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Review

Artificial Intelligence and Information Processing: A Systematic Literature Review

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Abstract: This study aims to understand the development trends and research structure of articles on artificial intelligence (AI) and information processing in the past 10 years. In particular, this study analyzed 13,294 papers published from 2012 to 2021 in the Web of Science, used the bibliometric analysis method to visualize the data of the papers, and drew a scientific knowledge map. By exploring the development of mainstream journals, author and country rankings, keyword evolution, and research field rankings in the past 10 years, this study uncovered key trends affecting AI progress and information processing that provide insights and serve as an important reference for future AI research and information processing. The results revealed a gradual increase in publications over the past decade, with explosive growth after 2020. The most prolific researchers in this field were Xu, Z.S.; Pedrycz, W.; Herrera-Viedma, E.; the major contributing countries were China, the USA, and Spain. In the AI and information processing research, keywords including "Deep learning", "Machine learning", and "Feature extraction" are components that play a crucial role. Additionally, the most representative research areas were "Engineering", "Operations Research and Management Science", and "Automation Control Systems". Overall, this study used bibliometric analysis to provide an overview of the latest trends in artificial intelligence and information processing. Although AI and information processing have been applied to various research areas, many other sub-topics can be further applied. Based on the findings, this study presented research insights and proposed suggestions for future research directions on AI and information processing.

Keywords: artificial intelligence; information processing; literature review; bibliometric analysis

MSC: 68T01; 68T20; 97P80; 68T27

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1. Introduction

Artificial intelligence (AI) is a technology that mimics human intelligence and thought processes. The availability of significant hardware resources, along with the accessibility of big data, has provided a solid foundation for AI models [1]. As a result, AI research and application have entered a renaissance era, particularly with the development of machine learning technology, which has achieved a major breakthrough. Machine learning enables computers to automatically learn and improve from experience and is an important means of realizing AI [2,3]. Mathematical problems play an indispensable role in machine learning algorithms, such as linear regression [4,5], support vector machines, decision trees [6,7], random forests, deep learning [8–11], and scheduling [12], which involve various mathematical concepts, including optimization [13–15], matrix decomposition, probability theory [16,17], weight considerations [18–20], simulations [21–23], heuristics algorithms [24,25], and statistics [26–28].

AI and information processing are inextricably linked. For instance, in deep learning, training the network requires dealing with vast amounts of high-dimensional data and developing efficient optimization algorithms to solve these problems [29–31]. In natural language processing, novel machine learning algorithms must be designed to address issues such as the structure and semantics of text data. Thus, the development of information

processing is essential in promoting the continuous evolution of AI technology [32–36]. Through evaluations and analyses, this study could obtain the growth trends and mainstream publications in the field of AI and information processing and define scholars who have made significant contributions—along with their countries and organizations, as well as their collaborative networks—to understand the development trajectory and trends. In addition, it also explored various research fields, key issues, and future development directions, providing important references for subsequent research.

This study analyzed publications in the field of AI and information processing, utilizing a metadata dataset of papers published between 2012 and 2021, sourced from the Web of Science academic database. With a ten-year range, this study provided a reliable evaluation of the trends in the investigated subject. Further, this study made contributions to the literature on AI and information processing in the following ways: (1) a statistical analysis of filtered data to reveal the distribution of publications over time and across journals; (2) the identification of the most influential authors and organizations and social network analysis on mapping collaboration networks among them; (3) an affiliation analysis to uncover the countries that make the greatest contributions; (4) a keyword analysis, providing insights into the research topic; and (5) an analysis of research areas and applications, examining publication numbers in representative research areas by stage, identifying research gaps, and highlighting potential opportunities for further investigation. Based on the results of this study, AI and information processing researchers can have a comprehensive understanding of the development trend of AI and information processing and receive key directions for future research topics.

