Discovering and analyzing the intellectual structure and its evolution of LIS in China, 1998–2007

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Abstract   The intellectual structure and its evolution of library and information science (LIS) in China are analyzed with time series data from Chinese Social Sciences Citation Index which is the properest database for ACA practice in the field of social science at present. The result indicates that the subfields of Library and Information Science in China kept changing from 1998 to 2007: some subfields have emerged and developed a lot, e.g., webometrics and competitive intelligence; some subfields maintain, e.g., bibliometrics and intellectual property; and some subfields have begun to decline, e.g., cataloging. Through the comparison with the international LIS, it is found that there are some unique subfields in Chinese LIS from 1998 to 2007, such as competitive intelligence and intellectual property. At the same time, I also suggest that Chinese authors in LIS should pay more attention to the applied research in the future.

Keywords   Author cocitation analysis · Intellectual structure · Library and Information Science · Domain mapping · Visualization · China

Mathematics Subject Classification   62P25

JEL Classification   I21

Introduction

Author cocitation analysis (ACA) has been a mature and widely accepted method of discovering the intellectual structure of a given filed after the proposal by White and

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Griffith ([1981](#)). The principle of ACA is that when two authors simultaneously appear in the reference list of a paper, the cocitation relationship is built between them and if two authors simultaneously appear in the reference list of N papers, the author cocitation strength or frequency between them is N (Qiu [2007](#)). The N stands for the similarity of research interest between the two authors. The bigger the N is, the more similar the interest between them is. When the raw author cocitation matrix is built by procedure or manually, we can use some statistical methods such as cluster analysis, multidimensional scaling analysis, etc., to discover its inner structure (McCain [1990](#)) and thus the authors with the same research interest will be clustered. In the end, the authors are separated into several clusters and we name these clusters based on the knowledge to the discipline or field (White and McCain [1998](#)). So far, ACA has been wildly applied in many practical subjects or domains (e.g. White and McCain [1998](#); Ahlgren et al. [2003](#); Leydesdorff and Vaughan [2006](#)).

The modern education of Chinese library and information science (LIS), started in 1920, has become an independent subject through several generations' unremitting efforts (Zhou and Liu [2006](#)). So far, there are 336 universities setting up undergraduate course and 67 of them has set up graduate course (Qiu [2011](#)). The number of student of LIS in China is very large and LIS has been the third largest undergraduate subject in China (Qiu [2011](#)). Many scholars have devoted themselves to the study on LIS and produced a large number of related works. However, some scholars also doubted its development, especially the research contents (e.g., Wang and Zhao [2006](#); Zhou [2011](#)). So it is necessary to know about its research directions in details and to find out the actual condition by the comparison with the intellectual LIS.

Many Chinese authors have done research on the structure discovering of a field using ACA since 2006. However, most of them were based on Web of Knowledge (WoK) and made use of the tool Citespace produced by C. Chen (e.g., Hou et al. [2006](#); Qiu and Wen [2011](#)). However, it is known to all that Chinese authors in LIS published relatively few articles in the journals indexed by WoK. Most of them published their articles in Chinese journals. So WoK are not the proper data source for the analysis of Chinese LIS due to the small data sample. But it is possible to do related research on the base of Chinese academic database. Some authors have also studied the subject structure of Chinese LIS with the aid of ACA. Ma and Song ([2006](#)) discovered the intellectual structure of LIS using ACA with the data from China national knowledge infrastructure (CNKI). However, after some demonstrations, it is found that CNKI is not the most ideal database for ACA study due to its fixed retrieval mode and downloading restriction (Ma [2009](#)). Ma et al. ([2009](#)) attempted to analyze the structure of LIS in China using ACA method with the data gathered from Chinese Google Scholar. But the data of Google Scholar are abnormal with large of reduplicate record and different datum organization formats. After the comparison with different academic databases, I find that the Chinese Social Sciences Citation Index (CSSCI) is the properest data source for ACA practice in the field of social science as we can handle the data in batch according to our research purpose (more introduction please read the section "Data source and author selection"). Zhu et al. ([2008](#)) developed certain software for domain mapping based on the CSSCI, but no articles has been published after that. In a word, until now, the researches on the intellectual structure of LIS on the basis of Chinese academic database are very few.

Therefore, this paper attempts to answer these three questions: (1) what the intellectual structure of LIS in China is; (2) how the intellectual structure evolves; (3) what the differences between the Chinese LIS and the international LIS are.

