.831
19	Journal of Information	JI	3,144	2,496	0.794
20	Journal of Academic Library and Information Science	JALIS	910	653	0.718
21	New Century Library	NCL	759	497	0.655
22	Modern Information	MI	5,264	3,280	0.623
23	Library World	LW	410	255	0.622
24	Information Research	IR	1,828	1,101	0.602

Table 2 The matrix of journal co-citation frequencies between 1999 and 2009 (portion)

Abbreviation	JAL	JLSC	JCSSTI	LT	LWS	LD	DIK	LJ	LIS	ISTA
JAL		3,937	1,105	2,858	1,540	3,243	1,682	2,483	3,837	977
JLSC	3,937		1,888	3,614	1,810	3,731	2,422	3,401	5,731	1,554
JCSSTI	1,105	1,888		780	384	820	942	777	2,237	1,804
LT	2,858	3,614	780		2,594	4,837	2,010	2,897	3,342	950
LWS	1,540	1,810	384	2,594		2,541	976	1,592	1,751	485
LD	3,243	3,731	820	4,837	2,541		2,000	3,000	3,755	930
DIK	1,682	2,422	942	2,010	976	2,000		1,482	2,449	2,374
LJ	2,483	3,401	777	2,897	1,592	3,000	1,482		3,345	854
LIS	3,837	5,731	2,237	3,342	1,751	3,755	2,449	3,345		2,155
ISTA	977	1,554	1,804	950	485	930	2,374	854	2,155	

chose CJFTD as the data source to conduct this study. Taking use of the retrieval function for JCA, the selected journals were paired and put in the retrieval items of “reference” and time span was defined between 1999 and 2009; and then the number of eligible papers was retrieved. Finally we obtained $(24 \times 23)/2 = 276$ different sets of data, and put into the matrix. The matrix is a symmetric matrix with the data in the diagonal cells treated as missing data and the values of non-diagonal cell were the co-citation frequencies (shown in Table 2).

Method of data analysis

SPSS13.0 and Ucinet6.0 are employed in this study. In order to illustrate the relationship of these journals, we utilize Pearson method (White 2003) to convert the original matrix into a correlation matrix (shown in Table 3). The hierarchical agglomerative cluster analysis with Ward’s method is conducted on the correlation data to determine the clusters of journals (Small et al. 1985). And a two-dimensional map is created by MDS (ALSCAL) to intuitively reflect the correlation degree through the location of journals in the map (Norusis 1997). Furthermore, factor analysis is used to complement the cluster analysis and multidimensional scaling analysis in this study and show a journal’s contribution to LIS (White and McCain 1998). In factor analysis, the journal can load on more than one factor unlike cluster analysis in which a journal is only assigned to one cluster. And the factors are extracted by principal component analysis with varimax rotation (Hung 2004).

Results and discussion

Analysis of co-citation frequencies

The mean co-citation frequencies and mean co-citation correlation coefficients of journals are calculated for comparison (shown in Table 4). Journals which have higher mean co-citation frequencies are LIS (2175.74), JLSC (2057.17), LT (1942.43), LD (1940.22) and JAL (1625.96) and their mean co-citation correlation coefficients are also relatively higher. Combining with the current reputation and influence of journals, it can be said that JLSC is ranked first among LIS journals in China. And the lower are IR (384.09), JNLC (366.70),

Table 3 The correlation matrix of journal co-citation (portion)

Abbreviation	JAL	JLSC	JCSSTI	LT	LWS	LD	DIK	LJ	LIS	ISTA
JAL	1.00	0.97	0.60	0.89	0.87	0.91	0.84	0.99	0.94	0.54
JLSC	0.97	1.00	0.60	0.78	0.79	0.85	0.84	0.95	0.97	0.59
JCSSTI	0.60	0.60	1.00	0.37	0.29	0.41	0.79	0.54	0.69	0.87
LT	0.89	0.78	0.37	1.00	0.99	0.98	0.70	0.90	0.77	0.34
LWS	0.87	0.79	0.29	0.99	1.00	0.99	0.72	0.91	0.75	0.28
LD	0.91	0.85	0.41	0.98	0.99	1.00	0.73	0.94	0.78	0.38
DIK	0.84	0.84	0.79	0.70	0.72	0.73	1.00	0.83	0.88	0.72
LJ	0.99	0.95	0.54	0.90	0.91	0.94	0.83	1.00	0.91	0.48
LIS	0.94	0.97	0.69	0.77	0.75	0.78	0.88	0.91	1.00	0.60
ISTA	0.54	0.59	0.87	0.34	0.28	0.38	0.72	0.48	0.60	1.00