The paper is structured as follows. Section 2 briefly introduces the data collection and methods, while Section 3 details the research design process of the bibliometric analysis. In Section 4, the software, including UCINET 6.594 (Analytic Technologies: Harvard, MA, USA), Word Art 4.14.1 (Word Art, Saratoga, CA, USA), and Microsoft Excel 2016 (Microsoft Corp., Redmond, WA, USA), that were used to perform data collection, metadata analysis, author analysis, affiliation analysis, and keyword analysis and to track the evolution of AI and information processing, are described. This section also examines the research fields and applications of AI and information processing. Section 5 presents the study's findings and identifies research gaps in the field of AI and information processing. Finally, Section 6 lays down the study's conclusion with a discussion of key takeaways and suggestions for future research in the field.

2. Data Collection and Methods

This study used the specific search terms in the Web of Science database to identify the published articles that related to AI and information processing. In this study, the WOS database was chosen because of its reputation for stringent peer review processes and its inclusion of high-impact and well-recognized journals across diverse disciplines. The search was limited to articles published between 2012 and 2021, focusing on article titles, abstracts, author keywords, and Keywords Plus. The screening process was conducted independently by two authors to ensure reliability, and any inconsistencies were resolved through mutual agreement. Then, the study employed a quantitative systematic literature review method to analyze the collected data.

A literature review aims to evaluate and analyze the current literature on a specific field of knowledge to provide valuable insights to researchers and professionals and determine potential research gaps. Fahimnia et al. [37] used literature network analysis to statistically analyze and evaluate the literature on green supply chain management to understand the research focus, hotspots, and trends in the field. At the same time, they conducted a comprehensive evaluation and analysis of the literature to identify the existing research gaps and shortcomings and provide direction and suggestions for future research. The requisite textual data extracted from the title, abstract, and keywords were valuable and representative. Nita et al. [38] conducted a study on the biodiversity hotspots of grasslands in Romania as an example and collected, classified, and analyzed relevant

literature. They extracted data from the title, abstract, and keywords of these articles and evaluated and analyzed the value and representativeness of these textual data, providing useful information for future research. Maditati et al. [39] suggest that various methods such as bibliometric analysis, meta-analysis, content analysis, and systematic literature review can be employed to aid in completing a literature review. The study was conducted on green supply chain management using bibliometric analysis to identify research trends and knowledge gaps in the field. Therefore, their study is a good example of how different approaches can be combined to conduct a comprehensive literature review. Inspired by these studies, this paper proposes a method for bibliometric analysis of previous research progress on AI and information processing.

Bibliometric analysis is a powerful method for quantitatively assessing the influence of published papers and generating novel research ideas through statistical analysis of their bibliographic information and citations. This approach can generate comprehensive and objective results, efficiently process vast datasets, and present visually compelling analysis outputs [40]. Therefore, this study employed bibliometric analysis to conduct a review of articles on artificial intelligence and information processing using line charts, horizontal bar graphs, social network diagrams, word clouds [41], timeline diagrams, and pie charts. These techniques are akin to data visualization. They identify popular objects to form simple and easily comprehensible information landscapes.

3. Proposed Design

In recent years, the field of AI has gained significant attention both in academia and the technology industry. As one of the fundamental subjects, information processing plays a pivotal role in the development and applications of AI. Research on AI and information processing is becoming increasingly important in academia, with topics such as deep learning, statistics, and optimization algorithms receiving greater focus. Therefore, this study aimed to conduct bibliometric analysis by collecting and analyzing research literature and citation data related to AI and information processing over the past decade. The proposed method utilized statistical metadata analysis and author analysis methods to gain insights into the growth trends, mainstream journals, and top contributing authors in the field. Affiliation analysis was used to identify the countries with the highest contributions and collaborative networks. Additionally, keyword analysis was used to explore the evolution of AI and information processing topics, while research area and application analysis helped identify the most representative research areas and their respective publication numbers. This analysis will help explore the development trends and application requirements of AI and information processing in the future and guide researchers toward the key development directions of AI and information processing. Finally, this research provides a crucial reference and guidance in promoting theoretical research and innovative applications of AI and information processing.

The implementation steps of the proposed method, shown in Figure 1, are as follows:

Step 1: Keyword definition and data collection

This study determined the selection of papers on artificial intelligence and information processing.