Methods

Method of domain mapping

For a successful mapping of a discipline based on ACA method, there are some basic requirements for the visualization of ACA result. *First, the visualization result should be simple*. In some author cocitation visualizations, there are links between most of authors in a set, which leads to a complicated network structure and is difficult to find the dominant authors in the cocitation network. *Second, the ACA visualization should be readable*. One purpose of visualization is in order to make our readers understand the structure of the discipline better. Those readers could be the people who are familiar with the discipline, e.g., researchers in the discipline, and also the people who know little about the discipline, e.g., some researchers in other disciplines and those who are only interested in knowing about the discipline. Therefore, it is very important to make the visualization readable and clear to all these authors. Simple visualization is not necessarily readable to all authors, but readable visualization should be simple. *Finally, the cross-cluster authors should be properly displayed in the visualization*. It is very common that an author clustered into a specific group is also influential in other groups, and I call it the cross-cluster author. Cross-cluster authors exist in many disciplines. The visualization should properly display those cross-cluster authors in order to make the result more accordable to the discipline.

Based on the above understanding, a new approach to the ACA result visualization that combines cluster analysis with pathfinder algorithm is proposed. However, we should pay attention to these details in the following when using this method. To begin with, the pathfinder algorithm is regarded as one of the mature and widely used methods for visualizing cocitation relationship between authors in terms of simplicity, as it captures the dominant relationships among authors and ignores comparatively unimportant ones (Chen 2003). The pathfinder algorithm requires dissimilarity matrices as input (Schvaneveldt 1989), while the raw author cocitation matrix is a typical similarity matrix. Qiu et al. (2008) have suggested using squared Euclidean distance as the normalization of the raw cocitation matrix, which can meet the input requirement of pathfinder. However, the results obtained by the pathfinder algorithm based on normalized data are not very interpretable in terms of cluster/group (White 2003), though the result itself is simple. In order to make up this insufficient and to display the mapping result more informatively, hierarchical clustering method is adopted. In hierarchical clustering, the raw cocitation matrix is normalized with squared Euclidean distance to ensure the consistence with the input format of pathfinder algorithm. The Ward algorithm is used in hierarchical clustering in this paper. The combination of clustering and pathfinder makes the visualization of cocitation relationship simple and informative. Both pathfinder and clustering analysis, show group/cluster information more or less, but they are two different methods after all: the former is based on minimum spanning tree and triangle inequality, while the latter Ward algorithm. Some authors in the same ACA result may belong to different clusters by combing these two different clustering methods, which, to some extent, can reveal the research diversity of the author.

The new approach can be implemented through the following steps.

Normalize the raw author cocitation matrix with squared Euclidean distance, which can be easily achieved by using the module "Cluster Analysis" in SPSS.
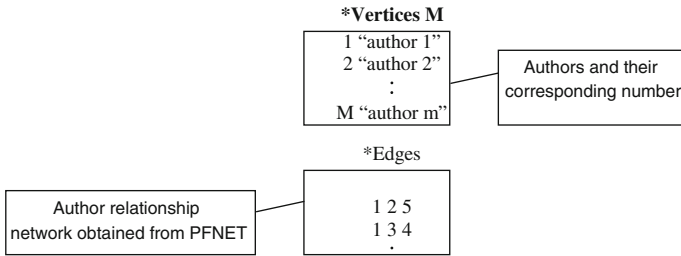
*Vertices M

| 1 "author 1" |
| 2 "author 2" |
| : |
| M "author m" |

Authors and their corresponding number

*Edges

Author relationship network obtained from PFNET

| 1 2 5 |
| 1 3 4 |
| : |

Fig. 1 Result of raw pathfinder network

*Vertices M+N

| 1 "author 1" |
| 2 "author 2" |
| : |
| M "author m" |

Authors and their corresponding number

| M+1 "cluster 1" |
| M+2 "cluster 2" |
| : |
| M+N "cluster N" |

Clusters and their corresponding number

*Edges

| 1 2 5 |
| 1 3 4 |
| : |

Author relationship network obtained from PFNET

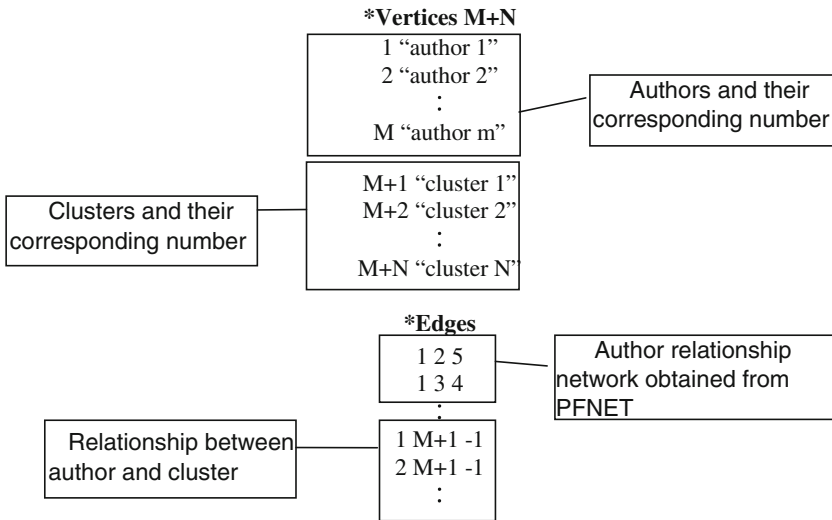| 1 M+1 -1 |
| 2 M+1 -1 |
| : |

Relationship between author and cluster

Fig. 2 New relationship networks obtained by the new method

Use the normalized dissimilarity matrix as input for pathfinder analysis and get the pathfinder result matrix (namely pathfinder network, PFNET), then convert the PFNET to the ".net" file for Pajek[1]. The result is shown as Fig. 1.

