Measuring Interdisciplinarity of a Given Body of Research

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Abstract
Identifying interdisciplinary research topics is an essential subject, not only for research policy but also research funding agencies. Previous research was constructed on measuring interdisciplinarity mainly at the macro level of research, such as Web of Science subject category and journal. However, these studies lack analysis at the micro level of the current science system. It means few studies have analyzed interdisciplinarity at the level of publications. To cover this gap, we introduce an approach for measuring interdisciplinarity at the level of micro research topics. The research topics are clustered by direct citation relations in a large scale database. According to the characteristics of boundary-crossing research, we provide an alternative approach to measure interdisciplinarity. Comparing with the widely used Rao-Stirring indicator (Integration score), we found that the results obtained by two indicators of interdisciplinarity have a strong correlation, thus we believe that this approach could effectively identify boundary-crossing research topics.

Conference Topic
Indicators

Introduction
In bibliometric and scientometric research, measuring interdisciplinarity is a difficult yet important topic. However, although it has been widely recognized that interdisciplinary research solves complex problems, promotes scientific developments and innovations, there is still no consensus on how to define and measure this type of research. Specifically, a variety of definitions on boundary-crossing research have been proposed, such as interdisciplinary multidisciplinary, transdisciplinary and cross-disciplinary; however the definitions of each term as well as discriminations among them are quite ambiguous (for more details see Huutoniemi K. et al., 2010; Wagner C.S. et al., 2011). In a broad sense, these concepts all refer to the research that cross boundaries between disciplines. We do not intend to explore the nuances among the concepts in this study. Thus, at the very beginning of this article we need to emphasis that, for the purpose of this research, the term *interdisciplinary research topics* used to refer to all type of boundary-crossing research, in other words, it covers all type of research with interdisciplinarity.
Furthermore, due to the controversy in defining research with interdisciplinarity at the conceptual level, there is no consensus on how to measure interdisciplinarity in practices. Various approaches are utilized to analyze interdisciplinarity, including both quantitative methods such as bibliometric indicators, text-mining and qualitative methods such as interviews and surveys. In particular, bibliometric approaches have been widely applied to measure and identify interdisciplinarity, such as citation-based indicators (Porter & Chubin, 1985; Leydestorff, 2007; Porter, Roessner & Heberger, 2008; Porter & Rafols, 2009; Rafols & Meyer, 2010; Leydestorff & Rafols, 2011; Rafols et al., 2012; Lariviere & Gingras, 2014), author-based indicators (Qin et al., 1997; Schummer, 2004; Abramo et al., 2012), as well as similar indicators but relying on a variety of classification systems of science (Tijssen, 1992; Morillo, Bordons, & Gomez, 2001; 2003; Braun & Schubert, 2003; Sugimoto, 2011;

Sugimoto et al., 2011). Additionally, a few studies have applied text-mining approaches, LDA for example, to explore interdisciplinarity of a given issue (Wang et al., 2013; Nichols, 2014).

In this article, we explore a citation-based measurement for identifying interdisciplinary research topics at the level of publications. We also use the Web of Science (WoS) classification system, but with a different approach. More specifically, we first construct micro research topics based on the direct citation relations among individual publications. Meanwhile, the publications are assigned into one or several subject categories on the basis of the journal where the publication has appeared and of WoS classification system. It implies that a research topic constructed might belong to one or several WoS subject categories according to publications within the cluster. In other words, WoS subject categories that attached to publications are regarded as traditional boundaries of scientific disciplines, whereas micro research topics constructed on the relatedness among publications might break the existing knowledge boundaries. We assume, then, that a cluster can be regarded as an interdisciplinary research topic if there is a considerable number of within-cluster citations spanning distant WoS subject categories. The indicator proposed in this article combines knowledge diversity with knowledge integration, in which heterogeneity and connectedness of subject categories within research topics are taken into account. It provides an alternative approach to measure interdisciplinarity and simplifies the previous citation-based approaches.