Step 2: Metadata statistical analysis

A statistical metadata analysis was performed to provide a synopsis of the distribution of publications across journals and time periods to observe growth trends in the last 10 years and the development of mainstream journals.

Step 3: Author analysis

The most contributing authors were listed, including name, country, organization, publication quantity, and total citations. Their collaborative networks were illustrated by a social network diagram.

Step 4: Affiliation analysis

The countries with the highest contributions were identified. An examination of the authors' collaborative networks established between countries and organizations was illustrated.

Step 5: Keyword analysis

A keyword co-occurrence analysis determines the commonly used keywords in research studies that center on AI and information processing. It can investigate the keywords of the included articles and explore the topic of evolution. This study presented the topic evolvement of each stage by a word cloud and further analyzed the keywords with the strongest citation bursts by a timeline diagram for each year.

Step 6: Research areas and applications analysis

An analysis of selected articles was performed to identify the most representative applications of research areas. Then, the publication number in representative research areas for each stage was analyzed.

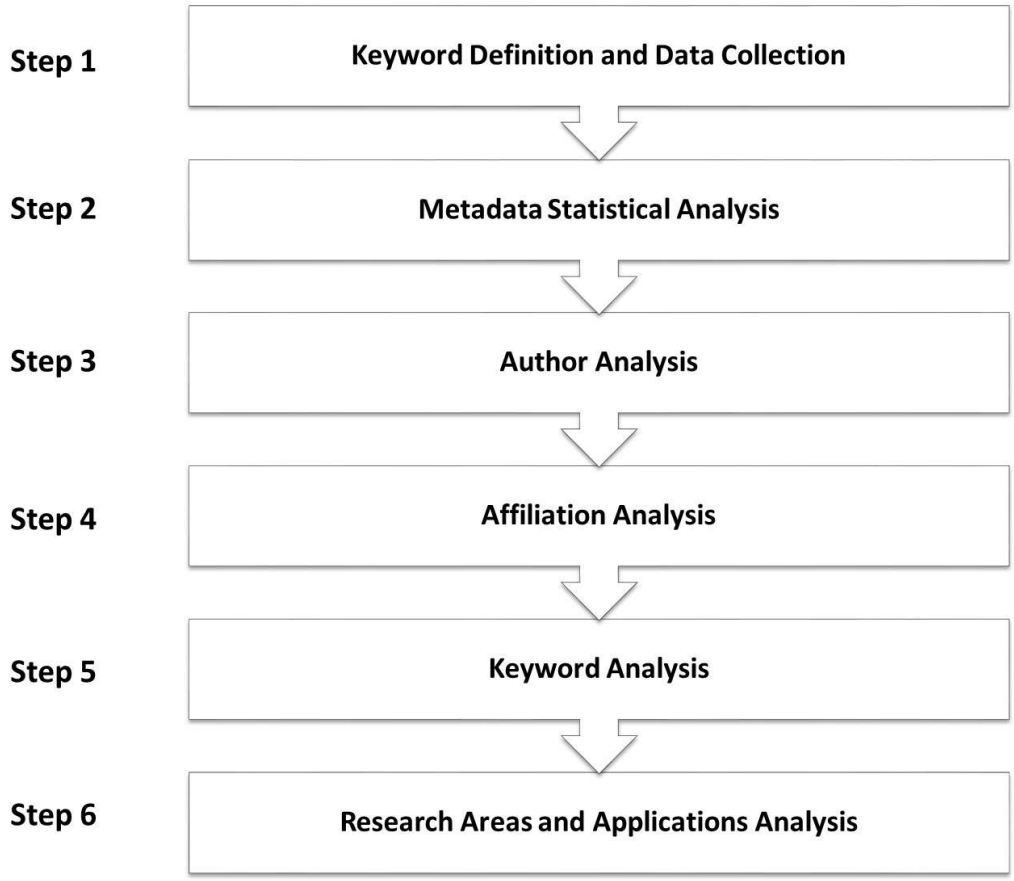

Figure 1. Flowchart of the research design.

