

## **Artificial Intelligence and Business Management: A Scientometric Analysis using CiteSpace** (Full Paper)

Rui Qiu, Business School, Sichuan University, Chengdu, 610064, P. R. China

Shuhua Hou\*, School for Environment and Sustainability, University of Michigan, Michigan, USA,  
shuhuah@umich.edu

Zhiyi Meng, Business School, Sichuan University, Chengdu, 610064, P. R. China

### **ABSTRACT**

The interactions between artificial intelligence and business management have been one of the most critical and dynamic research areas in the field of business in recent years. This paper reviews related literature of artificial intelligence and business management, and studies the evolution of emerging trends by using CiteSpace to evaluate all relevant academic publications. The cluster, timezone and timeline visualizations have identified emerging trends of artificial intelligence and business management with three key topics: cost justification, big data, and decision-making. Cost justification is the hottest one in early years, followed by big data. In the last several years, decision-making is hot for artificial intelligence and business management.

*Keywords:* Artificial intelligence; Business management; Scientometric analysis; CiteSpace

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\*Corresponding author

### **INTRODUCTION**

With the arrival of the “Age of Big Data”, artificial intelligence has been an increasing concern (Gandomi and Haider, 2015; Aradau and Blanke, 2017; Secundo et al., 2017). It involves the activities of specification, capture, storage, access, distribution, management, and analysis of large complex datasets, in order to gain insight into its content and exert its value in decision-making (Partridge and Hussain, 1992; Liebowitz, 2001; Dremel et al., 2015). The datasets often consist of massive volumes of heterogeneous data in unstructured text, audio, and video formats (Ernst and Ojha, 1986; Wu et al., 2014; Hashem, 2015). As an important application field for artificial intelligence, business management have greatly improved (Li, 1994; Kolbjørnsrud et al., 2016; Brynjolfsson, 2017). The interactions between artificial intelligence and business management have been extremely complex as time goes on (Xu et al., 2002; Wright and Schultz, 2018). The emerging trends of artificial intelligence and business management need to be grasped for the development of the both.

Scientific publications in the artificial intelligence and business management have increased dramatically over the past decades (Herschel and Jones, 2005; Klumpp, 2018). At the same time, owing to technology and methodology advances, the diversity of topics within business research has also increased (McDougall et al., 1994; Jourdan et al., 2008; Meyer and Peng, 2016). In the field of scientometrics, researchers have been using data of scientific publications to analyze the patterns and trends of scientific collaboration for a long time (Chen, 2006; Chen, 2017). However, scientometric studies of the artificial intelligence and business management still remain limited. Therefore, in order to discover and develop the trends to achieve the integrity and universality of these technologies and contribute to the related research in the artificial intelligence and business management, a scientometric analysis using CiteSpace is conducted to explore the artificial intelligence and business management emerging trends from the perspective of data-driven and accelerate the development of this area, which may generate new research ideas and offer a great reference for scholars.

This paper aims to excavate the trends of artificial intelligence and business management based on a scientometric analysis using CiteSpace. The remainder of this study is constructed as follows. Basic analysis for related academic publications is conducted in Section 2. In Section 3, the results by using CiteSpace to demonstrate artificial intelligence and business management emerging trends are provided. Finally, conclusions are presented in Section 4.

### **BASIC ANALYSIS**

To accurately summarize relevant studies from researchers, Web of Science Core Collection database is used to search for existing articles.

By using Boolean Logic technology and the search string “TS=(artificial Intelligence) AND TS=(business management)”, 359 related articles were found with the time slice ranging from 1990 to 2018 (publications till the end of 2018). Firstly, the research trend of artificial intelligence and business management by year is analyzed based on these articles, as shown in Fig. 1. It can be seen that artificial intelligence and business management related articles are few before 2008, and then increase, reaching a peak in recent years.