Data and Methodology

This study was based on data from the in-house WoS database of the Centre for Science and Technology Studies (CWTS) of Leiden University. The database used in this study covers the period from 2002 to 2013, a 10-year period. The total number of publications in our database is about 9 million. The methodology that we introduce for measuring interdisciplinarity of micro research topics can be divided into three steps.

Step 1 Clustering publications into micro research topics

The clustering method is mainly based on the previous studies by Waltman & van Eck (2012; 2013). First, the relatedness of publications was measured by the normalized direct citation relation among individual publications (for details see Waltman & van Eck, 2012). Furthermore, based on the relatedness matrix, an improved Louvain algorithm (Blondel et al., 2008), namely a 'Smart Local Moving algorithm' (SLM) was applied to cluster individual publications (for details see Waltman & van Eck, 2013). Labels of each cluster were selected from titles and abstracts of publications within cluster (for details see Waltman & van Eck, 2012).

Measuring interdisciplinarity on the level of micro research topics, constructed based on the citation relations, is one of the most important distinctions between this study and previous research. There are two reasons for measuring the degree of interdisciplinarity in this approach. First, WoS subject categories attached to journals cannot properly describe publication itself. For instance, although *Journal of the Association for Information Science and Technology* belongs to two categories, INFORMATION SCIENCE & LIBRARY SCIENCE and COMPUTER SCIENCE, it does not necessarily mean that all publications appeared in this journal span the two categories. More generally, some publications associated with the category of INFORMATION SCIENCE & LIBRARY SCIENCE and others related to the category of COMPUTER SCIENCE. The second reason is that WoS assigned journals such as *Nature*, *Science*, and *Plos One* as MULTIDISCIPLINARY SCIENCE. Instead of focusing on a specific scientific field, this sort of journals covers almost the full range of scientific disciplines. When measuring interdisciplinarity on the level of journals, this sort of journals may have high interdisciplinarity scores. However, although the journals are composed of publications spanning over different scientific disciplines, it does not necessarily mean the integration of knowledge from various sources exists.

In order to avoid the problems mentioned above, we constructed micro research topics based on the relatedness of individual publications, which are expected to provide a more accurate body of research topics within the current science system.

Step 2 Calculating a similarity matrix of ISI subject categories

Porter and Rafols (2009) analyzed a sample of more than 30,000 WoS publications and their cited references, in which publications were assigned to subject categories on the basis of the WOS classification of journals the publications appeared. They constructed a matrix of subject categories using the relations of articles and their cited references, and then applied Salton's cosine (Salton & McGill, 1983) to obtain the similarity matrix of subject categories. The similarity value s_{ij} is high if subject category i and j are cited a lot by the same publications.

However, in this study, two subject categories are considered to be strongly related if they both cite a lot to the same subject categories. Specifically, the construction of a similarity matrix of subject categories is done in two steps.

In the first step, for each pair of a citing subject category i and a cited subject category j, the number of citations from publications in subject category i to publications in subject category j is counted. We use c_{ij} to denote the number of citations from publications in subject category i to publications in subject category j. Note that according to the WoS classification system, one journal might be attributed into multiple subject categories. Therefore a fractional counting strategy is adopted to handle publications belonging to more than one subject category.

The second step is to construct a similarity matrix of subject categories based on the citation matrix created in the first step. The cosine similarity measure is used for this purpose. Hence, the similarity of two subject categories i and j is given by

$$s_{ij} = \frac{\sum_k c_{ik} c_{jk}}{\sqrt{(\sum_k c_{ik}^2)(\sum_k c_{jk}^2)}}$$

	…	*i*	*j*	…	*m*	*n*	…
…							
i		C_{ii} = 262.50	C_{ij} = 166.00		C_{im} = 171.25	C_{in} = 211.00	
j		C_{ji} = 106.33	C_{jj} = 288.00		C_{jm} = 124.00	C_{jn} = 207.40	
…							

	…	*i*	*j*	…	*m*	*n*	…
…							
i		S_{ii} = 1	S_{ij} = 0.87		S_{im}	S_{in}	
j		S_{ji} = 0.87	S_{jj} = 1		S_{jm}	S_{jn}	
…							

Figure 1. An example of the formula for calculating similarity.