Use SPSS to get the cluster result and label each cluster with $M + 1$, $M + 2$,..., $M + N$, where M represents the number of authors and N the number of clusters.

Add the label for each cluster to the file obtained from step (2), and the strength between the author and his/her corresponding cluster is labeled as " -1". The structure of the new ".net" file is shown in Fig. 2.

Use Kamada–Kawai and Fruchterman–Reingold[2] algorithm to visualize the result obtained from step (4) with Pajek.

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[1] This can be achieved in Network Workbench.

[2] We can get a comparatively stable result via Fruchterman–Reingold algorithm and optimize with Kamada–Kawai, which can done with Pajek. For the detailed information about this, please refer to de Nooy et al. (2004).

Table 1 The number of publishing articles in each year from 1998 to 2007

Year	Articles
1998	1,021
1999	1,144
2000	1,570
2001	1,644
2002	1,936
2003	2,097
2004	2,341
2005	2,354
2006	2,343
2007	2,281

Data source and author selection

The data used in this paper were collected from CSSCI. CSSCI is developed by a research group in Nanjing University in China. At present, it has become the most important index for the evaluation of an author, an institution and a discipline in terms of social and art science in China. The journals indexed in it are selected with high and strict standards and have been regarded as the core ones by many scholars and managers in universities. In addition, it labels every paper with a unique discipline according to its content rather than journal, which is very scientific and suitable for ACA study. The number of articles published from 1998 to 2007 in the discipline of LIS is 36215. In the CSCCI, the types of articles include research article, book review, letter, report, etc. For this study, only the research articles, about 18,731, are picked out for further analysis, which is adequate for the empirical study in the following. However, it is very difficult to retrieve the citation times of these articles in the CSSCI as the citing (source) database and citation database are independent. If one wants to know the citation condition of an article, he/she has to open the citation database first and then input the title of this article to retrieve and obtain the result. Apparently, it is impossible for us to get the citation of each paper one by one, which is very time-consuming. In order to solve this problem, I write a program with java language to automatically calculate the citations of articles that appear in the references of the articles published from 1998 to 2007. Based on these preliminary works, the citations of authors are obtained finally.

In this article, I not only explore the overall intellectual structure of LIS in China from 1998 to 2007, but also divide the 10 years into two sub-periods, i.e., 1998–2002 and 2003–2007, to discover the evolution of LIS in China. Table 1 shows the detailed information on the number of articles published each year. The reasons for the time division are as follows. (1) the 10 years can be evenly separated into two 5-year sub-periods easily; (2) from Table 2, we can observe that the number of published articles is less than 2,000 before the year 2002. So, the year 2002 can be seen as a turning point of the development of LIS in China.

Author selection is also one of key works for the ACA study. McCain (1990) ever summarized some selection channels of authors, e.g., from reviews, consultation with researchers, and conference lists, etc. However, at present, the author selection is mainly based on the citations of the authors in a discipline (e.g., White and McCain 1998; Zhao 2003). We rank the author according to their citation counts in descending order and then select the top authors as the initiatory research objects. In the White and McCain's article,

Table 2 Intellectual structure evolution of LIS in China

Subfields	1998–2007	1998–2002	2003–2007	Trend
Webmetrics	2	–	2	Rise
Bibliometrics	6	9	6	Stable
On-line information organization, retrieval and service	10	9	8	Stable
Basic theory and method of information science	12	12	12	Stable
Competitive intelligence	4	2	6	Rise
Intellectual property in LIS	3	4	4	Stable
Knowledge organization and management	5	11	4	Decline
Information resource allocation	4	3	6	Rise
Basic theory and method of information resource management	7	–	10	Rise
Digital information consulting	–	–	5	Rise
Digital information resource development and use (digital library)	24	23	10	Decline
Basic theories of library study	34	28	30	Stable
Catalog	6	9	–	Decline
Information indexing and retrieval	7	8	5	Stable
Ontology and system design	–	–	4	Rise
SUM	124	118	112	–

they selected 120 highest-rank authors in terms of citation. In this study, the authors are also selected in terms of citation. From 1998 to 2007, 132 authors with more than 100 citations are initially selected and 8 authors whose maximum cocitation strength with other authors <10 are excluded. So the total number of authors in this time period is 124. From 1998 to 2002, authors with more than 40 citations in this time period are first selected, and then 16 authors co-cited with no more than 5 times with other authors are excluded. Finally, 118 authors are selected. From 2003 to 2007, there are 112 authors selected totally, after excluding 22 authors with the maximum strength less than 10 from 134 authors who are cited more than 60 times in this period. In these two time slices, the number of the selected authors remains about 120, which is approximately equal to the number of the authors selected in White and McCain (1998) and it is adequate for the study.