4. Analysis Results

4.1. Keyword Definition and Data Collection

As far as previous literature on AI and information processing is concerned, using the large-scale search terms of the secondary keyword structure can comprehensively and reliably obtain published articles. The defined keywords were put into the Web of Science database, and the following constraints were set: (1) the keywords further narrowed the search scope "Web of Science Categories" and "article title, abstract, author keywords, and Keywords Plus" were used; (2) the time period for publication year was from 2012 to 2021—the search results were 14,411 items. Next, the titles and abstracts of the selected articles were reviewed to exclude irrelevant articles. To guarantee the

consistency and credibility of the process for selecting articles, the screening procedure for articles was conducted independently by two authors involved in this study. The two authors independently reviewed the literature and evaluated the identified articles based on predetermined criteria. Each author conducted preliminary screening based on their own judgment. Subsequently, the authors combined their results and compared their selection lists, merging any discrepancies. Finally, they cross-checked their results to achieve mutual consensus and resolved any remaining inconsistencies at this stage. Finally, 13,294 papers were deemed to fit the theme of this study.

4.2. Metadata Statistical Analysis

To gain an in-depth understanding of the research trends and development directions in the field of AI and information processing, this study conducted a statistical analysis on the number of papers published each year and the development trends of mainstream journals to determine the research activity and growth and understand the influential and widely recognized journals. Figure 2 shows the number of papers published each year from 2012–2021. It can be seen that the number of papers published from 2012–2021 showed a slow growth trend, while explosive growth occurred in 2020. Furthermore, out of all the papers available online, 5974 were published within the past three years, which accounts for 45% of the total. This finding indicates that the research subject has recently garnered growing attention among scholars. In addition, a total of 152 journals have contributed the selected publications of the theme. Figure 3 shows the 10 journals with the most published papers. *EXPERT SYSTEMS WITH APPLICATIONS* ranks first in this field with 894 papers, followed by *NEUROCOMPUTING* with 827 articles, *JOURNAL OF INTELLIGENT* and *FUZZY SYSTEMS* with 628 articles, *KNOWLEDGE-BASED SYSTEMS* with 574 articles, *APPLIED SOFT COMPUTING* with 522 articles, and the other journals with less than 500 articles.

