

Analysis on Mapping Knowledge of “Social Tagging” Based on CiteSpace

Yanling Luo*¹, Jianpeng Hu²

¹ Jiangxi Science & Technology Normal University, ² Nanchang University

Abstract — Choosing documents about “Social Tagging” published from 2004 to 2014 from Web of Science database as the research sample, this paper analyzes datum information in this field by operating CiteSpace as an analysis software of information visualization and mapping knowledge in the field of “Social Tagging”, and combing some key indicators such as frequency, centrality and burst term, etc. The paper shows spatial distribution characteristics, author collaboration network and main research hotpots and research fronts in the field of “Social Tagging”.

Keywords - Social tagging; Visualization analysis; CiteSpace

I. INTRODUCTION

In 2004, information expert Thomas Vander Wal firstly put forward the noun “Folksonomy”. This conception has been paid much attention by society when it was proposed. Since then, the number of documents about studying social tagging increased geometric times. Scholars generally consider that social tagging is from users and is generated autonomously when users organize, process and share network contents. Social tagging is totally different from traditional knowledge organization system but rather one bottom-up organization classification system.

Until now, academia has no unified definition about social tagging. There are many different appellations such as “folk taxonomy”, “folksonomy”, “folk classification” and “cooperation annotation”, etc. Foreign scholars often equate “Folksonomy” with “Social tagging”, “Social classification” and “social indexing”[1]. Nonetheless, scholars made great achievements in the field of “social tagging”.

On the basis of previous studies, this paper makes visualization analysis to “social tagging” field by CiteSpace software in order to study distributions of countries (regions) and institutions, author collaboration network, main research hotpots and research fronts in the field. More visualized way is used to show current research situations and research trends of social tagging field to readers. The paper tries to provide valuable references for the study in this field and guidance for further study.

II. RESEARCH METHODS AND DATUM RESOURCES

This paper chooses documentary records about “Social Tagging” research retrieved from Web of Science database. The retrieval time is November 24th, 2014. Searches is (TS= (Folksonomy OR Social tagging)). The document type is Article and language is English.

Time span is from 2004 to 2014. 919 documentary records has been retrieved and all record fields are selected to download as datum resources in this research. Figure 1 shows that 26 documentary records have been downloaded in 2004 as the start year. In 2005, the downloaded documentary records were decreased to only 8 pieces; with the rapid increase of document number, number of documentary records reached the peak as 159 pieces. While the number of documentary records was decreased slightly to 144.

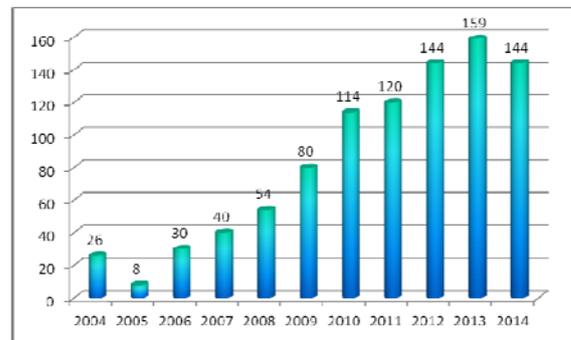


Fig.1 Increasing Trends of “Social Tagging” Documents from 2004 to 2014

As a new research method in information science and library science fields, mapping knowledge domain puts scientific knowledge as measurement object and shows the process of scientific knowledge development and structural relations by visualization method, and reveals dynamic developing law in this field to apply tangible and valuable references for disciplinary research[2], where CiteSpace is an important tool for the research of mapping knowledge domain. Mapping knowledge domain operates based on Java platform and is suitable for visualization software of multivariate, time-sharing and dynamic complex network analysis.