Table 4 Mean co-citation frequencies and mean co-citation correlation coefficients of LIS journals in China

No.	Abbreviation	Mean co-citation frequencies	Mean co-citation correlation coefficients
1	JAL	1625.96	0.83
2	JLSC	2057.17	0.81
3	JCSSTI	872.00	0.56
4	LT	1942.43	0.80
5	LWS	1050.87	0.79
6	LD	1940.22	0.81
7	DIK	1206.74	0.77
8	LJ	1422.17	0.83
9	LIS	2175.74	0.79
10	ISTA	947.22	0.53
11	JNLC	366.70	0.81
12	LWCU	744.61	0.77
13	IDS	963.17	0.82
14	IS	1313.91	0.68
15	NTLIS	809.43	0.74
16	LTP	1112.43	0.84
17	LI	711.43	0.85
18	RLS	1178.35	0.85
19	JL	1255.96	0.74
20	JALIS	363.65	0.67
21	NCL	430.91	0.81
22	MI	1299.22	0.77
23	LW	255.87	0.75
24	IR	384.09	0.62

JALIS (363.65) and LW (255.87). The mean co-citation frequencies and mean co-citation correlation coefficients of all journals is respectively 1101.26 and 0.76, indicating a better association among journals across the set.

Cluster analysis

LIS journals in China are divided into four clusters in this study, named cluster1, cluster2, cluster3 and cluster4. The dendrogram of the cluster analysis is shown in Fig. 1. The four-cluster solution is best fit for interpretation and the current actual situation of LIS journals in China.

There are more journals in cluster1, less in cluster2 and cluster4, least in cluster3, illustrating that the study subjects of LIS in China are focused on cluster1, cluster2 and cluster4; and cluster3 is marginal. In terms of the articles published in journals, cluster1

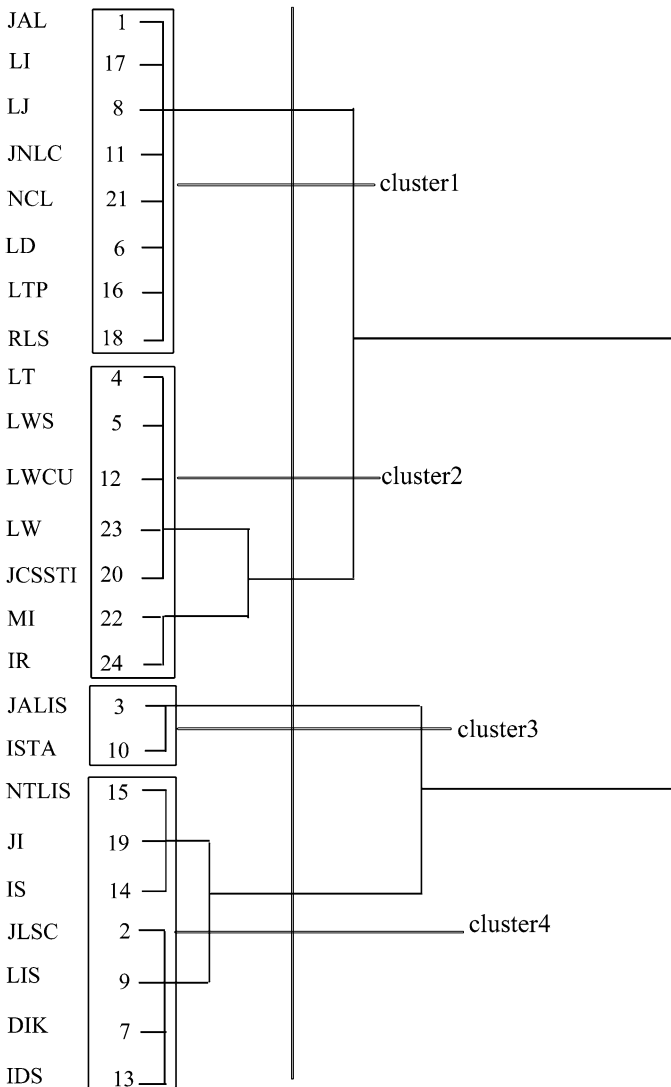


Fig. 1 Dendrogram of cluster analysis of 24 LIS journals in China

Table 5 The mean co-citation frequencies and mean co-citation correlation coefficients of the four clusters