Figure 1 can be used as an example to illustrate how the formula of similarity applied. The top left table is the matrix of citation relations among subject categories, which is not symmetric. Since a fractional counting strategy is used in this study, the numbers of citations are not always integers. As we mentioned above, c_{ij} means the number of citations from subject category i to j. Moreover, according to the above formula, we obtained the symmetric similarity matrix of subject categories, which is shown in lower right of figure 1. In this case, subject category *i* and *j* are all cite a lot to the categories *i*, *j*, *m* and *n*. Therefore, the similarity between *i* and *j* is quite high, that is 0.87.

In short, using the cosine similarity measure, s_{ij} is high if publications in the two categories tend to cite the same categories. If publications in two subject categories tend to cite completely different categories, the similarity between the categories is low.

Step 3 Determining the degree of interdisciplinarity

As mentioned above, we suppose that a research topic could be regarded as an interdisciplinary research topic should satisfy two criteria; one is that it contains distant subject categories, the other is there are citation relations among different subject categories within this topic. In short, a cluster that is consisted with citation relations spanning different subject categories might be an interdisciplinary research topic.

Following the criterion discussed above, we explore the indicator to measure interdisciplinarity, whose formula is as follows:

$$Interdisciplinarity = \frac{1}{n\_cit} \sum_i^k \sum_j^k n\_cit_{ij} d_{ij},$$

where $d_{ij} = 1 - s_{ij}$. Within a cluster, n_cit_{ij} is the number of citations between subject categories i and j, and n_cit is the sum of citations obtained by $n\_cit = \sum_i^k \sum_i^k n\_cit_{ij}$. The indicator includes three attributes: *variety*, the number of subject categories within a cluster (denoted as k), *connectedness*, the number of cross-citations (denoted as n_cit_{ij}) and *distance*, the degree of distinctiveness between subject categories (denoted as d_{ij}). In short, a research topic can be considered to be more interdisciplinary if the citation relations within that cluster cross various WoS subject categories.

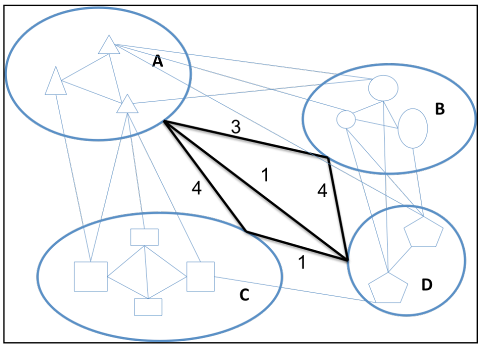

Figure 2. An example of the citation relations within a research topic.

Figure 2 shows a research topic including 12 publications that belong to 4 subject categories. The black lines represent the citation relations among different subject categories, and the blue lines are the links within the same category. In our measurement, the citations crossing subject categories (black lines in the Figure) and distances of subject categories are taken into account.

Results

Clustering analysis

Table 1 provides the basic statistic results of original and restricted database. The restricted database was constructed based on two criteria. First, we expect to analyze research topics with a relatively large number of publications only. Therefore, we set a restriction on the number of publications of each cluster so that clusters with more than 100 publications could be advanced in the next step. Second since the accuracy of measurement is highly related to the quality of clustering results, we reviewed the clusters with the indicator, *mean citation score*. It obtained by using the total number of citations divided by the total number of publications within a cluster. If the number of citations is less than the number of publications of a cluster, publications belong to the cluster are connected loosely, resulting in the emergence of clusters with poor qualities. In this case, we found 667 clusters with low mean citation scores (defined as less than 2), which accounted for 7% of the total. Thus, it turns out that most of clusters have relatively strong interconnections. The analysis in the following sections is performed base on the restricted database.

Table 1. Basic statistic results of original and restricted database.