This paper studies documentary geographical distributions, author collaboration network, research hotspots and fronts in “social tagging” field from indicators such as frequency, centrality and burst term, etc

by operating CiteSpace as a visualization software. Firstly, the author studies distributions of countries (regions) and institutions based on word frequency and centrality and determines productive countries (regions) and institutions according to word frequency and centrality; secondly, the author adopts the same method to study author collaboration network in this field; thirdly, the author determines research hotspots in this field in the light of frequency and centrality of key words; finally research fronts in this field are determined by the presence frequencies of cited documents and burst term.

III. RESEARCH RESULTS AND ANALYSIS

Datum downloaded from web of science database are imported to Citespace software and right control panel is set which can map knowledge domain with different types.

A. Geographical Distribution

1) Distribution of Countries (Regions)

In Citespace, we selected the option in "Node types" as country, time zone as 2004-2014, then "Term source" as Title, Abstract, Keywords and so on, later thresholds as (2, 2, 20) in threshold settings (C, CC, CCV) (Where C is documentary amounts in different time partitions, CC represents frequency of total citation and CCV means coefficient of total citation), option in Pruning as Minimum Spanning algorithm and other options as default. We clicked to operate CiteSpace software and the mapping knowledge domain of related countries and regions is concluded (as shown in Figure 2). In Figure 2, each node represents one country and the size of node means cited frequency of document. And color of node means cited time of document in which cool colour tone represents early time and warm color tone represents near future.

We can see from the angle of posting frequency in Table I that America takes the leading position in scientific research strength and its frequency is 242; China is only second to America and its frequency is 117; the third is the United Kingdom and its frequency is 89; the posting frequencies between 30-60 are close in countries like Germany, Canada, Spain, Australia, South Korea, Japan and Italy, etc. However, from the angle of centrality, Spain is the country with highest centrality as

0.23. While South is the country with lowest centrality as 0.00.

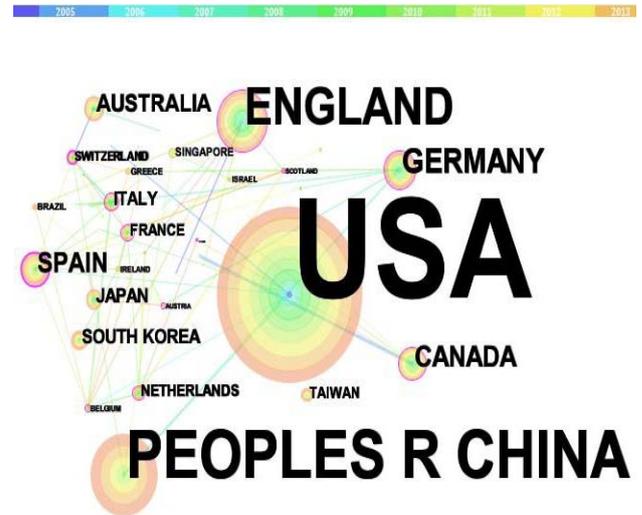


Fig.2 Distribution of Countries (Regions) of "Social Tagging" Documents

TABLE I. DISTRIBUTION TABLE OF SCIENTIFIC RESEARCH STRENGTH IN "SOCIAL TAGGING" FIELD FROM COUNTRIES (REGIONS) (FREQUENCY>30)

Country	Frequency	Centrality	Fixed Number of Years
USA	242	0.06	2004
PEOPLES R CHINA	117	0.07	2005
ENGLAND	89	0.18	2004
GERMANY	58	0.15	2006
CANADA	51	0.12	2004
SPAIN	49	0.23	2007
AUSTRALIA	43	0.04	2004
SOUTH KOREA	33	0.00	2009
JAPAN	33	0.04	2004
ITALY	31	0.16	2005

2) Distribution of Institutions

The visualization operation of institution distribution is similar to countries (regions) distribution. The institution distribution figure of "Social Tagging" documents was concluded only by setting Institution in "Node types" and same options in other settings, and clicking to operate CiteSpace software (as shown in Figure 2).