Cluster	Mean co-citation frequencies	Mean co-citation correlation coefficients
1	1012.594	0.96
2	709.4694	0.88
3	542	0.94
4	1664.286	0.89

and cluster2 more focus on Library Science; cluster3 and cluster4 more focus on Information Science. Cluster1 and cluster2 include a total of fifteen journals (62.5% of all journals) and Library Science remains the main study area in Chinese LIS.

1. Cluster1: There are most journals with high mean co-citation frequencies and mean co-citation correlation coefficients in cluster1. Journals in cluster1 are clustered together at the first instance with the close relationship among them. However, several exceptional journals (such as NCL and JNLC) have lower co-citation frequencies and correlation coefficients in cluster1 because of the similar themes.
2. Cluster2: There are obviously two branches in cluster2: MI and IR named sub-cluster 2-a, the others named sub-cluster 2-b. Journals in sub-cluster 2-a focus on Information Science and sub-cluster 2-b more focus on application and practice, so it is can be said that there are no clear boundaries between Library Science and Information Science.
3. Cluster3: Cluster3 contains only two journals (JCSSTI and ISTA). The two journals are on the edge of LIS with more research topics of computers and information technology.
4. Cluster4: Seven journals have the relatively higher co-citation frequencies. Clearly cluster4 consists of two sub-clusters: one named sub-cluster 4-a including IS, NTLIS and JI (mainly related to the applications of computer technology in LIS); the other named sub-cluster 4-b including JLSC, DIK, LIS and IDS (related to research of theory and practice in LIS). The study subjects in cluster4 are inclined to research for applications in LIS as a whole.

The mean co-citation frequencies and mean co-citation correlation coefficients of the four clusters are shown in Table 5. As can be seen, cluster1 and cluster4 have the highest mean co-citation frequencies and mean co-citation correlation coefficients and journals in the two clusters have closer relationship. Especially cluster1 has the largest mean co-citation correlation coefficients, indicating the closest relationship among journals and the most centralized study subjects. Journals in cluster1 have a high status in Chinese LIS.

Multidimensional scaling analysis

In order to visualize the subject relatedness among the journals in a multivariate space, two-dimensional map is generated by MDS. The correlation degree of journals can be intuitively discerned through the location and distance in the map. Journals with high correlation coefficient are located together. The closer their locations are, the more similar their study subjects are. In this analysis, Stress is equal to 0.02703 and RSQ is equal to 0.99744; the effect of analysis is very good. Figure 2 shows the two-dimensional solution.

1. The four clusters obtained by cluster analysis were embedded into the two-dimensional map to facilitate the interpretation. Cluster1 is in the first quadrant; cluster2 is in the forth; cluster3 is in the third and cluster4 is in the second. Cluster1 is

