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Knowledge Graph Analysis of Smart Justice Research in China: A Visualization Method Based on CiteSpace

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Key Words: Judicial reform; Intelligent justice; Legal expert system; Legal community; CiteSpace.

1. Introduction

In the digital age, emerging technologies such as big data, cloud computing, the Internet, blockchain, and artificial intelligence are reshaping human social productivity. As an important path to realizing the rule of law, the judicial system should adjust to changes in production methods. Judicial reform, as a major national task, has basically completed the informatization of the judiciary, and the results are remarkable.[1] With the rapid iteration of artificial intelligence technology and the accumulation of data generated by informatization, judicial reform has entered a new era of development of intelligent justice.

2. Data Sources and Research Methods

This paper intends to use the research method of bibliometric analysis to visually present the characteristics of relevant research on China's intelligent justice.

2.1 Data Sources

This paper takes literature from the CNKI database between January 1, 2000, and January 27, 2022 and gets a total of 209 highly relevant papers were obtained and exported in RefWorks format for CiteSpace analysis.[2]

2.2 Research Methodology

In this paper, we use CiteSpace, which is a widely recognized and widely used bibliographic analysis software in many disciplines worldwide. Its feature lies in the use of existing bibliographic data, through bibliometric, data analysis, and visualization of data analysis results, to systematically mine large amounts of bibliographic information and present them in a visual manner.

3. Data Analysis

3.1 Annual Publication Trend

Visual charts of the distribution of publication time and annual publication volume can intuitively reflect the research development of intelligent judicial research (see Figure 1).[1]

From Figure 1, it can be seen that from 2000 to 2022, except for the initial core publication in 2001, there were no other publications related to intelligent judiciary in CNKI core journal data for several years. It was not until 2016 that research on intelligent judiciary in China began to show a year-on-year increase, and by January 2022, there were already three publications closely related to the topic of intelligent judiciary. This indicates that research on intelligent judiciary has gained increasing attention and importance from scholars, and the research momentum has been continuously increasing.

1. Author's note: From the search results, there are very few literature results before 2016.

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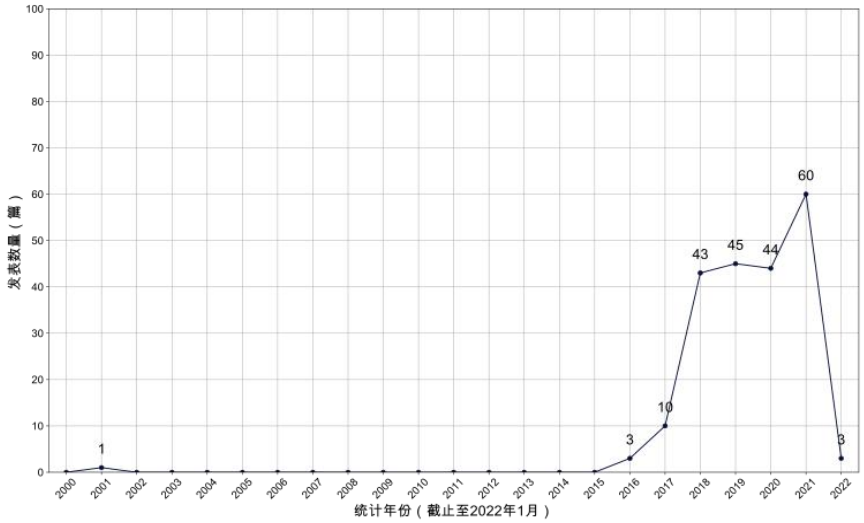

Figure 1: Number of research publications in the field of "Intelligent Judiciary" from 2000 to 2022.

3.2 Number and Collaboration of Core Authors

Core authors are the backbone of academic research in various disciplines. During a certain period, the academic papers published by core authors that are highly cited or have a large number of downloads have a leading role in related fields. At the same time, the continuous publication of an author in the same field also reflects to some extent the situation and trends in the research field. From 2000 to 2022, 196 authors published one paper, 21 authors published two papers, only 7 authors published three papers, and only 3 authors published four papers (see Figure 2).If we define authors who have published more than three papers as core authors, then these authors should occupy all the author positions. Calculated by the first author, there should be 209 first authors for 209 papers, which is 23.22 on average. However, in this statistical analysis, there were only 7 first authors, far fewer than 23. Based on this analysis, it can be inferred that a core author group has not yet formed in the field of intelligent justice.