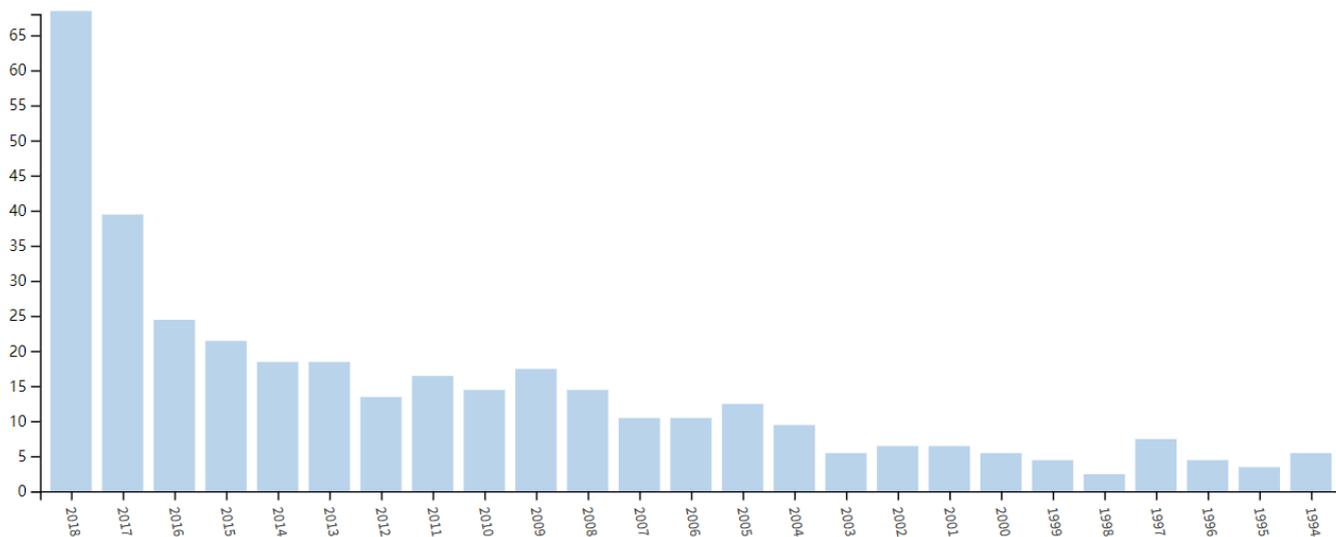


Figure 1: Publication number of artificial intelligence and business management related articles by year.

Fig. 2 demonstrates related results based on research fields. From this figure, computer science, engineering, and business economics are the fields with the most related publications. In addition, operations research management science has a relatively high number of relevant papers.



Figure 2: Research fields of artificial intelligence and business management related articles.

Then the artificial intelligence and business management related articles are analyzed by countries as shown in Fig. 3. It can be seen that the country which most studied artificial intelligence and business management is the United States, accounting for nearly 19% of the total related articles, followed by China with a proportion of over 12%. The third is England, which occupies just below 7% of the total. The academic publications related to artificial intelligence and business management of these three countries make up nearly 38% of the total. Besides, there are some other countries with articles focusing on artificial intelligence and business management, such as Germany, India, Italy, Romania, Australia, France and Spain.

Field: Countries/Regions	Record Count	% of 359
USA	68	18.942 %
PEOPLES R CHINA	44	12.256 %
ENGLAND	24	6.685 %
GERMANY	22	6.128 %
INDIA	17	4.735 %
ITALY	17	4.735 %
ROMANIA	17	4.735 %
AUSTRALIA	16	4.457 %
FRANCE	16	4.457 %
SPAIN	15	4.178 %
NETHERLANDS	11	3.064 %
CZECH REPUBLIC	10	2.786 %
RUSSIA	10	2.786 %

Figure 3: Countries of artificial intelligence and business management related articles.

### ARTIFICIAL INTELLIGENCE AND BUSINESS MANAGEMENT EMERGING TRENDS

In this section, the emerging trends of artificial intelligence and business management are explored based on Citespace.