Some other details

What's more, some other details on data processing and result display need consideration. To begin with, the diagonal value issue should be dealt with. In this article, "maximum number of a row plus one" is used as the corresponding diagonal value to ensure that each author is most similar to himself/herself than to any others (Ma et al. 2009). In addition, some conditions in the visualization result should be explained: each square in the result stands for an author and the size of each square is proportional to the total citation of the author. Each circle represents a subfield (i.e., a cluster from the clustering analysis result). A dash line connecting a square with a circle indicates the membership of an author in the cluster analysis result. A solid line between two squares reflects the connectivity between authors in pathfinder result. Authors are colored according to their cluster membership (displayed in terms of depths of color for black and white printing).
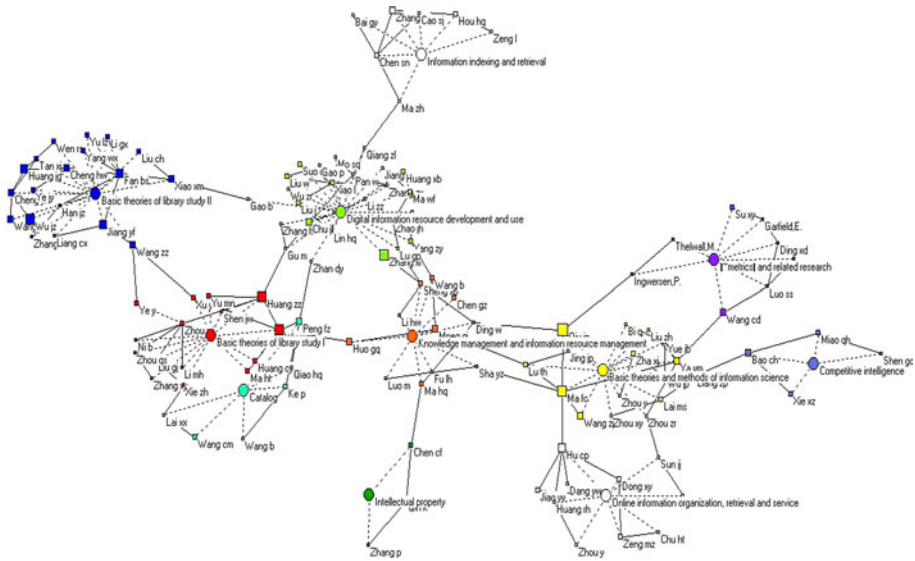
Fig. 3 Mapping of LIS structure in China (1998–2007)

Results

Overall mapping of LIS from 1998 to 2007

The Fig. 3 shows the ACA result of the period from 1998 to 2007. Eleven subfields can be revealed. In the 10 years, *"Metrics" and related research* have become increasingly important and attracted more attention from in and out of Library and Information Science. Its researches are not limited to traditional bibliometrics and scientometrics, but have spreaded to some newly emerged "metrics" topics, e.g., webometrics. In Fig. 3, we can find that two international scientists on webometrics, Thelwall and Ingwersen, are located in the cluster, which proves that many Chinese authors have been devoted to the studies on webometrics. *Competitive intelligence* is very unique in LIS in China. It concentrates on the sources, approaches of enterprise competitive intelligence and the use of information system for enhancing enterprise competitiveness. Among the four authors, Bao and Xie co-published a highly cited book *Competitive Intelligence of Enterprise*. Miao also published a high-quality book *The Applications of Competitive Intelligence*. *Information indexing and retrieval* is always seen as one of the important parts of LIS research and evolves with the development of Internet. It mainly focuses on classification and organization of information of not only traditional paper document, but also digital resource. Many authors also focus on the studies of basic theory and method of LIS. There are many authors that scatter in three related clusters, namely *Basic theories and methods of information, Basic theories of library I and II*. The former one is interested in scientific communication, information economics, information allocation, etc. The latter two focus on library users, library education, information sharing, library spirit, library philosophy, etc. Among these authors, Yan published the famous book named *Conspectus of Information Science* that first built up the basic framework of information science in China. Qiu published the first book about bibliometrics named *bibliometrics*. Ma published the widely influential

textbook named *An Introduction to Information Management* that has been widely used in the teaching of information science by many related universities. Ma and Wu also respectively wrote a book both named *Information Economics* that also attracts the attentions of many scholars in information science and economics. Lu is interested in the methods of information science and has published a book named *Information Analysis*. With the development of internet, more and more researchers in LIS expand their research scopes to grasp this new development opportunity. *Online information organization, retrieval and service* and *Digital information resource development and use* begin to emerge under this background. The former mainly pays attention to the tools and methods for accessing information, the ways of storing and organizing on-line information, and on-line information service. And the latter concerns digital information consulting, information share, digital library, metadata, etc. With the importation of some theories and methods from other disciplines, such as law, economics and management, the research content of LIS in China becomes deeper and larger, which leads to some interdisciplinary research subfields. *Intellectual property in LIS* and *Knowledge management and information resource management* are the two typical representations. The former is imported from law and applied to solve the intellectual property problems of digital library, database and software. The latter is imported from management focusing on the theories and basic methods of library knowledge management and enterprise knowledge management, which has not been widely applied in practice so far. The last one subfield is *Catalog*, which is one of the traditional areas in LIS and has a long history (Chen et al. 2008). Authors in this subfield concentrate on library cataloging, bibliography indexing, etc.