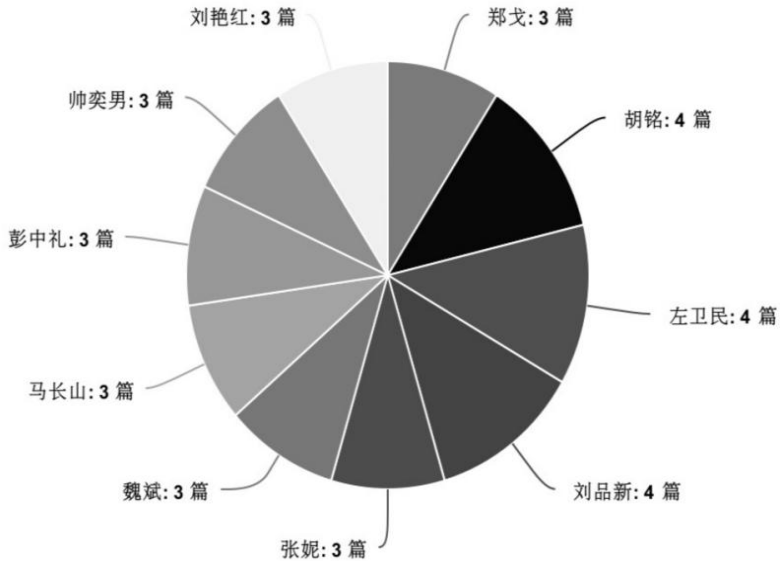

Figure 2: Publication Status of Chinese Smart Judiciary Research Authors between 2000-2022.

After importing data exported from CNKI into CiteSpace, the time range of 2000-2022 was selected, and the data was sliced into one-year intervals. The threshold for each time slice was set

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to Top 50, meaning that data from the top 50 ranked authors in each time slice was extracted to generate the visualization network. The selected node type was "author", resulting in a network map of author collaborations in the field of Chinese smart justice research (see Figure 3). Figure 3 shows that the density value of the smart justice author collaboration network is 0.0024, with Network:N=222,E=60. In other words, a total of 222 scholars had published articles in this field during the target time period, with a total of 60 collaborations. Density is an indicator that measures the degree of collaboration, and a value of 0.0024 indicates a relatively low level of collaboration.

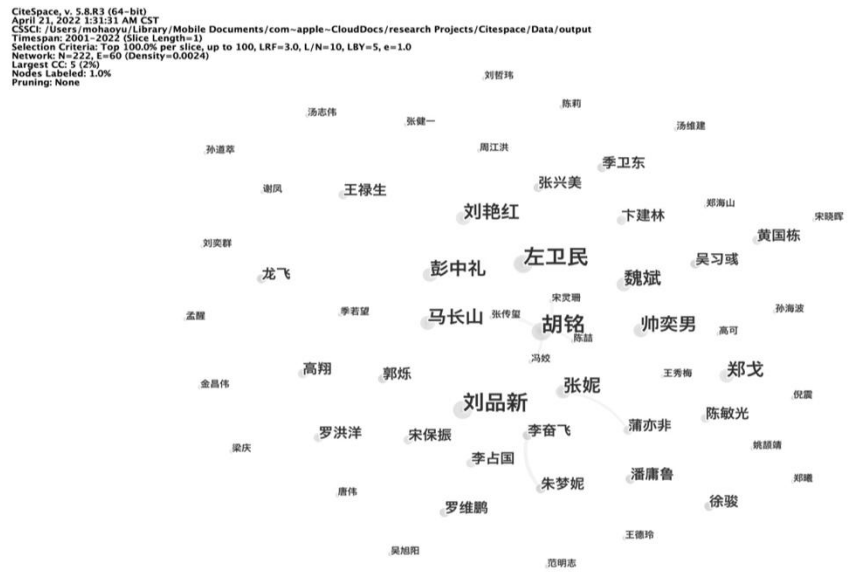

Figure 3: Author Collaboration Network of Chinese Non-Traditional Security Research Literature Based on CNKI.