CiteSpace is a free Java application for visualizing and analyzing citations and contents in scientific literature (Chen et al., 2012; Wei et al., 2015). It can be applied to the analysis of multiple, time-sharing, and dynamic complex networks, and to detect the hotspots and evolution in a certain field (Cui et al., 2018). Based on the 359 related articles with the time slice ranging from 1990 to 2018, CiteSpace is used to analyze artificial intelligence and business management emerging trends. As a type of co-occurrence analysis, keyword-based analysis has played an important role in understanding knowledge development dynamics. For visualization, different network analysis views; cluster, timeline, and timezone; were available, from which the patterns and trends in artificial intelligence and business management literature were revealed.

Science mapping is a strong literature measurement technology for studying the conceptual structure of the specific research field, because it allows for the monitoring and delineation of research areas in the field of science to determine structure and evolution (Cobo et al., 2011). It is based on the knowledge of the field and it describes the progress and framework, reveals the complicated relationship between singles and groups of knowledge (Healey et al., 1986). CiteSpace can identify spectral features. In the early days, science did not have a unified paradigm. In the medium term, a paradigm is needed to develop science, and finding this paradigm is a scientific revolution (Lahneman, 2012; Wion et al, 2015). Therefore, using CiteSpace to build knowledge mapping, reveal cutting-edge research, and find the evolution of knowledge.

CiteSpace's cluster recognition trajectory is used to simulate the development trends of artificial intelligence and business management. Because CiteSpace recognizes co-citation clustering in the literature index to track research trends, most CiteSpace software is a technique for selecting algorithms through spectral clustering and features, allowing visualization of results to understand trends and evolution. Its timeline view allows visualization and identification of the artificial intelligence and business management trends of the publication year. A visualization of the search results to make sense of the trends and evolutions is the main characteristic of CiteSpace, with the CiteSpace cluster analyses revealing the relationships between the keywords from artificial intelligence and business management related articles. The 'Cluster View' graph is shown in Fig. 4.

The modularity and mean silhouette scores are the two important metrics used to describe the overall structural network properties. In general, the modularity values in Fig. 4 (0.9293) were relatively high, which indicated that the network's loosely coupled clusters were reasonably divided. The silhouette measure is used to determine whether the data is appropriately clustered; when the silhouette measure is close to one, the data is appropriately clustered and when it is close to minus one, the

data is not appropriately clustered. However, when the silhouette measure is near zero, the data is on the border of these two natural clusters. The mean silhouette scores suggested that on average, the cluster homogeneity of artificial intelligence and business management trends (0.4105) was relatively high.