What's more, the Fig. 3 provides more information than cluster membership. Take *"metrics" and related research* subfield for example. Firstly, as indicated by the dash lines, this area contains eight authors (the cluster label is connected to 8 authors), and Chongde Wang is the most influential one in terms of citation (denoted by the size of the square). Secondly, for the inner subfield structure (pathfinder result), there is a solid line between Mike Thelwall and Peter Ingwersen as both of whom are the figures of webometrics. Other authors in this subfield are connected as they do researches on bibliometrics and scientometrics: Xuedong Ding, Liansheng Meng, Chongde Wang and Shisheng Luo are connected closely, as they all published books in bibliometrics. Eugune Garfield and Xinning Su are regarded as the most similar pair, because both of them created citation index: the former established science citation index and the latter created Chinese Social Science Index. Thirdly, considering its relationship with other subfields, there are two authors (Peter Ingwerson and Chongde Wang) connected to authors in the subfield *basic theory and method of LIS*, which indicates the close relationship between the two subfields. Taking into account the fact that many authors who are engaged in *Basic theory and method of LIS* also take advantage of many theories and methods of metrics, it is reasonable that "metrics" related research is connected with "basic theory and method of LIS". Finally, a closer look at the individual node (author) in the result reveals other information. Take Chongde Wang for example, he is clustered into *"metrics" related research* subfield, but is connected with Yimin Yan in *basic theory and method of LIS* by pathfinder result. By an investigation of their publications, it is found that these two authors are indeed very similar in terms of research areas, who are both interested in basic theory of LIS. Therefore, we can conclude that Chongde Wang is influential in both subfields. Thus the diversity of research interests for Chongde Wang is discovered and displayed better with the new visualization approach.

Furthermore, we can also find from Fig. 3 that *Knowledge management and information resource management* have many connections with some other subfields. I think that

maybe it is a new field or a transitional field, which needs further observation in future. Some interdisciplinary subfields also appear in the figure, e.g., *Intellectual property in LIS*, but the number of authors in them is comparatively small and the authors are not very influential in terms of their citation counts. These immature but meaningful subfields need to be strengthened with the efforts of more researchers.

Mapping of LIS from 1998 to 2002

Figure 4 displays the nine subfields of LIS in China from 1998 to 2002. In these five years, internet began to popularize day by day and had great effect on the research scope and content of LIS in China. At the same time, the development of information technology provided a good opportunity to the researchers, because they could achieve their research goals automatically and surely enhance their studies efficiency. The research content of many subfields more or less involves the aspects of internet, such as the following three subfields: *On-line information resource retrieval, Digital information resource development, use and management* and *Information indexing and retrieval.* These three subfields are studies about one aspect or multiaspects of the retrieval, storage, organization and usage of on-line resource. We should note that there are a great many studies on the digital library including its theory, ways of organization, etc. In the meanwhile, many projects of national level on the digital library are subsidized (Qiu and Ma 2006), which indicates that this subfield is a hot spot of LIS in China indeed in this period. A large number of authors are engaged in the studies of *Basic theory and method of information science and Basic theory and method of library science.* Most of them are influential scholars in the whole LIS. Moreover, it is very interesting that the subfield, *Knowledge organization, service and management*, begins to emerge. However, there are many theoretical studies on this aspect while the empirical studies are scarce. More works that can be applied to practice are expected in future. The *Catalog* was very popular in these 5 years, which can be observed by the comparatively large number of authors distributed in it. With the increasing of law consciousness, scholars also pay more and more attention to the intellectual property of library resource in order to avoid the disputes between author and author or between author and institution and to guide the reasonable usage of the resource for users. In these 5 years, the studies on bibliometrics mainly focused on the traditional research content, such as the distribution model of articles, authors or words, the evaluation of journals, and the construction of indexed database, etc. There were few studies on webmetrics that had rapidly developed abroad. The *competitive intelligence* emerged but the authors who engaged in it were few (only Changhuo Bao and Qihao Miao), so it was not displayed as a separate cluster in Fig. 4.

In addition, the *Knowledge organization, service and management* and the *Catalog* are connected to authors in some other subfields. The *Knowledge organization, service and management* is a newly emerged area and has great space to develop, while the *Catalog* is a traditional area which is about to transform to a new field. Both these two subfields are not very stable and need further observation.