3.3 Analysis of Research Institution Collaboration Network

The data exported from CNKI was imported into CiteSpace, and a co-occurrence graph of domestic research institutions was formed by selecting the time period of 2000-2022 with a one-year time slice and setting the threshold value to Top100 for each time slice (see Figure 3). The graph shows a network density value of 0, Network: N=133, E=0, indicating that there are 133 nodes and 0 connections in total. The larger the node representing an institution, the thicker the annual ring it forms in the graph, indicating that the institution has made greater contributions to and produced more literature on the research of smart justice in China. In addition, the connections between the nodes also reflect the collaboration relationships among institutions. The density value intuitively reflects the research collaboration situation among institutions in the field of smart justice.

According to the analysis of Figure 4, this network suggests that there is relatively little cooperation and interaction among the research institutions, and most collaborations only occur within institutions, presenting a "solitary fortress" status. This phenomenon further reflects the insufficient cooperation in the legal aspects of China's smart justice research, which has not yet met the requirement of building an intelligent expert system to form a legal community and consensus in the legal field.

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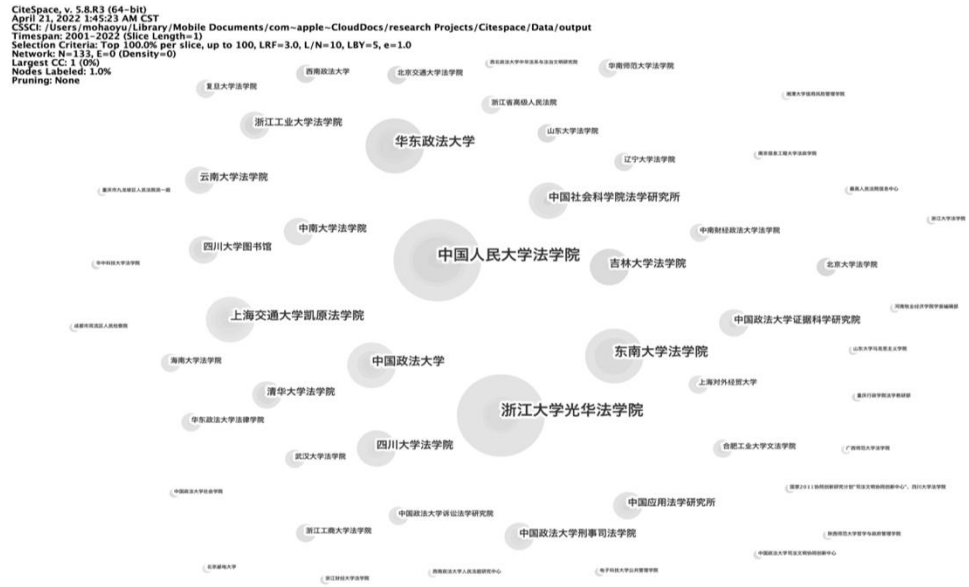

Figure 4. Collaborative network map of institutions in research literature on China's smart justice based on CNKI.

4. Analysis of Keyword Co-occurrence Map in Smart Justice Research

Keywords are highly condensed representations of the research topics in an article. To explore the research hot topics in smart justice, we can analyze the frequency and centrality of keywords to quantify the research hot topics in smart justice.

4.1 Keyword Clustering Analysis.

This paper uses the CiteSpace tool to analyze 209 core literature data obtained from CNKI. After forming a visualized map, it is clustered by keywords (see Figure 5). The network density value is 0.0114 and Network: N=399, E=902, meaning that a total of 399 nodes were formed in the keyword set and 902 connections were formed. The larger nodes mean that this keyword appears more frequently in domestic smart justice research and has higher research popularity.

Figure 5: Keyword Co-occurrence Map of Smart Justice Research in China based on CNKI

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In addition, CiteSpace measures the effectiveness of map drawing through two indicators: Q value and S value based on network structure and clarity of clustering. The first is Q value (Modularity), which measures the degree of sub-module formation in a keyword co-occurrence network. The higher this value, the more obvious the trend of sub-modules being aggregated between keywords. The range of Q values is [0,1], and according to Professor Chen Chaomei's introduction to bibliometric principles, when Q>0.3 it means that the community structure divided by the selected keyword set is significant. The second is S value (Weighted Mean Silhouette), which measures the quality of clustering. The higher this value, the higher the cohesion within clusters and lower separation between clusters. Similarly, according to Professor Chen Chaomei's setting, S>0.5 indicates that clustering is reasonable and S>0.7 indicates that clustering has high credibility.[3]

Figure 5 shows that Network Modularity Q=0.6469 which is much larger than the above standard (Q>0.3). In addition, this clustering has an S value of 0.9389 which is much larger than the critical value of 0.5 and also exceeds an S value of 0.7 with high credibility. [4]These two points indicate that research hot topics represented by keywords show a significant tendency to group together in groups which means that related scholars have shown a clear network community structure in their research interests and directions in China's smart justice research field.