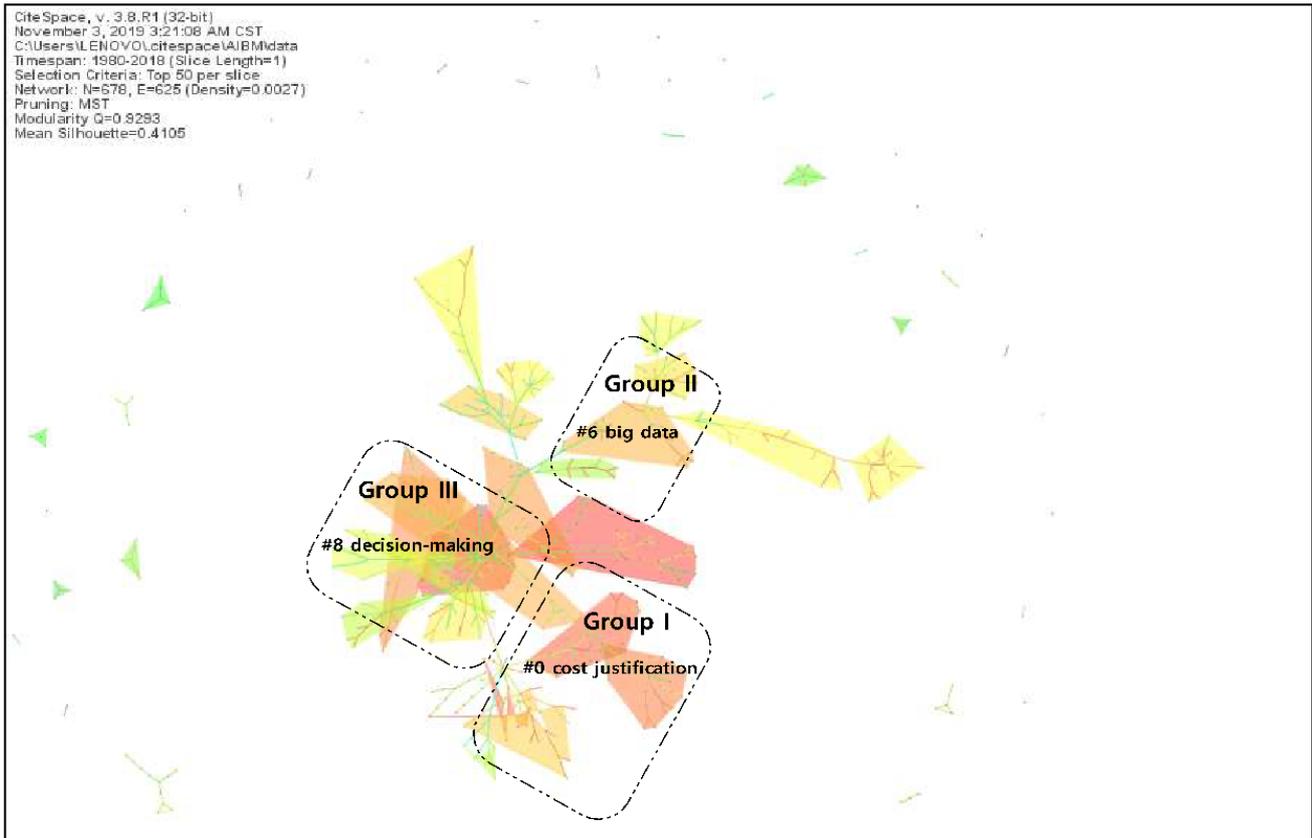


Figure 4: Keywords co-occurrence and cluster view of related studies for artificial intelligence and business management.

To determine the most appropriate clusters, silhouette and size measures were used. Three clusters with the cluster label (LLR); “cost justification”, “big data” and “decision-making”; were extracted as they had high silhouettes (ID: 0, 6, 8; silhouette: 0.658, 0.552, 0.704) and were a relatively large size (38, 29, 27). The mean years of these three topics are 2003, 2008, and 2012, respectively. As the keywords in the above three clusters were distinct, it was decided that these were representative of the different artificial intelligence and business management trends. All three clusters and the associated keywords were gathered into three groups, as shown in Fig. 4.

Changing the layout to ‘Timeline View’ and ‘Timezone View’ in Figs. 5 and 6, the clusters vary with time (year), with the distribution of the three groups each occurring in different time periods; “cost justification”, followed by “big data” and then “decision-making”, clearly indicating the artificial intelligence and business management evolution. Therefore, from the above analysis, three clear artificial intelligence and business management stages were revealed.