Fig.3 Institutions Distribution of “Social Tagging” Documents

In Figure 2, the author selected structure whose centrality is larger than 0 as research samples. Centrality in this paper is betweenness centrality and represents ability of actor in network as intermediary broker. It measures control ability of actors to resources. The higher centrality is, the more influences and effects the institution will get. What can be known in Figure 2 is that most institutions whose centrality are larger than 0 distribute in Chinese mainland and Hongkong. Harbin Institute of Technology is the institution with highest centrality as 0.03; the institution concentrated on the new technological researches of social tagging and made great achievements in the aspects of Web page search optimization, tag recommendation methods and automatic tagging technology of extensive document tabs, etc. There is relatively high about frequency of documentary citation. These institutions which lies in second groups with the same centrality of 0.01 are Chinese Academy of Sciences, Tsinghua University, National University of Singapore, Microsoft Asia Research Institute, University of Science and Technology of China and Hong Kong Baptist University.

TABLE II. INSTITUTION DISTRIBUTION TABLE OF SOCIAL TAGGING DOCUMENTS (CENTRALITY>0)

Institution	Centrality	Frequency	Fixed Number of Years
Harbin Inst Technol	0.03	3	2011
Chinese Acad Sci	0.01	16	2011
Tsinghua Univ	0.01	9	2012
Natl Univ Singapore	0.01	8	2011
Microsoft Res Asia	0.01	4	2011
Univ Sci&&Technol China	0.01	3	2011
Hong Kong Baptist Univ	0.01	2	2014

B. Author Collaboration Network

In the operation-interface of CiteSpace, we set option Author in “Node types” and same options in other settings, and clicked to operate CiteSpace software, so the author collaboration network map in social tagging field was concluded(as shown in Figure 4). In Figure 4, each node represents author and size of node means posting frequency of author. Cooperation between authors is expressed by same color of two adjacent nodes and link between them. 110 scholars are detected and 67 lines are existed between them which means 67 groups of cooperation relationships.



Fig.4 Author Collaboration Network of Social Tagging Documents

In Table III, the author selected authors whose posting frequencies are more than 5 (included 5) to study their scientific research capacities, and combined Google scholar to analyze research areas of scholars. It can be found by analysis that the number of isolated scholars in this field is relatively high. Few authors form cooperation relationship, which easily forms small group network. Jason J.Jung is the one who posted most frequently and his research areas are mainly in the aspects of ontology semantic web and information retrieval system,etc. He considered that social semantic web is organic combination of social network, ontology network and conceptual network, and designed semantic structural model which includes social layer, ontology layer and conceptual layer; Qing Li and Yi Cai have cooperated for

many times in social tagging field. They focused on studying tag recommendation system and personalized search, etc. Based on the purpose of improving user retrieval qualities, they proposed prototype system of FMRS to collocate documents and sources for users from the wider perspective; Ciro Cattuto and Vittorio Loreto worked together to study in the aspects of collaborative tagging and symbolic dynamics. They designed one stochastic model of user behaviors which includes two aspects: frequency deviation mechanism which is related to the mutual-opening of tagging behaviors among users; resources aging which accords with heavy-tailed distribution. They illustrated datum characteristics exactly in Delicious and Connotea by using this model.

TABLE III. AUTHOR'S SCIENTIFIC RESEARCH CAPACITY TABLE OF SOCIAL TAGGING DOCUMENTS (FREQUENCY≥5)

Author	Frequency	Centrality	Research Area
Jason J.Jung	8	0.00	Intelligent Data Analysis, Semantic Web Mining
Vittorio Loreto	6	0.00	Theoretical Physics, Mathematical Model
Ciro Cattuto	6	0.00	Social Network, Distributed and Intelligent Web Applications
Abdulmotaleb EI Saddik	6	0.00	Information Technology Research, Distributed Collaborative Computing
Qing Li	6	0.00	Research On Recommendation System
ZiKe Zhang	5	0.00	Research On Personalized Recommend System
HakLae Kim	5	0.00	Tag Cloud, Semantic Model, Meta Data
HongGee Kim	5	0.00	Research On Mathematical Model
Ulrike Cress	5	0.00	Knowledge Construction
John G.Breslin	5	0.00	Research On Information Organization, Semantic Model
Yi Cai	5	0.00	Personalized Search, Semantic Network