4.2 Hot Topics in Smart Justice Research

According to the keyword clustering information, themain keywords in order of cluster size are: artificial

intelligence, smart court, smart justice, algorithm, judicial reform, judicial judgment, justice, algorithm black box, rule of law construction , criminal justice , intelligent judgment , legal challenge.[5]

5. Evolutionary Trends of Smart Justice Research

5.1 Keyword Timeline Clustering Map Analysis.

As shown in Figure 6, since 2015, with judicial reform and informatization construction as the opportunity, smart justice has gradually evolved from judicial informatization to judicial intelligence. It has gradually been refined into specific different directions under the background of judicial intelligence.

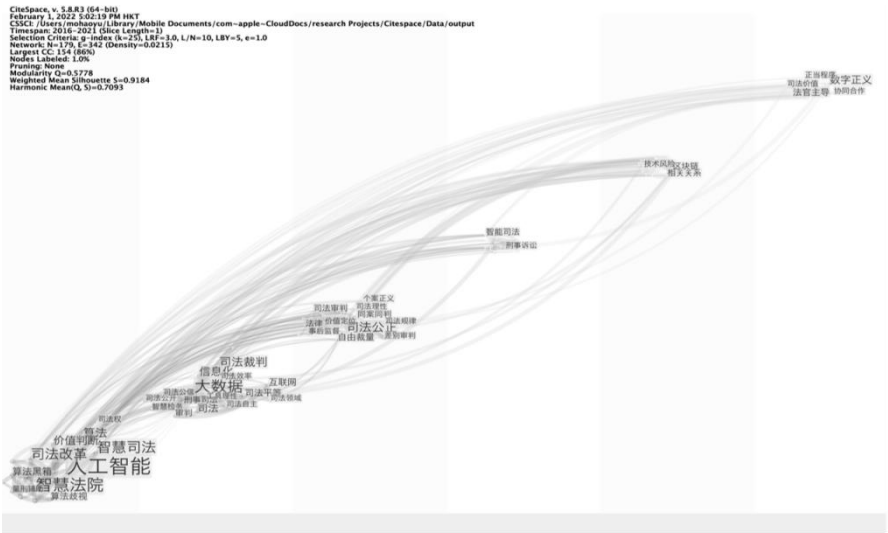

Figure 6: Timeline Knowledge Graph of Keywords in Smart Justice

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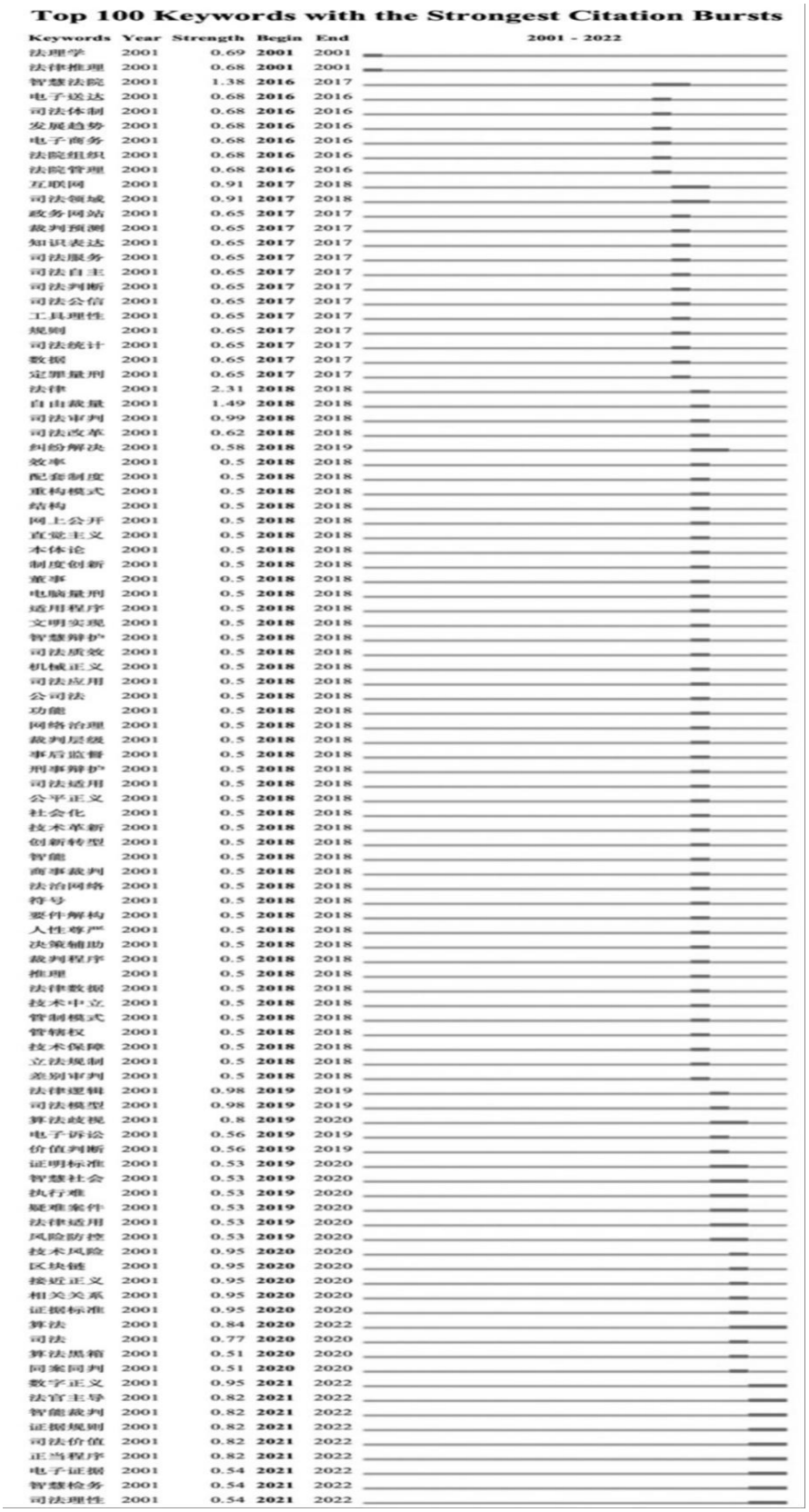