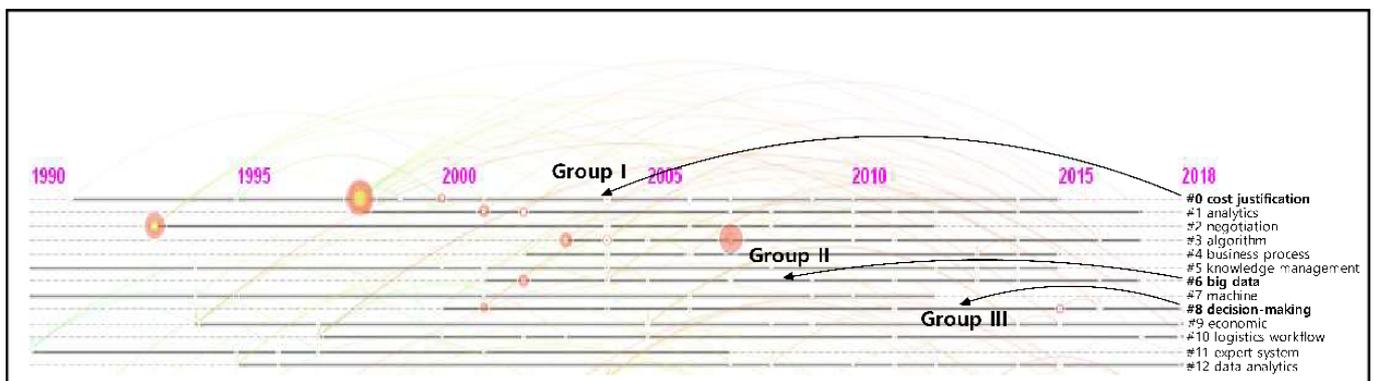


Figure 5: Clusters with timeline view of related studies for artificial intelligence and business management.

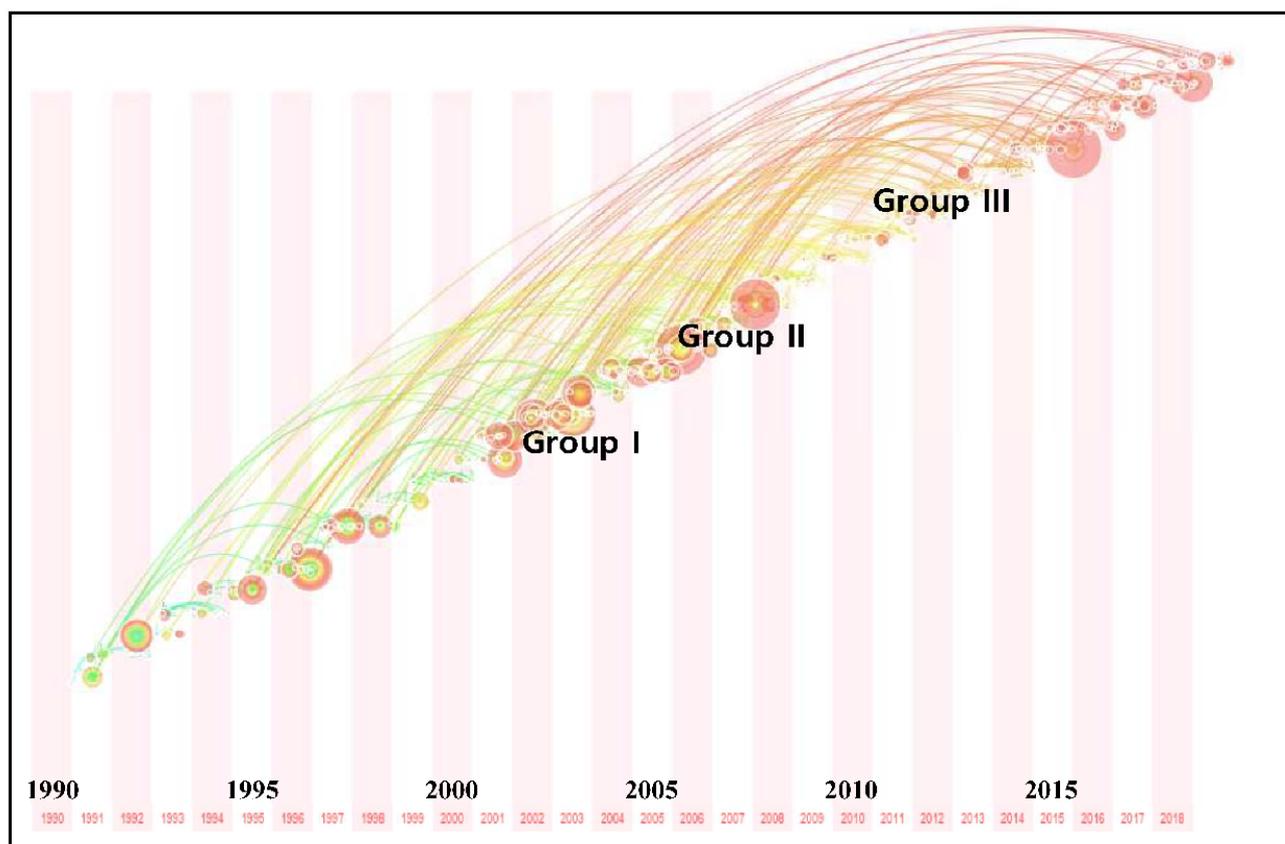


Figure 6: Clusters with timezone view of related studies for artificial intelligence and business management.