C. Analysis of Research Hotspots

Hotspot issues in one research field are generally determined by keywords and subject terms with high frequency[4]. The research hotspots and trends in research field can be grasped by analyzing keywords of documents. In the operation-interface of CiteSpace, the author selected subject terms and keywords and minimum Spanning algorithm in Pruning, and kept the same options

in other settings. We clicked to operate CiteSpace software, and map of research hotspots in social tagging field was concluded (as shown in Figure 5). During the research of hotspot map, circular nodes (black fonts) mean keywords. Quadrate nodes (red fonts) mean subject terms. The size of node determines frequency of presence. The research subjects in the social tagging field are showed by these nodes.

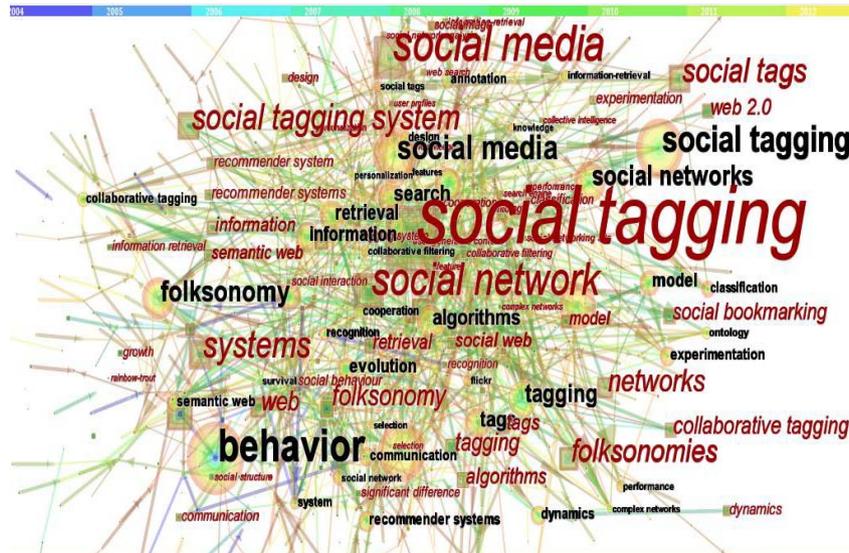


Fig.5 Research Hotspot Map of Social Tagging

By arranging and analyzing keywords and subject terms, it can be found that most research hotspots converge on the following five aspects: fundamental theoretical research, research on user's behavioural characteristics, knowledge management and innovation, applied research on new technique and applied research on social platform(as shown in Figure 4).

1) Fundamental Theoretical Research

On the concept of social tagging, although the scholars reached consensus that social tagging is one new method of information organization which users involve in information discovery and management, content description and sharing in the environment of Web 2.0. There was divergence from the perspective of formal definition[5]. In the studied documents, scholars usually used many forms such as social tagging, folksonomies, social bookmarking and so on to represent social tagging. Social tagging has a wider range of application by comparing with other expressions, but ascription problem of conceptional words is still not solved [6]; scholars from American Purdue University like N. Titus gave colloquial definition from user's angle. They also pointed out that social tagging was object which users selected freely and tagged. And social tagging included all key information given by users. The user's mastery degree of identity

objects and understanding level of vocabulary would lead to difference of tagging labelling [7]. T. B. Munk and K. Mork from University of Copenhagen in Denmark from attribute of meta data of social tagging proposed that the nature of social tagging is application of descriptive meta data created independently by users in text labelling and classification[8].