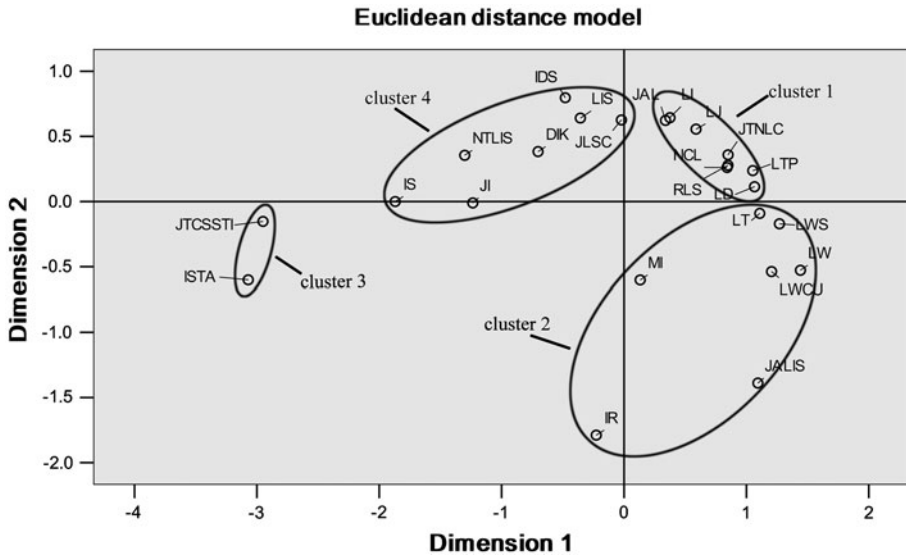


Fig. 2 Two-dimensional map of journal co-citation of LIS in China

located close to cluster2 and cluster4, in which journals have close relationship among them. The two sub clusters of cluster2 are separated far away from each other; sub-cluster2-b is closer to cluster1. Cluster3 is located in the far left of the map, in other words in the marginal location. Journals in cluster4 are relatively dispersed; sub-cluster4-b is closer to cluster1 because of its focusing subjects.

2. Combined with the cluster analysis, journals in cluster3 and cluster4 located on the left of coordinate axis focus on Information Science; journals in cluster1 and cluster2 on the right focus on Library Science. Viewed from left to right, the subject is from Information Science to Library Science. The mean co-citation frequencies and mean co-citation correlation coefficients of journals above the coordinate axis are larger than the below. Cluster1 and cluster4 are above the horizontal axis simultaneously and the number of journals in the two clusters is roughly equal, indicating that Library Science and Information Science are developing evenly in the main.
3. There are several special journals which almost overlap on the map (LI and JAL; TNLC, LJ and NCL) because of the closer relationship among them.

JLSC on the vertical axis is the bridge connecting cluster1 with cluster2 and its mean co-citation frequencies and mean co-citation correlation coefficients are relatively higher. We can initially conclude that JLSC is the core of all journals.

Factor analysis

A three-factor solution is generated in the factor analysis. As shown in Table 6, it suggests the extraction of three factors explaining 98.67% of the total variance. Although there is no perfect match between the factor assignment and the cluster assignment, there are ample similarities between the two. It should be noted that the high factor loading indicates the high status and large contribution of journal. Table 7 shows the result of the rotated factor

Table 6 The total variance explained by factor analysis

Factor	% of Variance	Cumulative (%)
1	46.96	46.96
2	36	82.959
3	15.72	98.679

Table 7 Rotated component matrix of 24 journals of LIS in China

Cluster	Abbreviation	1	2	3
1	LI	0.996		
1	JAL	0.994		
1	LJ	0.991		
1	JNLC	0.949		
4-b	JLSC	0.926		
1	NCL	0.909		
1	LTP	0.832		
1	LD	0.824		
1	RLS	0.810		
4-b	LIS	0.803	0.525	
2-b	LT	0.766		
2-b	LWS	0.734		
2-b	LW	0.710		
4-a	NTLIS		0.962	
4-a	JI		0.956	
4-a	IS		0.941	
3	JCSSTI		0.903	
3	ISTA		0.855	
4-b	DIK		0.811	
4-b	IDS	0.570	0.783	
2-b	JALIS			0.565
2-b	LWCU	0.572		0.543
2-a	MI			0.939
2-a	IR			0.930

analysis of the correlation coefficient matrix and the factor loadings are greater than or equal to 0.5.

1. In terms of the number of journals, three factors are significantly reduced as a trapezoid structure. The total variance of factor1 and factor2 is 82.96% and journals in these two factors are the master journals of LIS in China. Journals in factor3 whose variance is the least contribute fewer to LIS.
2. Factor1 includes all the journals in cluster1 (factor loadings are greater than 0.8), four in sub-cluster 2-b and three in sub-cluster 4-b, indicating that there are large correlation degree among them. Factor 2 contains all the journals in cluster3 and a majority in cluster4, indicating the stronger subject overlapping between cluster3 and cluster4.

3. Factor loadings of journals in cluster1 and cluster4 are relatively higher, illustrating the high status in LIS again. It is notable that there are three journals across two factors: LIS, IDS, LWCUC because that there is intersection between two factors and the study subjects of the journals are comparatively extensive.
4. Journals in cluster2 and cluster4 are separated respectively because of the different focused study subjects.

Comparison with related studies

Compared with the previous related researches (e.g., Tian 2009; Song and Ye 2009), the major contributions of this paper are as follows:

1. The time span selected between 1999 and 2009, is longer than other studies, and the amount of data is large enough to guarantee the accuracy.
2. The integrated application of cluster analysis, multidimensional scaling analysis and factor analysis supplements and conforms with the results more scientifically.
3. The judgments about the clusters of journals and their subject areas are more accurate. And the correlation degrees among journals are fully and distinctly exhibited.