Scientific mapping with cluster and visualization was inspired by Kuhn's scientific paradigm notion, which provided a framework for matching visual-spatial patterns to the movements of an underlying paradigm. In Dosi's model, the sense of "trajectory" was aligned with "normal science", as technological activities guided by a specific paradigm naturally form a "technological trajectory". In other words, technological trajectories can be found in the clusters analyzed using the CiteSpace, with the turning points being the research papers that connect the different clusters. From the visual knowledge map (i.e., Fig 4), there were three distinct clusters; "cost justification", "big data" and "decision-making"; which could be further analyzed for artificial intelligence and business management trends. By combining the three life cycle stages of the paradigm theory and the above three cluster classifications, artificial intelligence and business management trends were identified, as shown in Fig. 6. Cost justification is the initial phase of the artificial intelligence applied into the business management, which focused on the cost when conducting operation activities. Big data is hot with the arrival of the "Age of Big Data", which gave rise to data-driven business management. The most current keyword, decision-making, reflects the business management being back to itself (including logistics, operational risk, finance, and so on) in recent years.

### CONCLUSIONS

In this paper, a scientometric analysis using CiteSpace is applied to elucidate the current and future artificial intelligence and business management trends. Using appropriate technology and software, this scientometric analysis was developed with data collection and visualization to determine the relevant research foci. Using the scientometric analysis, keyword focus trends were identified to assess the three distinct artificial intelligence and business management stages. The scientometric analysis gives a view of the current foci and trends of artificial intelligence and business management. From the exploration trajectory in this paper, the technologies preceding the "shift stage" acted as the developmental foundation.

### ACKNOWLEDGMENTS

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### APPENDIX

The details of CiteSpace are introduced here. Fig. A1 shows the system of CiteSpace. It can be seen that there are two important links for this system: Project Home and Data Directory. Generally, the files downloaded (i.e., Data Directory) from

Web of Science Core Collection database should be stored in Disk C, such as C:\Users\LENOVO\.citespace\AIBM\data. Meanwhile, the results (i.e., Project Home) based on CiteSpace should be stored in the same folder of Disk C, such as C:\Users\LENOVO\.citespace\AIBM\project. To run a new project in CiteSpace, we should click the “New” button to select proper dataset and results storage links, as shown in Fig. A2. At the same time, the language can be chosen based on the database. For example, Chinese can be selected when the database are from Chinese National Knowledge Infrastructure (CNKI). After making a new project, the time slicing can be set: the time range and the years per slice. For the text processing, term sources (title, abstract, author keywords, and keywords plus) can be chosen, and term types (noun phrases and burst terms) can be adopted. For the network configuration, there are various node types can be chosen: author, institution, country, term, keyword, category, cited reference, cited author, cited journal, paper and grant. The keyword is usually taken to analyze the research trends of a specific research field. The options for Cosine, Dice and Jaccard coefficients can be adopted as link strengths, while the options of within slice and across slice are selectable as link scopes for users. The options for top N per slice, top N% per slice, threshold interpolation, and select citers can be chosen as node selection criteria. For the top N per slice, top 50 most cited or occurred items from each slice is the default. For the top N% per slice, top 1% most cited or occurred items from each slice is the default. In the pruning options, pathfinder, and minimum spanning tree can be adopted as pruning tools, while pruning sliced networks and pruning the merged network can be taken as pruning detailed methods. In the visualization options, static and animated modes can be chosen as cluster views. Meanwhile, networks by time slice and merged network can be adopted as presentation modes in CiteSpace. When these options are set, the “GO!” can be clicked to run this new project. About several minutes later, the basic results can be generated. As we can see from Fig. A1, the 359 related articles have been pruned into 325 records. Then we can choose visualization modes for further analysis.