2) Research on User's Behavioural Characteristics

Users tag resources by their cognitive degrees and proficiency to objects, which shows initiative and personalization. The references and lessons from tagging of other users also present sociability and interactivity. Understanding users' tagging behaviour is conducive to tap users' needs and preferences. Understanding users' utilization level to resources contributes to the construction of recommendation system. Shilad Sen pointed out that tagging behaviours of social tagging are generally influenced by three factors: personal intention, social influence and tag selection algorithm included in system. Influenced by habits, users tends to repeat former behaviour. So he considered that people's tagging behaviour in future has little difference with present behaviour [9]. Golder & Huberman stated that proportion of social tagging labeled by users formed a relatively stable trend as time goes by, because users were

influenced by tagging behaviours from other community members in the process of tagging[10]. Umer Farooq put forward six indicators of describing users' tagging behaviours based on conclusion of former researches: tagging growth, tagging reuse, dominant and recessive of tagging, tagging discrimination, tagging frequency and tagging way. Among them, dominant and recessive of tagging is similar to TF-IDF principle. The lower frequency of tagging presence is, the more characteristic resources capacity has[11].

3) Knowledge Management and Innovation

With the development of Web technique, social tagging has been applied extensively in the network. The characteristics of personalization and sociality gradually became apparent and improved management efficiency of open knowledge effectively and made up the shortcomings of knowledge management. Scholars like Dan Huang put forward open knowledge management model based on social tagging. They considered that social tagging mainly utilized recommendation technology and collaborative tagging technique and distributed and used in four cyclical links of open knowledge management (open knowledge acquisition, open knowledge organization, open knowledge sharing and open knowledge innovation), which changed traditional knowledge management model and produced one open knowledge management model with user participation based on social tagging[12]. Junping Qiu believed that social networking sites (such as Wiki, Blog, delicious) provided the platform of communicating, sharing and releasing knowledge for users. The interactions in groups made knowledge of individuals and groups complement for each other to reach the purposes of knowledge discovery and knowledge innovation [13].

4) Applied Research on New Technique

The researches of new technique and method are still the research emphasis and hotspot in social tagging field, and can be classified into three aspects: research on recommendation system, research on ontology and semantic Web, and clustering research.

Recommendation system extracts interests and preferences of users and provides unique information for users based on information characteristics of user personalization. P.De Meo from Italy proposed one new method for query expansion and user's descriptive set theory extension. When users submit query of one set of tagging to enter into system retrieval, system can search more authoritative extension tagging to users. Finally, all query behaviors and refining behaviors are stored in user's descriptive set theory. This test indicated that utilization of user's descriptive set theory could effectively guide recommendation system to find invisible related resources of users and improve performances of recommendation system[14]. Scholars like Luo X. put forward new method of integrating social tagging information which mainly solved the problem of low

precision of personalized recommendation system. This method analyzes tagging correlation in Folksonomy Network and integrates tagging into recommendation system which is based on domain model [15].

Ontology and semantic Web are clear formal and standard specification of sharing conceptual model. It can provide unified structure (sharing conceptual model) and semantic expression (clear formal and standard specification) for Folksonomies system[16]. Gruber tried to put forward tagging activity model whose conceptual model is: Tagging: (object,tag,tagger,source,polarity). In which, object, tag,tagger represent resources, tags and users respectively. Source means origins of application procedures and services. Polarity represents collaborative filtering[17]. Kim proposed one objective of integrating tagging ontology and realizing complete general ontology on the basis of much tagging ontology. And he considered that existing ontology has its own design goals and emphasized aspects. For support system tagging, the tagging processes and queries of all aspects can't be finished by single tagging ontology. Therefore, after compared mapping possibilities among conceptions of existing tagging ontology models, he proposed to integrate existing ontology in order to establish one unified structural and semantic expression in Folksonomies system [18].