Top 100 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2001 - 2022
法理学	2001	0.69	2001	2001	
法律推理	2001	0.68	2001	2001	
智慧法院	2001	1.38	2016	2017	
电子送达	2001	0.68	2016	2016	
司法体制	2001	0.68	2016	2016	
发展趋势	2001	0.68	2016	2016	
电子商务	2001	0.68	2016	2016	
法院组织	2001	0.68	2016	2016	
法院管理	2001	0.68	2016	2016	
互联网	2001	0.91	2017	2018	
司法领域	2001	0.91	2017	2018	
政务网站	2001	0.65	2017	2017	
裁判预测	2001	0.65	2017	2017	
知识表达	2001	0.65	2017	2017	
司法服务	2001	0.65	2017	2017	
司法自主	2001	0.65	2017	2017	
司法判断	2001	0.65	2017	2017	
司法公信	2001	0.65	2017	2017	
工具理性	2001	0.65	2017	2017	
规则	2001	0.65	2017	2017	
司法统计	2001	0.65	2017	2017	
数据	2001	0.65	2017	2017	
定罪量刑	2001	0.65	2017	2017	
法律	2001	2.31	2018	2018	
自由裁量	2001	1.49	2018	2018	
司法审判	2001	0.99	2018	2018	
司法改革	2001	0.62	2018	2018	
纠纷解决	2001	0.58	2018	2019	
效率	2001	0.5	2018	2018	
配套制度	2001	0.5	2018	2018	
重构模式	2001	0.5	2018	2018	
结构	2001	0.5	2018	2018	
网上公开	2001	0.5	2018	2018	
直觉主义	2001	0.5	2018	2018	
本体论	2001	0.5	2018	2018	
制度创新	2001	0.5	2018	2018	
董事	2001	0.5	2018	2018	
电脑量刑	2001	0.5	2018	2018	
适用程序	2001	0.5	2018	2018	
文明实现	2001	0.5	2018	2018	
智慧辩护	2001	0.5	2018	2018	
司法质效	2001	0.5	2018	2018	
机械正义	2001	0.5	2018	2018	
司法应用	2001	0.5	2018	2018	
公司法	2001	0.5	2018	2018	
功能	2001	0.5	2018	2018	
网络治理	2001	0.5	2018	2018	
裁判层级	2001	0.5	2018	2018	
事后监督	2001	0.5	2018	2018	
刑事辩护	2001	0.5	2018	2018	
司法适用	2001	0.5	2018	2018	
公平正义	2001	0.5	2018	2018	
社会化	2001	0.5	2018	2018	
技术革新	2001	0.5	2018	2018	
创新转型	2001	0.5	2018	2018	
智能	2001	0.5	2018	2018	
商事裁判	2001	0.5	2018	2018	
法治网络	2001	0.5	2018	2018	
符号	2001	0.5	2018	2018	
要件解构	2001	0.5	2018	2018	
人性尊严	2001	0.5	2018	2018	
决策辅助	2001	0.5	2018	2018	
裁判程序	2001	0.5	2018	2018	
推理	2001	0.5	2018	2018	
法律数据	2001	0.5	2018	2018	
技术中立	2001	0.5	2018	2018	
管制模式	2001	0.5	2018	2018	
管辖权	2001	0.5	2018	2018	
技术保障	2001	0.5	2018	2018	
立法规制	2001	0.5	2018	2018	
差别审判	2001	0.5	2018	2018	
法律逻辑	2001	0.98	2019	2019	
司法模型	2001	0.98	2019	2019	
算法歧视	2001	0.8	2019	2020	
电子诉讼	2001	0.56	2019	2019	
价值判断	2001	0.56	2019	2019	
证明标准	2001	0.53	2019	2020	
智慧社会	2001	0.53	2019	2020	
执行难	2001	0.53	2019	2020	
疑难案件	2001	0.53	2019	2020	
法律适用	2001	0.53	2019	2020	
风险防控	2001	0.53	2019	2020	
技术风险	2001	0.95	2020	2020	
区块链	2001	0.95	2020	2020	
接近正义	2001	0.95	2020	2020	
相关关系	2001	0.95	2020	2020	
证据标准	2001	0.95	2020	2020	
算法	2001	0.84	2020	2022	
司法	2001	0.77	2020	2020	
算法黑箱	2001	0.51	2020	2020	
同案同判	2001	0.51	2020	2020	
数字正义	2001	0.95	2021	2022	
法官主导	2001	0.82	2021	2022	
智能裁判	2001	0.82	2021	2022	
证据规则	2001	0.82	2021	2022	
司法价值	2001	0.82	2021	2022	
正当程序	2001	0.82	2021	2022	
电子证据	2001	0.54	2021	2022	
智慧检务	2001	0.54	2021	2022	
司法理性	2001	0.54	2021	2022	

Figure 7: The Top 100 Emerging Terms and Their Evolution in China's Smart Justice Research

5.2 Analysis of Emerging Terms in China's Smart Justice

Research Frontier Emerging terms (Burst Terms) refer to words that suddenly have a higher frequency of occurrence in a specific period compared to before. Through the analysis of 209

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literature data, 100 emerging terms were obtained (see Figure 7), providing data support for analyzing China's smart justice research frontier and show the turning point of Chinese smart justice research.

6. Research Conclusion

Overall, domestic research on smart justice shows a trend of rapid development. With the development of intelligent technology and the importance attached to smart justice by national policies, the popularity of domestic smart justice research will continue to rise. [6]

From the co-occurrence map of authors and research institutions, it can be seen that a core group of authors for domestic smart justice research has not yet formed.

The co-occurrence and mutation of keywords show that legal experts have different hot topics in their focus on smart justice research and have different views on empowering various aspects of justice.

Based on keyword timeline maps and keyword emergence detection maps, this paper summarizes the temporal information and evolution process of domestic smart justice research development through silent period (2001-2015), transition period (2016-2017) and deepening period (2018-2022). This provides a useful reference for understanding the basic context of domestic smart justice research.

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