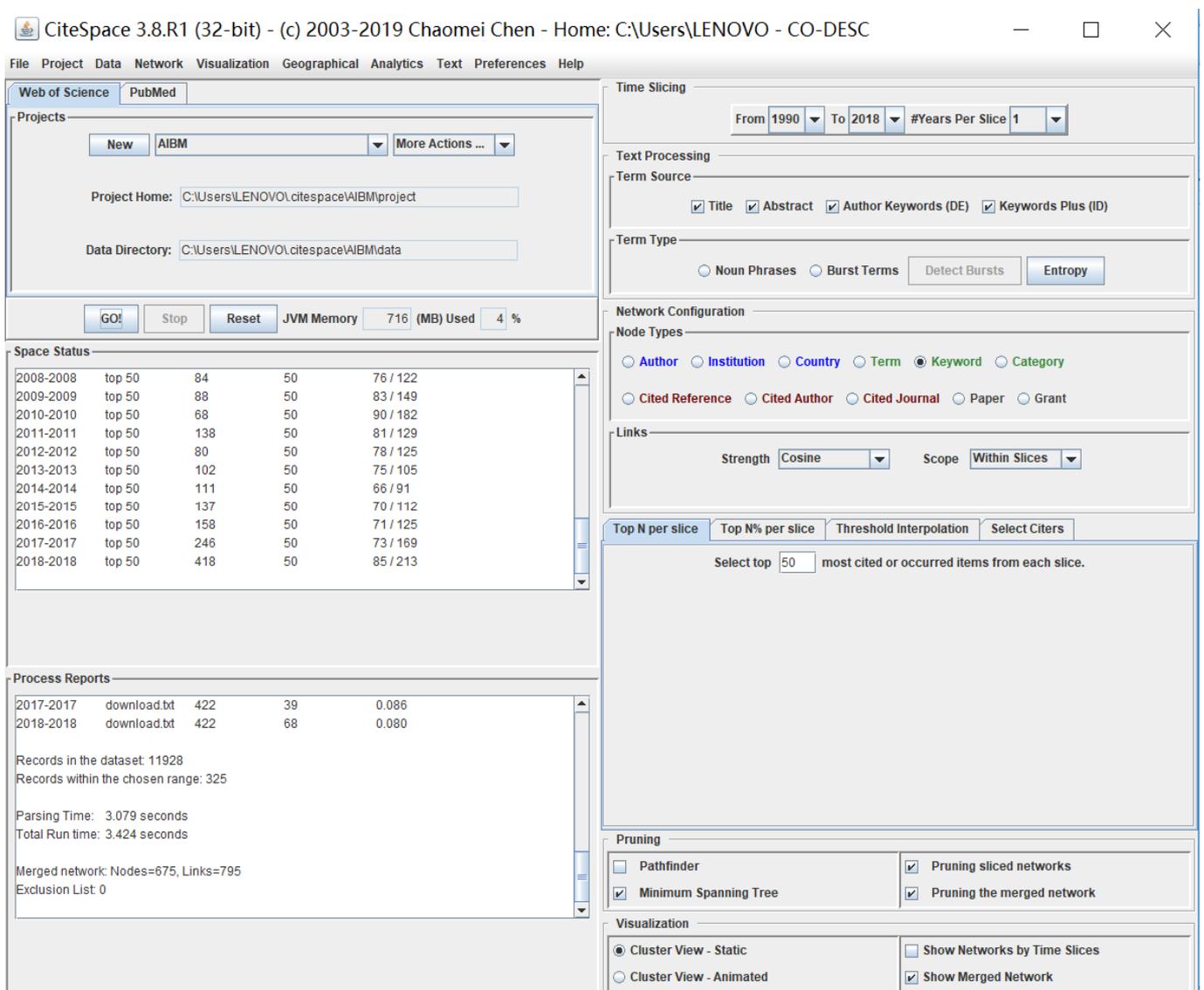


Figure A1: The system of CiteSpace.

Figure A2: The new project window in CiteSpace.

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