	# of pubs	# of topics	Average pubs	Max pubs	Min pubs	St.d pubs
Original	9,146,302	9,565	956	10744	1	1026
Restricted	8,930,360	7,864	1,135	10744	100	1040

Similarity matrix

Using Salton's cosine (Salton & McGill, 1983), we obtained a similarity matrix of WoS subject category, the range of similarity values is between 0 and 1. It implies that the similarity s_{ij} is zero if subject category *i* and *j* never cite to the same categories, whereas s_{ij} approaches one if they both cite a lot to the same categories. To test the accuracy and reliability of our similarity matrix, we have compared it with the one obtained by Porter & Rafols (2009), whose method have been introduced above. As expected, the result shows there is positive correlation between the two matrices ($r = 0.7405$). In general, we believe that the results obtained from the two approaches with slight differences are consistent.

Interdisciplinarity of research topics

The average interdisciplinarity score of each research topic is about 0.42 with a standard deviation of 0.11. The largest score is 0.72 associated with the research on respiratory system, while the lowest is close to 0.0086. The distribution of research topics over the interdisciplinarity score is shown in figure2. As can be seen, the majority of research topics have interdisciplinarity scores between 0.35 and 0.55.

In order to better interpret the results, we aggregated the WoS subject category into five main fields according to the Leiden Ranking 2013. Table 2 lists the five main fields. Specifically, a publication appearing in one or several main fields is based on the journal where it has been published. When a publication has appeared in a journal of multi-assignation and these subject categories are assigned into different main fields, the publication is expected to appear in more than one field (more details see CWTS Leiden Rank 2013, pp4). Thus, a research topic might be assigned into several main fields if the publications within this topic belong to more than one field.

Before turning to the interdisciplinarity score, we emphasize that it is quite difficult and almost impossible to define a clear cutting-off point between interdisciplinary and non-interdisciplinary research topics. Considering the difficulty, we selected the research topics with an interdisciplinarity score greater than 0.6143, which account for around 1% of the total. For the purpose of understanding the knowledge integration across main fields in the macro level, we applied following strategy. Regarding a research topic, if the number of publications in one main field is larger than 50% of the total, then the topic is assigned into this main field. Otherwise, the research topic would be assigned into its two dominant main fields. In doing so, the select topics (top 1% of the total) are tabulated in Table 3, in which each row is the main field with the most number of publications and each column is the main field holding the second number of publications. For instance, in the first row, 1 means there is one research topic whose publications mostly appear in main fields 1 and 2, as well as main field 1 has the most number of publications.

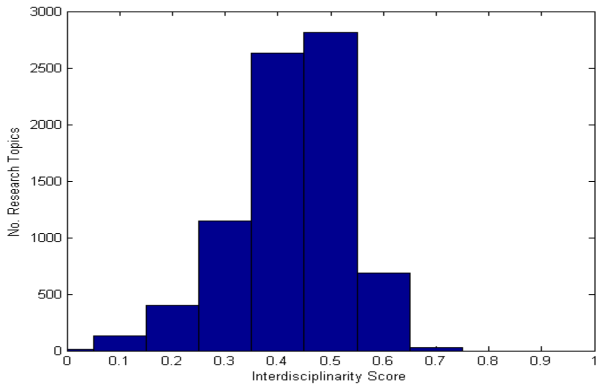

Figure 3. Distribution of research topics over interdisciplinarity score.

Table 2. Labels of main fields.

ID	*Labels of Main Fields*
Main Field -1	Social sciences & humanities
Main Field -2	Biomedical &health sciences
Main Field -3	Natural sciences & engineering
Main Field -4	Life & earth sciences
Main Field -5	Mathematics & computer science

Table 3. Distribution of research topics over the main fields.