Mapping of LIS from 2003 to 2007

In this 5-year period, there were 14 subfields of LIS in China shown as figure 5. The *Webmetrics* began to emerge. However, no leading researchers from China were found according to the data, and the two leading researchers were Mike Thelwall from UK and Peter Ingwerson from Denmark. The studies on the *Bibliometrics* still attracted attention of
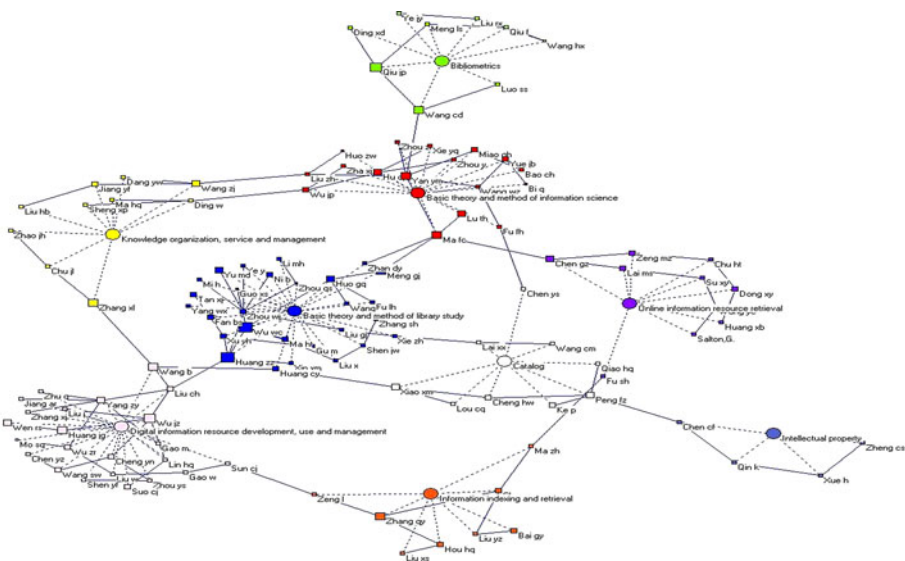
Fig. 4 Mapping of LIS structure in China (1998–2002)

many authors, which could be indicated by the large number of authors and publications in this field. Compared with 1998–2002 time period, the number of authors in the *Competitive intelligence* increased and more papers were published in this period. This subfield plays more and more important role in study areas of LIS in China (Ma et al. 2009). Three new subfields also appeared, i.e., *Information resource allocation*, *Ontology and system design* and *Digital information consulting*. The former belongs to the field *information resource management* which in fact focuses on the economical model in order to allocate information resource more scientifically and fairly. The middle focuses on ontology retrieval and its system design. There have been more and more articles concerning this field. The last is a branch of information service, whose purpose is to achieve information consultation for customers online automatically and efficiently. Many subfields from 1998 to 2002 still appear in the current period, such as *Basic theory and method of information science, Information indexing and retrieval, Basic theories of library study,* Intellectual property in LIS, *etc.* A large number of authors still devote themselves to the studies of digital information and have formed two big clusters *Digital information resource development and use* and *On-line information organization, retrieval and service.*

Moreover, Fig. 5 also shows that the frequent interaction between *information resource management (comprehensive)* and *basic theories of library study*, indicating that these two subfields are closely related. Overall, the *Information resource management (comprehensive)*, as indicated by the name, bears certain interdisciplinary features, which may lead to some concrete research directions.

Evolution analysis of LIS in China

To explore the evolution of LIS in China, it is necessary to compare the intellectual structure of each time period above, namely, 1998–2002, 2003–2007, and 1998–2007. Table 2 displays the number of authors in each subfield of three different time periods. It is
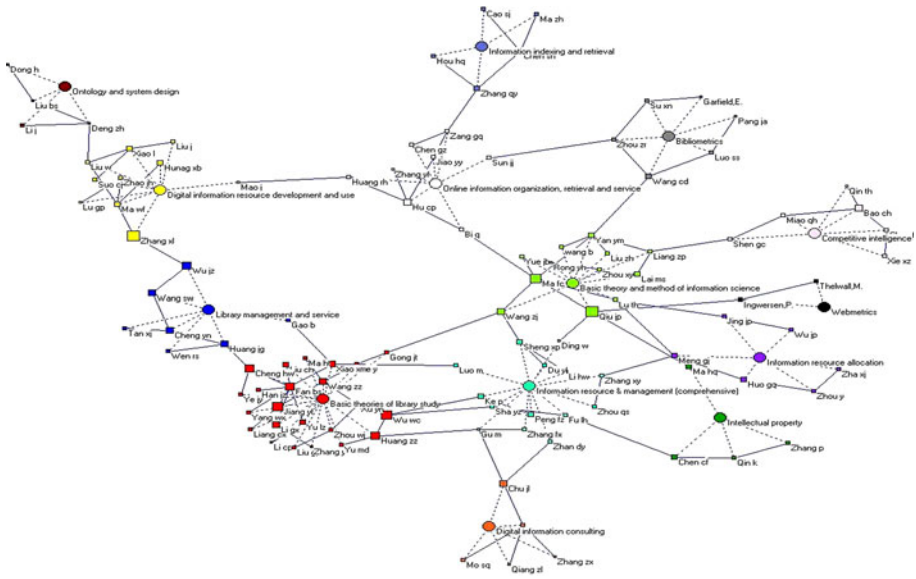
Fig. 5 Mapping of LIS structure in China (2003–2007)