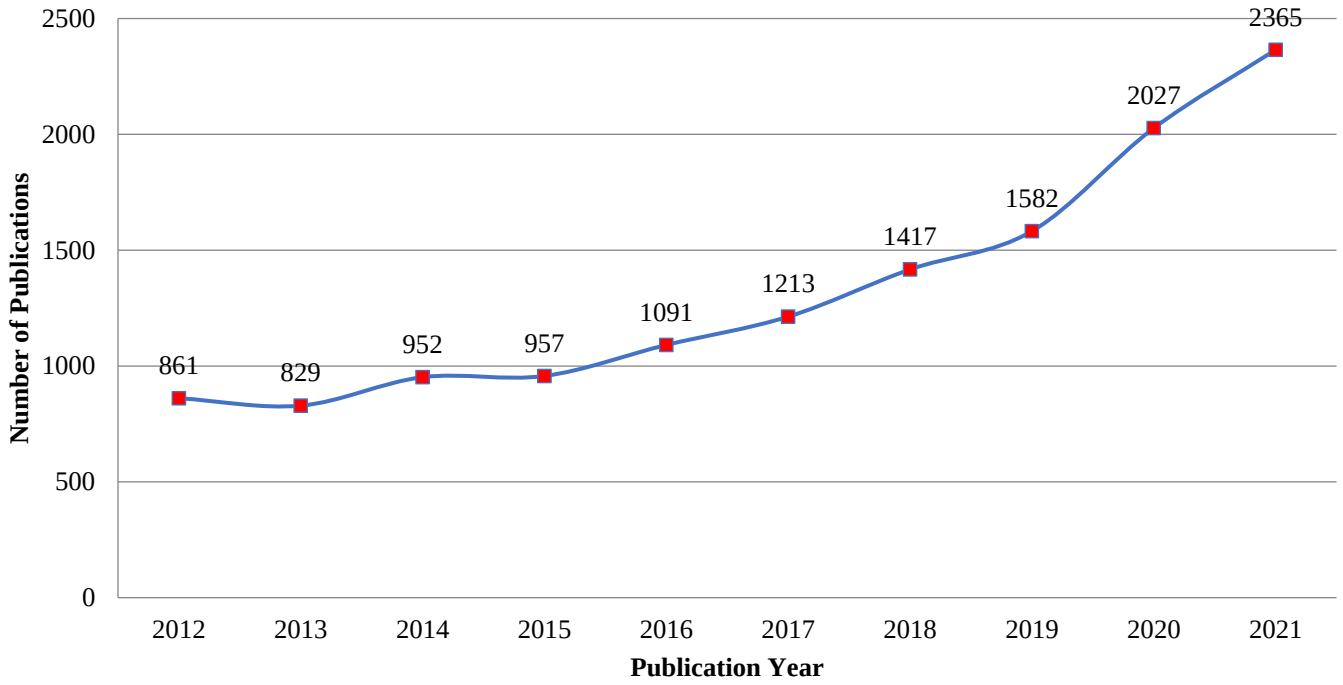

Figure 2. The distribution of publications by year.