Clustering research refers selection approach which takes social tagging as research sample and analyzes characteristics of social tagging. It optimizes organization and management of social resources to some extent. There are three parts about clustering research: user clustering, resource clustering and tagging clustering. For user clustering, Ae-Ttie learnt users with same preferences by calculating similarity among users [19]; For resource clustering, Mobasher clustered resource and tagging, then made them relevant and recommended resources to users by adopting collaborative filtering method based on same resources [20]; for tagging clustering, Min Han, etc, made tagging clustering based on TF-IDF similarity and compared with existing methods and analyzed. New clustering method has higher accuracy and wide application prospects in Web-page classification and Web-page recommendation for datum mining of social tagging [21].

5) Application Research on Social Platform

As Delicious goes live, more and more scholars threw themselves into practical application of social tagging. For the research on Delicious system, RobertWetzker choose 20 most active users in samples to observe, and the result showed that 19 users may use automatic tagging procedure. Through analysis, it may be related to open API procedure of this system[22]. For Flickr's research, Cameron Marlow selected 10 users at random and analyzed growth of their tag set capacities. Meanwhile, he researched overlap problem of vocabulary between user tags. The result presented that vocabulary

overlap between friends was relatively high but overlapping ratio between random users was relatively

low, which is only suitable for overlap of common vocabulary[23].

TABLE IV. MAIN KEYWORDS AND SUBJECT TERMS OF SOCIAL TAGGING

Category	Keywords	Frequency	Category	Keywords	Frequency
fundamental theoretical research	Social tagging	126	Application Research on New Technique	Social tagging systems	55
	folksonomies	49		algorithm	34
	Social bookmarking	35		model	29
	Social classification	21		Semantic web	28
	Collaborative tagging	20		Recommender systems	26
behaviour	70	dynamics		24	
Research on Users' Behaviour Characteristics	search	34	ontology	17	
	retrieval	32	metadata	11	
	Social behaviour	22	Application Research on Social Platform	Social media	76
	User preference	9		flicker	16
Social network	70	Twitter		10	
Knowledge management	18	Facebook		10	
Knowledge sharing	12	delicious		10	
Knowledge Management and Innovation	Collective knowledge	10			

D. Analysis of Research Fronts

Frontal analysis in one disciplinary field mainly researches gradually arisen hotspot trends, direction of public attention and potential research value. By burst term detection technology and algorithm of CiteSpace software and time distribution of word frequency, we can detect vocabulary with high rate of frequency changes. In the light of change tendency of word frequency, we also

can determine frontal domains and development trends of industrial cluster knowledge network[24].

In the control interface of CiteSpace software, we selected Burst term as type of term, Cite Reference as network node. We kept the same options as before. We clicked to operate CiteSpace and selected timeline in operation panel, mapping knowledge of research fronts in this field would be concluded. It can be shown in the following figure.