emphasized that in hierarchical clustering result, we are able to find out some sub-cluster (sub-subfield) in each cluster (subfield). For instance, in the period 1998–2007, information resource allocation was a sub-subfield of information resource management. Therefore, some sub-subfields that are very clear in hierarchical clustering result are listed in Table 2 in order to make the results of different time periods more comparable.

The "Trend" labeled in Table 2 means that the variation tendency of the corresponding subfield. The status "rise" means that the number of authors from 2003 to 2007 is not only 3 times larger than that from 1998 to 2002, but also larger than that from 1998 to 2007; or the number of authors from 1998 to 2002 is zero, but that from 2003 to 2007 is not null. The status "decline" means that the number of authors from 2003 to 2007 is not only 3 times less than that from 1998 to 2002, but also less than that from 1998 to 2007. Other situations belong to the status "stable".

Within the whole time period (i.e., 1998–2007), *basic theories of library study*, *digital information resource development and use*, and *basic theory and method of LIS* rank the top 3 by the number of authors in every subfield. The number of authors in these three subfields is about 60.4 % of the total LIS authors in the data set. Therefore, we can learn that in these 10 years, major attention has been paid to theoretical studies of Library and Information Science. In the period of 1998–2002, *basic theories of library research*, *digital information resource development and use*, *basic theory and method of LIS*, and *knowledge organization and management* rank the top 3 in terms of author quantity, which is about 61.4 % of total authors in that period. While in the period of 2003–2007, the top 4 are *basic theory of library study*, *basic theory and method of LIS*, *basic theory and method of information resource management* and *digital information resource development and use* in terms of author quantity, and the number of authors in the four subfields is about 55.4 % of the total number of LIS authors in this period. Hence, research on basic theories and methods has still been a major part of LIS in China in this 10-year, which may be a possible reason for the fact that LIS in China lacks applied studies.
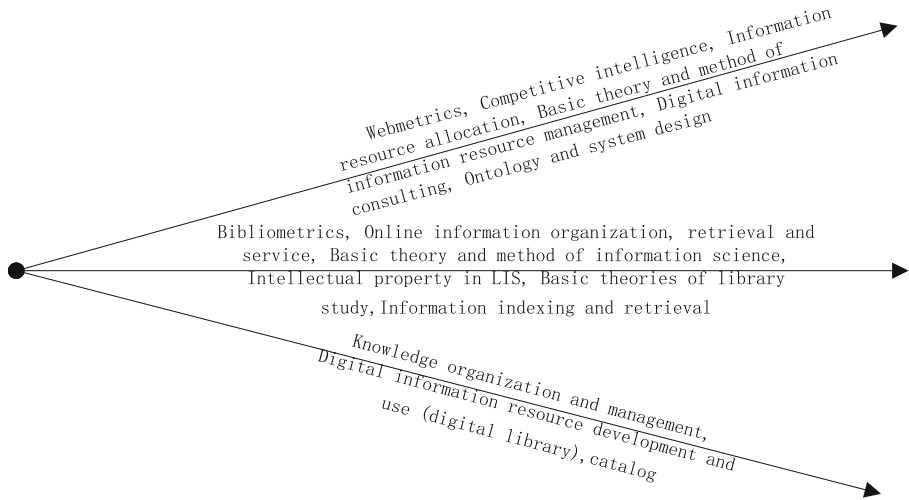
Fig. 6 Development trend of LIS in China

Moreover, the number of authors who do research on *intellectual property* and *competitive intelligence*, though not large, has increased gradually, which indicates that these two subfields continually develop. *Webmetrics*, *information resource management theory and method*, *digital information consulting* and *ontology and system design* are new areas emerging in the 2003–2007 time period. On the contrary, *catalog* is a declining area and the number of authors in that subfield has decreased. The Fig. 6 shows the overall structure change of LIS in the whole time period.

Comparisons with the international LIS

In order to analyze the structure of LIS in China more particularly, I compare it with that of the international below. I don't analyze the structure of international LIS by myself in this paper, but use the result obtained in (Zhao and Strotmann 2008). The time span used in their article is from 1996 to 2005[3]. Figure 7 shows the detailed comparison information between them. The line between the left and the right indicates the similar research fields between the fields obtained by this paper and by Zhao and Strotmann's.