Consequently, the relationship structure of LIS journals in China in this study is more obvious to acquaint us with the development status.

Conclusion

Using the co-citation data of 24 LIS journals in China and taking CJFTD as the data source, we obtain clear and reasonable results about the relationship and structure of LIS studies in China.

1. As a whole, the journals of LIS in China are strongly related to each other. The LIS field in China has the stable mainstream journals group in which JLSC is the core.
2. Journals can be divided into four clusters with different focusing study subjects. The relationship in each cluster and between clusters is different.
3. The integrated tendency of Library Science and Information Science in China are getting more and more obvious, but the development is not balanced as a whole; Library Science occupies the dominant position.

This study can provide a general grasp of the structure of journals of LIS in China. This paper identifies the relationship and structure of LIS in China though the journals, but not described the network characters of journal co-citation, such as: centrality, density and core/periphery structure. Therefore, we will furthermore utilize the theory and methods of social network to analyze the data of journal co-citation and achieve more valuable results.

Appendix

See Tables 8 and 9.

Table 8 Journal co-citation frequency

Journal title	JAL	JLSC	JCSSTI	LT	LWS	LD	DIK	LJ	LIS	ISTA	JNLC	LWCU
JAL		3,937	1,105	2,858	1,540	3,243	1,682	2,483	3,837	977	631	1,221
JLSC	3,937		1,888	3,614	1,810	3,731	2,422	3,401	5,731	1,554	716	1,102
JCSSTI	1,105	1,888		780	384	820	942	777	2,237	1,804	162	305
LT	2,858	3,614	780		2,594	4,837	2,010	2,897	3,342	950	700	1,789
LWS	1,540	1,810	384	2,594		2,541	976	1,592	1,751	485	331	936
LD	3,243	3,731	820	4,837	2,541		2,000	3,000	3,755	930	709	1,490
DIK	1,682	2,422	942	2,010	976	2,000		1,482	2,449	2,374	369	712
LJ	2,483	3,401	777	2,897	1,592	3,000	1,482		3,345	854	575	807
LIS	3,837	5,731	2,237	3,342	1,751	3,755	2,449	3,345		2,155	688	1,111
ISTA	977	1,554	1,804	950	485	930	2,374	854	2,155		206	326
JNLC	631	716	162	700	331	709	369	575	688	206		209
LWCU	1,221	1,102	305	1,789	936	1,490	712	807	1,111	326	209	
IDS	1,340	2,107	894	1,478	759	1,541	1,073	1,129	2,354	1,073	294	490
IS	1,554	2,301	2,085	1,728	799	1,680	1,459	1,202	2,837	1,966	272	747
NTLIS	1,410	1,498	1,289	1,016	492	1,270	784	973	1,707	979	236	335
LTP	1,611	2,139	486	2,439	1,330	2,431	1,090	1,564	2,007	622	386	796
LI	1,024	1,553	490	1,289	707	1,287	839	974	1,491	492	255	502
RLS	1,741	2,322	550	2,471	1,361	2,293	1,246	1,479	2,267	592	442	1,001
JI	1,602	1,970	1,589	1,956	902	1,743	1,373	1,213	2,540	1,655	324	657
JALIS	591	427	112	875	496	777	364	379	474	156	122	496
NCL	639	796	165	945	427	940	415	653	984	170	225	330
MI	1,583	1,554	880	2,713	1,272	2,393	1,149	1,218	2,064	1,034	354	1,204
LW	381	419	64	644	300	571	231	362	403	97	124	199
IR	407	323	248	751	385	643	314	351	513	335	104	361