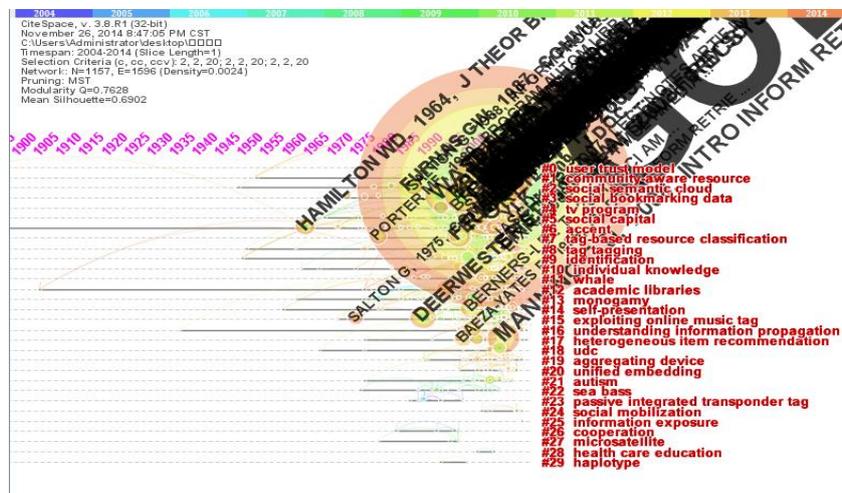


Fig.6 Research Frontal Mapping Knowledge Domain of Social Tagging

In the mapping knowledge domain as shown in figure 6, all node documents are arranged in time order and displayed by black font. The right side is burst term by calculation and showed by red font; "Link Walkthrough" in the CiteSpace interface is operated, then evolution path in each year from 2004 to 2014 can be observed. We further analyzed node documents, sorted out right burst term and discarded redundant cluster so as to find that research fronts of social tagging domain mainly focused on the following two aspects:

1) Application of New Technology

Cluster#0 User trust model: Some scholars considered that trust was one of important factor to influence recommendation and if collaborative filtering algorithm is introduced to trust relationship, the drawback can be settled that traditional algorithm excessively emphasizes similarity. Cluster# Social semantic cloud, cluster#6 accent and cluster#9 identification are hot topics of semantic identification. Semantic identification still is one threshold in the process of social tagging

intellectualization. Based on current gradually mature software development technique, scholars proposed that by open API platform datum acquisition, speech and text were analyzed and processed through cloud, and accurate tagging information is given feedback to users. Cluster#17 heterogeneous item recommendation: Semantic heterogeneous problem of social tagging became increasingly prominent. Lijuan Tang indicated that tag clustering can cluster tagging with similar semantic to solve the problem of language heterogeneity efficiently. And on this basis the discovery of social network and friends recommendation are achieved [25].

2) Social Network Research

Cluster#5 social capital: social capital theory is put forward firstly by sociologist Granovetter and is one of essential theories of social network. On the basis of analyzing ordering characteristics and limitations of existing social tagging, Ming Yi, etc raised that efficient organization of social tagging is realized in the form of socialized tagging network by the reference of methods of social network. Comparing with other methods like tag cloud, tag clustering and tagging conceptual space, etc, method of social network can establish local interest view of Web users. And personalized information service model is established on this basis which also can satisfy personalized demands of users[26]. Besides, cluster#1 community aware resource, cluster#16 understanding information propagation and cluster#20 unified embedding are research focuses of social network. Zhuoxiang Zhao supposed that the discovery of community with high quality is research hotspot of social network. Traditional community detection algorithm based on tagging transfer has high randomness and uncertainty. Therefore, they raised one new algorithm. Firstly, they selected one small vertex set as seed-set and unique tagging was given to each seed. Then it has been transferred which started from seed-set. In the propagation process, this algorithm synthetically considered various factors: proportion of same tags in vertex neighbors, vertex degree and edge weight, etc. The algorithm calculated tagging impact value of each vertex to update vertical tagging. The results showed that new algorithm apparently improved the quality of community discovery and had higher stability[27].

IV. CONCLUSION

After visualization analysis of social tagging documents by CiteSpace, the following conclusions can be made:

(1) From countries (regions) distribution, America takes the leading position in scientific research strength. China is only second to America and the third is the United Kingdom; from institution distribution, Most institutions with higher centrality are located in Chinese mainland and HongKong, and Harbin Institute of

Technology is the institution with highest centrality as 0.03;

(2) From author collaboration network, there are relatively high about the number of isolated scholars in social tagging domain. Only few authors form cooperation relationship, which easily forms small group network.

(3) From research hotspots, there converge on five aspects: fundamental theoretical research, research on user's behavioral characteristics, knowledge management and innovation, applied research on new technique and applied research on social platform. Fundamental theoretical research has been done throughout research development. Applied research on new technique is the most redundant and includes ontology and semantic Web researches, tagging recommendation system research and clustering research, etc.

(4) From research fronts, research on new technique represented by user trust model, semantic identification and heterogeneous project recommendation, research on social network represented by information transfer are frontal domains of social tagging in recent years and represent development trends in future.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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