From the observation and analysis of Fig. 7, we can reach the conclusion that the subfields of the international LIS are more concrete than those of the Chinese LIS, which can be observed by the one-to-many connections among them, e.g., webmetrics is an independent area in the right while it is merged into a wide area named "metrics and related research". Some unique subfields in both sides are also discovered, e.g., *catalog, Intellectual property of LIS, competitive intelligence, basic theories of library/*and*//* in the left, while *cocitation mapping, evaluation/policy* and *relevance* in the right. It must be emphasized that there are comparatively clear divisions between the theories and methods

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[3] The classification between the two data source is different, e.g., the articles on information economics are classified into information science in CSSCI, while they may be sorted to economics in SCI or other database. Although the classification difference may be small, we should explain the results between this study and Zhao and Strotmann's prudently and carefully.
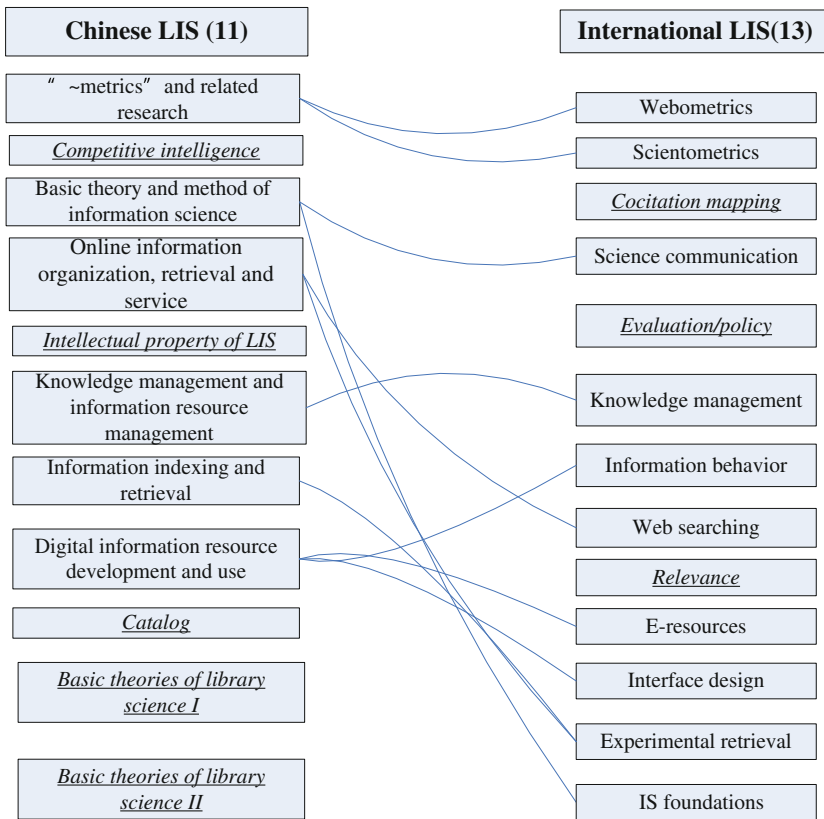
Fig. 7 Comparisons of structure of LIS between the Chinese and the international

of library science and that of information science in China, which results in that *basic theories of library/and//* are listed as two separate fields in the left. There are very few studies on *cocitation mapping* in this 10-year time, which becomes popular and hot until 2008. Although there has been many evaluation practices on journals or universities (e.g., the world class university evaluation by Shanghai Jiaotong University), the related articles are not published in the journals of LIS. These related researches on evaluation belong to an independent discipline, i.e., science of science and S&T policy. The *relevance* also appears in the international LIS for the first time, and the related studies in China are also scarce and it has not formed a research direction.

What's more, considering the real situation of LIS in China, I find that the authors in Chinese LIS prefer to engage in the basic theory study (which is also analyzed above), while the international authors are inclined to the applied study with a lot of data. The two subfields *basic theories of library/and//* that own lots of authors are the typical representations.

Conclusions

This article studies the intellectual structure and its evolution of LIS in China using the data from CSSCI, a proper database for the ACA study purpose. From this study, we can

find that some subfields have begun to emerge such as webmetrics, digital information consulting and ontology and system design, etc. Some subfields have become more and more popular such as competitive intelligence and information resource allocation. However, the decline tendency of some subfields has also turned up such as knowledge organization and management, and catalog, etc. It is also found that about 60 % of LIS authors in China focus on theoretical research in all three time windows. Therefore, researchers in Library and Information Science in China should pay more attention to empirical study (Liu et al. 2009). Through the comparison with the international LIS, it is found that there are some unique subfields in the Chinese LIS, such as competitive intelligence, intellectual property in LIS, etc. However, a big deficiency lies in the research of LIS, namely the researchers are partial to the macroscopical studies, which leads to the lack of applied studies. What's more, I also suggest that the authors of LIS in China should crystallize their researches in the further study.

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