	Main field-1	Main field-2	Main field-3	Main field-4	Main field-5	Total
Main field-1	11	1	0	0	0	12
Main field-2	1	33	6	1	2	43
Main field-3	0	2	25	1	0	28
Main field-4	0	0	1	8	0	9
Main field-5	0	2	1	0	5	8

As can be seen, most research topics in the top 1% of the total belong to the main field 2, that is BIOMEDICAL & HEALTH SCIENCES. Meanwhile, among the research topics that across two main fields, the topics whose publications mainly appear in the main field 2 contribute the largest proportion. Primarily, this is because the most number of research topics fall into this main field. In addition, the research conducted by Porter & Rafols (2009) have demonstrated that subject categories MEDICINE- RESEARCH & EXPERIMENTAL and NEUROSCIENCES have high degrees of interdisciplinary according to the Integration score (aka, Rao-Stirling's diversity) (more details see Porter & Rafols, 2009, pp723). In our classification system, the two subject categories both belong to main field 2, which is partially verified that the main field of BIOMEDICAL &HEALTH SCIENCES has relatively high interdisciplinarity. Main field 5, that is MATHEMATICS & COMPUTER SCIENCE, holds the smallest number of research topics with high interdisciplinarity, as shown in table 3. This result is also consist with the research by Porter & Rafols (2009), in which they showed subject category MATHEMATICS that is assigned into main field 5 in our study has the lowest integration score between 1975 and 2005.

For the purpose of examining the quality of the indicator, we now take a more derailed look at research topics. In doing so, we randomly select 5 research topics from the top 1%, one from each main field. For each research topic, Table 4 gives the three most important subject categories and the two most cited publications.

Table 4. Selected research topics with high interdisciplinarity.

Cluster ID	Information of Publication	
4323	Main field (R_pubs)	Main Field -1 (53%); Main Field -4 (27%)
	T_pubs	705
	Rank	56
	Subject Categories (N_pubs)	VETERINARY SCIENCES (244); SOCIOLOGY (225); PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH (47)
	Title (Times cited)	Rijken M et al. (2005). Comorbidity of chronic diseases - Effects of disease pairs on physical and mental functioning (88) Odendaal J.S.J. & Meintjes R.A. (2003). Neurophysiological correlates of affiliative behaviour between humans and dogs (82)
3644	Main field (R_pubs)	Main Field -2 (54%); Main Field -3 (25%)
	T_pubs	875
	Rank	36
	Subject Categories (N_pubs)	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING (715); NUCLEAR SCIENCE & TECHNOLOGY (533); ENVIRONMENTAL SCIENCES (464)
	Title (Times cited)	Stabin M.G. et al. (2005). OLINDA/EXM: The second-generation personal computer software for internal dose assessment in nuclear medicine (370) Gorden A.E.V. et al. (2003). Rational design of sequestering agents for plutonium and other actinides. (227)
4083	Main field (R_pubs)	Main Field -3 (74%); Main Field -2 (13%)
	T_pubs	760
	Rank	63
	Subject Categories (N_pubs)	NUCLEAR SCIENCE & TECHNOLOGY(282); INSTRUMENTS & INSTRUMENTATION (259); PHYSICS, NUCLEAR (255)
	Title (Times cited)	Spalding K.L. et al. (2005). Retrospective birth dating of cells in humans (182) Lappin G. & Garner R.C. (2003). Big physics, small doses: the use of AMS and PET in human microdosing of development drugs (137)
7577	Main field (R_pubs)	Main Field -4 (50%); Main Field -3 (46%)
	T_pubs	190
	Rank	26
	Subject Categories (N_pubs)	ASTRONOMY & ASTROPHYSICS(100); GEOSCIENCES, MULTIDISCIPLINARY (81); METEOROLOGY & ATMOSPHERIC SCIENCES (67)
	Title (Times cited)	Rietveld M.T. et al. (2003). Ionospheric electron heating, optical emissions, and striations induced by powerful HF radio waves at high latitudes: Aspect angle dependence (91) Pedersen T.R. et al. (2003). Magnetic zenith enhancement of HF radio-induced airglow production at HAARP (45)
8434	Main field (R_pubs)	Main Field -5 (55%); Main Field -3 (34%)
	T_pubs	108
	Rank	99
	Subject Categories (N_pubs)	ROBOTICS (49); COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE (34); INSTRUMENTS & INSTRUMENTATION (22)
	Title (Times cited)	Vergassola M. et al. (2007) 'Infotaxis' as a strategy for searching without gradients (103) Yoerger D.R. et al. (2007). Techniques for deep sea near bottom survey using an autonomous underwater vehicle (38)