Journal title	IDS	IS	NTLIS	LTP	LI	RLS	JI	JALIS	NCL	MI	LW	IR
JAL	1,340	1,554	1,410	1,611	1,024	1,741	1,602	591	639	1,583	381	407
JLSC	2,107	2,301	1,498	2,139	1,553	2,322	1,970	427	796	1,554	419	323
JCSSTI	894	2,085	1,289	486	490	550	1,589	112	165	880	64	248
LT	1,478	1,728	1,016	2,439	1,289	2,471	1,956	875	945	2,713	644	751
LWS	759	799	492	1,330	707	1,361	902	496	427	1,272	300	385
LD	1,541	1,680	1,270	2,431	1,287	2,293	1,743	777	940	2,393	571	643
DIK	1,073	1,459	784	1,090	839	1,246	1,373	364	415	1,149	231	314
LJ	1,129	1,202	973	1,564	974	1,479	1,213	379	653	1,218	362	351
LIS	2,354	2,837	1,707	2,007	1,491	2,267	2,540	474	984	2,064	403	513
ISTA	1,073	1,966	979	622	492	592	1,655	156	170	1,034	97	335
JNLC	294	272	236	386	255	442	324	122	225	354	124	104
LWCU	490	747	335	796	502	1,001	657	496	330	1,204	199	361
IDS		1,348	649	855	586	913	1,199	219	357	1,052	157	286
IS	1,348		1,383	983	813	1,209	2,429	347	381	2,003	212	482
NTLIS	649	1,383		630	332	668	1,162	180	222	1,064	107	231
LTP	855	983	630		780	1,395	1,082	417	491	1,362	304	386
LI	586	813	332	780		601	731	208	289	704	208	208

Table 8 continued

Journal title	IDS	IS	NTLIS	LTP	LI	RLS	JI	JALIS	NCL	MI	LW	IR
RLS	913	1,209	668	1,395	601		1,305	280	262	1,786	369	549
JI	1,199	2,429	1,162	1,082	731	1,305		252	391	2,106	146	560
JALIS	219	347	180	417	208	280	252		158	675	127	232
NCL	357	381	222	491	289	262	391	158		469	71	131
MI	1,052	2,003	1,064	1,362	704	1,786	2,106	675	469		299	944
LW	157	212	107	304	208	369	146	127	71	299		90
IR	286	482	231	386	208	549	560	232	131	944	90	

Table 9 Correlation coefficient of journal co-citation

Journal title	JAL	JLSC	JCSSTI	LT	LWS	LD	DIK	LJ	LIS	ISTA	JNLC	LWCU
JAL	1.00	0.97	0.60	0.89	0.87	0.91	0.84	0.99	0.94	0.54	0.96	0.79
JLSC	0.97	1.00	0.60	0.78	0.80	0.85	0.84	0.95	0.97	0.60	0.92	0.73
JCSSTI	0.60	0.60	1.00	0.37	0.29	0.42	0.79	0.54	0.69	0.87	0.42	0.27
LT	0.89	0.78	0.37	1.00	1.00	0.98	0.70	0.91	0.77	0.34	0.93	0.95
LWS	0.87	0.80	0.29	1.00	1.00	0.99	0.72	0.91	0.75	0.28	0.94	0.96
LD	0.91	0.85	0.42	0.98	0.99	1.00	0.73	0.95	0.78	0.38	0.96	0.94
DIK	0.84	0.84	0.79	0.70	0.72	0.73	1.00	0.83	0.88	0.72	0.79	0.66
LJ	0.99	0.95	0.54	0.91	0.91	0.95	0.83	1.00	0.91	0.48	0.98	0.84
LIS	0.94	0.97	0.69	0.77	0.75	0.78	0.88	0.91	1.00	0.60	0.87	0.69
ISTA	0.54	0.60	0.87	0.34	0.28	0.38	0.72	0.48	0.60	1.00	0.37	0.27
JNLC	0.96	0.92	0.42	0.93	0.94	0.96	0.79	0.98	0.87	0.37	1.00	0.87
LWCU	0.79	0.73	0.27	0.95	0.96	0.94	0.66	0.84	0.69	0.27	0.87	1.00
IDS	0.93	0.94	0.81	0.77	0.74	0.80	0.93	0.90	0.97	0.74	0.84	0.70
IS	0.71	0.70	0.93	0.52	0.50	0.55	0.83	0.65	0.76	0.86	0.57	0.49
NTLIS	0.79	0.82	0.88	0.64	0.59	0.63	0.85	0.74	0.87	0.80	0.69	0.59
LTP	0.93	0.86	0.43	0.99	0.98	0.99	0.79	0.96	0.83	0.39	0.97	0.95
LI	0.97	0.95	0.61	0.89	0.88	0.92	0.87	0.97	0.94	0.58	0.94	0.82
RLS	0.93	0.85	0.50	0.96	0.95	0.96	0.78	0.94	0.83	0.48	0.93	0.94
JI	0.73	0.76	0.86	0.60	0.61	0.65	0.84	0.71	0.78	0.81	0.64	0.65
JALIS	0.65	0.59	0.12	0.87	0.89	0.84	0.51	0.72	0.52	0.14	0.73	0.96
NCL	0.94	0.89	0.43	0.93	0.94	0.96	0.76	0.96	0.81	0.40	0.95	0.87
MI	0.75	0.74	0.55	0.79	0.83	0.79	0.73	0.76	0.68	0.50	0.74	0.86
LW	0.82	0.75	0.18	0.97	0.99	0.96	0.65	0.88	0.68	0.16	0.91	0.96
IR	0.52	0.50	0.33	0.66	0.69	0.63	0.53	0.51	0.43	0.32	0.52	0.81