Take two clusters as examples, cluster 3644 and cluster 4083 are randomly selected from BIOMEDICAL & HEALTH SCIENCES and NATURAL SCIENCES & ENGINEERING respectively; however, the two most frequent main fields of both clusters are the same. Apart from that, as can be concluded from table 4, most publications of both clusters belong to the subject category of NUCLEAR SCIENCE & TECHNOLOGY. Hence we infer that the two research topics are similar at a certain degree. Observing the detailed information of publications in each cluster, we found that both clusters are related to the research on nuclear medicine, that is “a medical specialty involving the application of radioactive substances in the diagnosis and treatment of disease”[1]. However, there is a considerable difference in terms of the degree of interdisciplinary score. Cluster 3644 is much more interdisciplinary than cluster 4083 as shown from table 4. To understand the differences, we visualized the two clusters using the map of subject categories.

The map of subject categories can represent the position of a cluster in the global map of science, as well as show whether the cluster has the characteristics of interdisciplinary research. For instance, we can observe from the map of subject categories whether clusters are dispersed over many distant subject categories. The software VOSviewer (van Eck & Waltman, 2010) was used to construct the map of subject categories. In this study, the baseline map was generated by the citations between WoS subject categories using publications from 2002 to 2013. Figure 4 and 5 were generated by overlaying on the baseline map with circles, in which size of circles represents the number of publications in each WoS subject category, nodes represent subject categories, as well as links shows citations among them.

Comparing the two figures, we found that cluster 3644 are more diverse that it contains citations spanning various subject categories with larger distances (i.e. COMPUTER SCIENCE THEORY AND METHOD, ENGINEERING ELECTRICAL AND ELECTRONIC), as well as its number of publications in various subject categories are quite even. Thus, it is reasonable that cluster 3644 has a higher interdisciplinary score than cluster 4083, although they have a similar research topic. Meanwhile, it can be inferred that the two clusters have different research focuses since the subject categories with the most number of publications of the two clusters are quite different. That also explains why publications with a similar research topic were classified into two clusters.

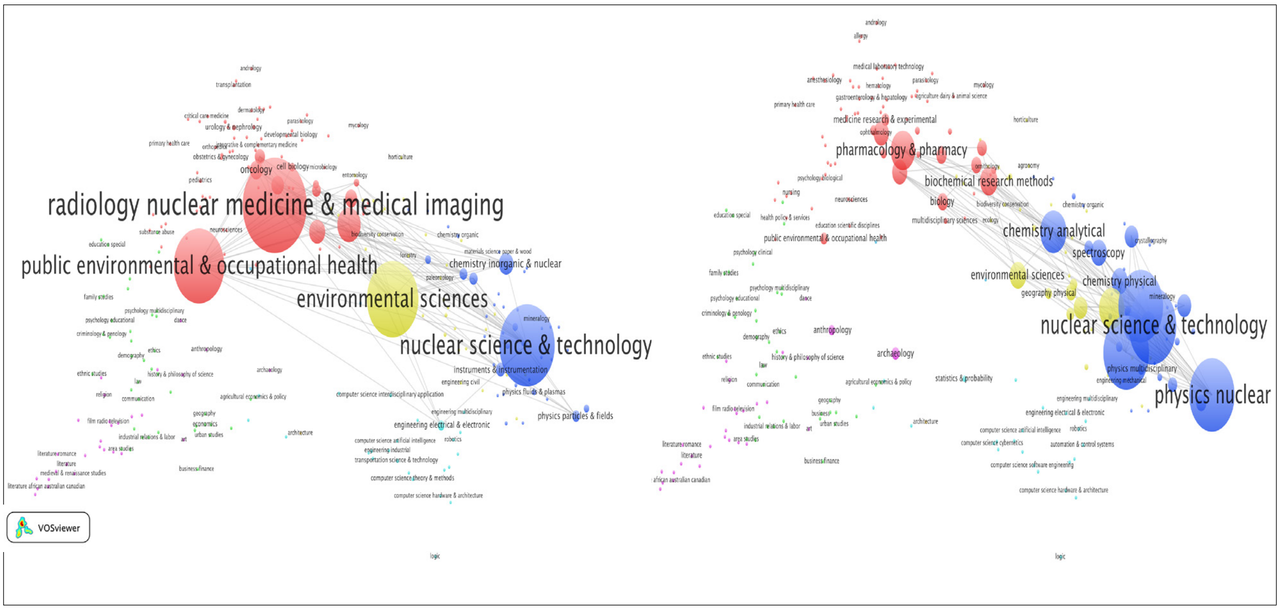

Figure. 4. A map of subject categories (note: the left panel is cluster 3644; the right panel is cluster 4083).

[1] http://en.wikipedia.org/wiki/Nuclear_medicine.

An example of Information Science and Library Science. Readers of this paper might be familiar with research in the field of information and library science; therefore, we now take a specific look at a cluster in this subject category. To give an example, we select the cluster that holds the highest interdisciplinarity value among all the clusters whose most publications belong to this subject category. In doing so, we obtained cluster 4982, which ranks 72 among the top 1% most interdisciplinary clusters. The detailed information of this cluster is shown in table 6.

As can be seen, the cluster includes 565 publications, and most of them belong to main fields of SOCIAL SCIENCES AND HUMANITIES and MATHEMATICS AND COMPUTER SCIENCE, that fit what figure 10 shows. Moreover, it also can be seen that this research topic covers various subject categories, such as computer science research, ergonomics, business, laws, and psychology. Furthermore, based on the most cited publications and the figure of citation network of this cluster, we can estimate that this research topic is rated to the research on information privacy. This is probably in line with what our cognition, that research on information privacy involves studies on either information or computer technology, or social science research such as law and psychology, or studies which overlap the two types of research.

To find more evidence, we searched the courses related to information privacy in MIT OpenCourseWare, using "information privacy" as the key words. Then, 1150 results have been obtained. The courses include from *The Economics of Information*, *Communications and Information Policy* to *Biomedical Computing*, *Information and Entropy*. That proves the research topic of information privacy is interdisciplinary in character.

Table 5. Publication information of cluster 4982.

Cluster ID	Information of Publication	
4982	Main field (R_pubs)	Main Field -1 (52%); Main Field -5 (44%)
	T_pubs	565
	Rank	72
	Subject Categories (N_pubs)	COMPUTER SCIENCE, INFORMATION SYSTEMS (141); BUSINESS (108);
		INFORMATION SCIENCE & LIBRARY SCIENCE (107)
	Title (Times cited)	Malhotra N.K., Kim S.S. & Agarwal J. (2004). Internet users' information privacy concerns (IUIPC): The construct, the scale, and a causal model (169)
		Nissenbaum H. (2004). Privacy as contextual integrity (110)