Journal title	IDS	IS	NTLIS	LTP	LI	RLS	JI	JALIS	NCL	MI	LW	IR
JAL	0.93	0.71	0.79	0.93	0.97	0.93	0.73	0.65	0.94	0.75	0.82	0.52
JLSC	0.94	0.70	0.82	0.86	0.95	0.85	0.76	0.59	0.89	0.74	0.75	0.50
JCSSTI	0.81	0.93	0.88	0.43	0.61	0.50	0.86	0.12	0.43	0.55	0.18	0.33
LT	0.77	0.52	0.64	0.99	0.89	0.96	0.60	0.87	0.93	0.79	0.97	0.66
LWS	0.74	0.50	0.59	0.98	0.88	0.95	0.61	0.89	0.94	0.83	0.99	0.69
LD	0.80	0.55	0.63	0.99	0.92	0.96	0.65	0.84	0.96	0.79	0.96	0.63

Table 9 continued

Journal title	IDS	IS	NTLIS	LTP	LI	RLS	JI	JALIS	NCL	MI	LW	IR
DIK	0.93	0.83	0.85	0.79	0.87	0.78	0.84	0.51	0.76	0.73	0.65	0.53
LJ	0.90	0.65	0.74	0.96	0.97	0.94	0.71	0.72	0.96	0.76	0.88	0.51
LIS	0.97	0.76	0.87	0.83	0.94	0.83	0.78	0.52	0.81	0.68	0.68	0.43
ISTA	0.74	0.86	0.80	0.39	0.58	0.48	0.81	0.14	0.40	0.50	0.16	0.32
JNLC	0.84	0.57	0.69	0.97	0.94	0.93	0.64	0.73	0.95	0.74	0.91	0.52
LWCU	0.70	0.49	0.59	0.95	0.82	0.94	0.65	0.96	0.87	0.86	0.96	0.81
IDS	1.00	0.87	0.92	0.83	0.94	0.86	0.90	0.54	0.84	0.77	0.67	0.55
IS	0.87	1.00	0.94	0.60	0.71	0.66	0.97	0.34	0.57	0.68	0.36	0.58
NTLIS	0.92	0.94	1.00	0.68	0.81	0.74	0.94	0.44	0.68	0.71	0.49	0.55
LTP	0.83	0.60	0.68	1.00	0.94	0.98	0.69	0.85	0.96	0.84	0.96	0.69
LI	0.94	0.71	0.81	0.94	1.00	0.95	0.77	0.71	0.95	0.78	0.84	0.55
RLS	0.86	0.66	0.74	0.98	0.95	1.00	0.75	0.87	0.96	0.87	0.92	0.75
JI	0.90	0.97	0.94	0.69	0.77	0.75	1.00	0.53	0.66	0.81	0.54	0.70
JALIS	0.54	0.34	0.44	0.85	0.71	0.87	0.53	1.00	0.81	0.78	0.87	0.78
NCL	0.84	0.57	0.68	0.96	0.95	0.96	0.66	0.81	1.00	0.77	0.90	0.57
MI	0.77	0.68	0.71	0.84	0.78	0.87	0.81	0.78	0.77	1.00	0.78	0.98
LW	0.67	0.36	0.49	0.96	0.84	0.92	0.54	0.87	0.90	0.78	1.00	0.64
IR	0.55	0.58	0.55	0.69	0.55	0.75	0.70	0.78	0.57	0.98	0.64	1.00

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