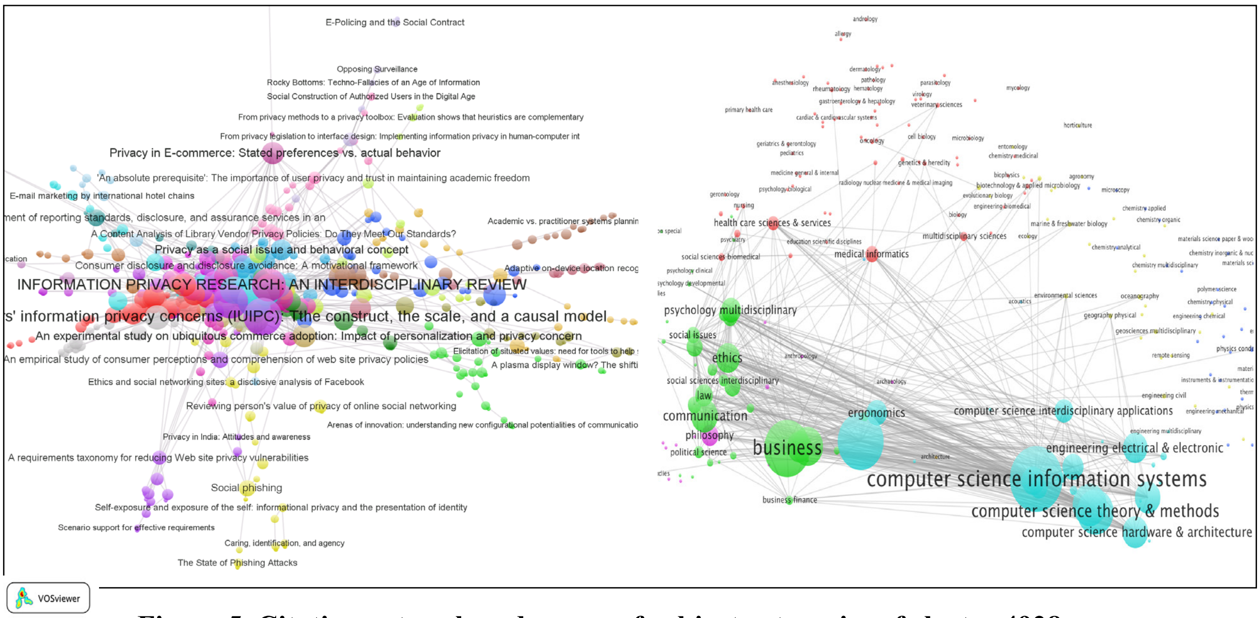

Figure 5. Citation network and a map of subject categories of cluster 4928.

Discussion and Conclusion

In this article, we proposed an alternative approach to investigate interdisciplinarity. The measurement is based on a publication-level and direct citation relations based classification system. Hence, several interdisciplinarity research topics were identified with the new interdisciplinarity score in the current science system.

The interdisciplinarity score proposed not only takes citation relations among various WoS subject categories within a cluster into consideration, but it incorporates a measure of how distant the subject categories. As mentioned above, the indicator proposed in this article is similar, to some extent, with the widely used indicator of interdisciplinarity, that is Rao-Stirling index or Integration score (Porter & Rafols, 2009). The most crucial distinction between the two indicators of interdisciplinarity is that, for each research topic, we use the number of citations among subject categories instead of the number of publications in different subject categories. We consider that the number of citations among subject categories can reflect both how diverse as well as how compact a cluster is. Furthermore, to test the robust of this approach, we estimated Pearson's correlation between the two indicators. The correlation coefficient is 0.9552, which high correlation suggests that there is no difference between the original Rao-Stirling index and the variant proposed in this article.

Another distinction with previous research is that our study is based on a publication-level and direct citation relations based classification system, in which publications were assigned into different research topics according to their citation relations. It implies the research topics constructed can more closely match the current structure of scientific research and provide more detailed information of the research content per se (Waltman & van Eck, 2012). There are 250 WoS subject categories in total, providing a coarse description of science. On the contrary, we worked on a classification with around 10,000 research topics, deriving from large-scale clustering. While the clusters in this study are small compared with WoS classification, it is important and necessary to explore interdisciplinary research topics at different level of classification system of science.

Moreover, we need to emphasis the concept of 'interdisciplinary research topic' that we used in this article again. Here, this term is related to all types of crossing boundary research topics, which can be considered as a loose standard. Since there is a gradual transition from mono-disciplinary to interdisciplinary research, it is somewhat impossible to define a clear line to distinguish mono-disciplinary and interdisciplinary related research.

In summary, we have introduced an alternative approach for identifying interdisciplinary research topics. By in-depth analysis of some randomly selected topics, especially based on citation networks and overlay maps, we believe that they are boundary-crossing research topics. Since most research on the measurement of interdisciplinarity have conducted based on an existing classification system of science, such as journal and WoS subject category, we expect this study could provide another perspective on the current science system. The identified research topics could more accurately reveal interdisciplinary research within the current structure of scientific research.

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