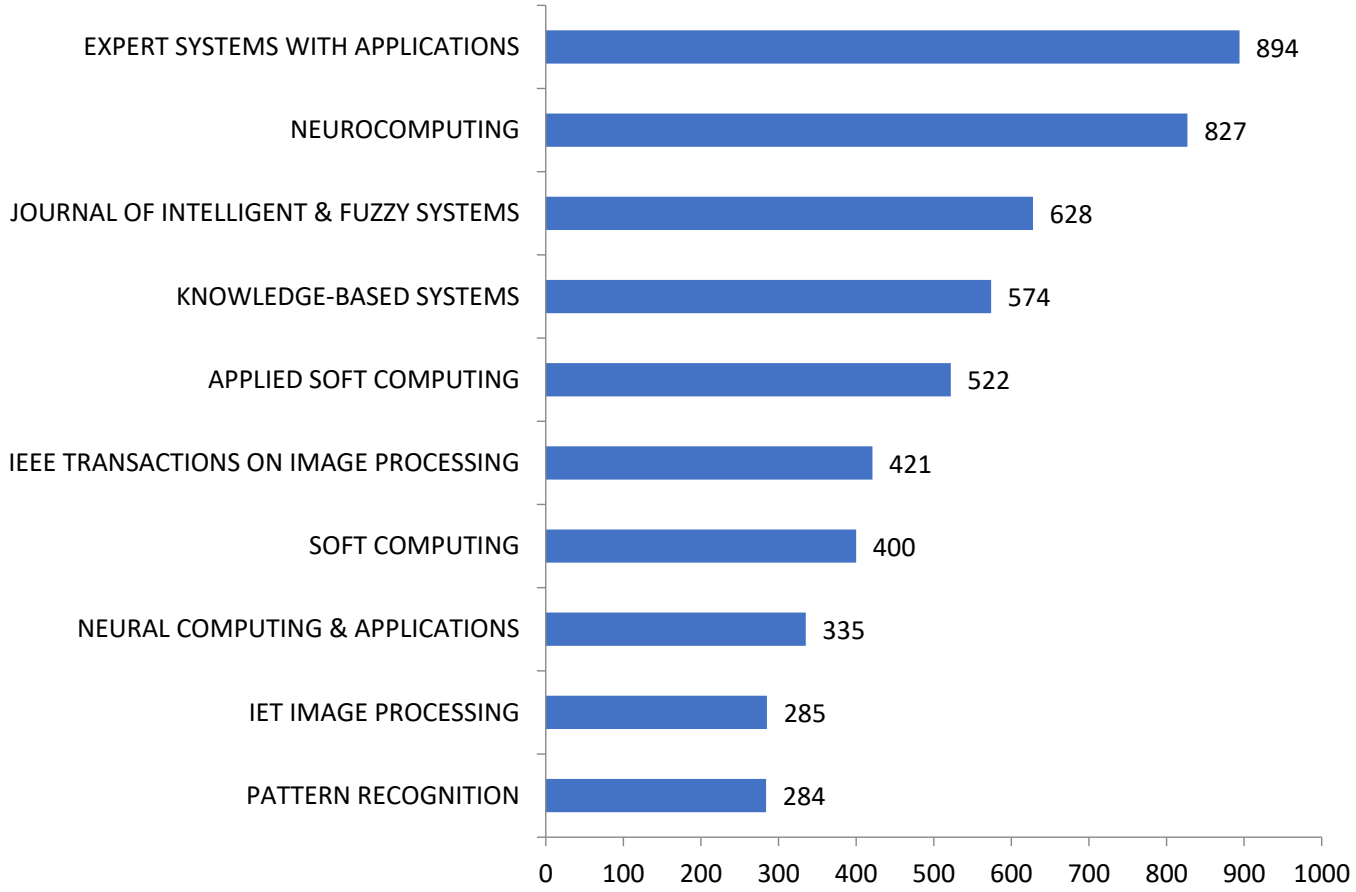

Figure 3. The distribution of publications by journals.

4.3. Author Analysis

Author analysis can help researchers discover scholars who have made great contributions to promoting the field of AI and information processing and identify research hotspots in this field in different countries or organizations. Table 1 displays the top ten authors who have made significant contributions in terms of country, organization, the number of publications, and the number of total citations. Xu, Z.S. and Pedrycz, W. are the most prolific authors with 103 papers; the authors on this list have published more than 100 papers in the field. In terms of total citations, Xu, Z.S. has the most with 5177 citations, dominating the list. Pedrycz, W. has been cited 4621 times. Herrera-Viedma, E., Martinez, L., and Dong, Y.C. have been cited more than 2000 times, while the other authors have been cited less than 2000 times.

Table 1. The top ten contributing authors.

No.	Authors	Country	Organization	Publication Quantity	Total Citations
1	Xu, Z.S.	China	Sichuan University	103	5177
2	Pedrycz, W.	Canada	University of Alberta	103	4621
3	Herrera-Viedma, E.	Spain	University of Granada	40	2344
4	Martinez, L.	Spain	University of Jaén	39	2208
5	Fujita, H.	Japan	Iwate Prefectural University	34	1759
6	Garg, H.	India	Thapar Inst of Engn and Technol	32	1543
7	Liu, P.D.	China	Shandong University of Finance and Econ	32	1324
8	Herrera, F.	Spain	University of Granada	31	1976
9	Dong, Y.C.	China	Sichuan University	29	2068
10	Jiao, L.C.	China	Xidian University	28	1495

As many studies are completed by different authors or teams, drawing collaborative networks among authors can show the frequency of collaboration between authors and categorize authors or teams into different groups based on their co-operative relationships, facilitating the understanding of the distribution and interactions of research ecology. Additionally, collaborative networks can identify key players in the fields of AI and information processing. They also show which collaborations between authors can promote further research development. The main collaborative networks among the top ten contributing authors are depicted in Figure 4. Different line thicknesses represent the frequency of collaboration between two authors, and thicker lines and larger numbers indicate more frequent collaboration between the authors. The color and shape of each node represent different groups. As shown in Figure 4, eight primary collaboration groups were identified. Group 1 (red) is hosted by Xu, Z.S. In this group, Xu, Z.S has collaborated with Liao, H.C. fifteen times; Gou, X.J. and Wang, H. eleven times. It shows that Xu, Z.S. has a stronger link with the above authors and a higher frequency of collaborative publication. Group 1 mainly focuses on topics such as multi-attribute decision making, hesitant fuzzy preference relations, consensus-reaching processes, and nonlinear programming models. Their research areas include computer science [42–48], operations research management science [49,50], and engineering [51,52].

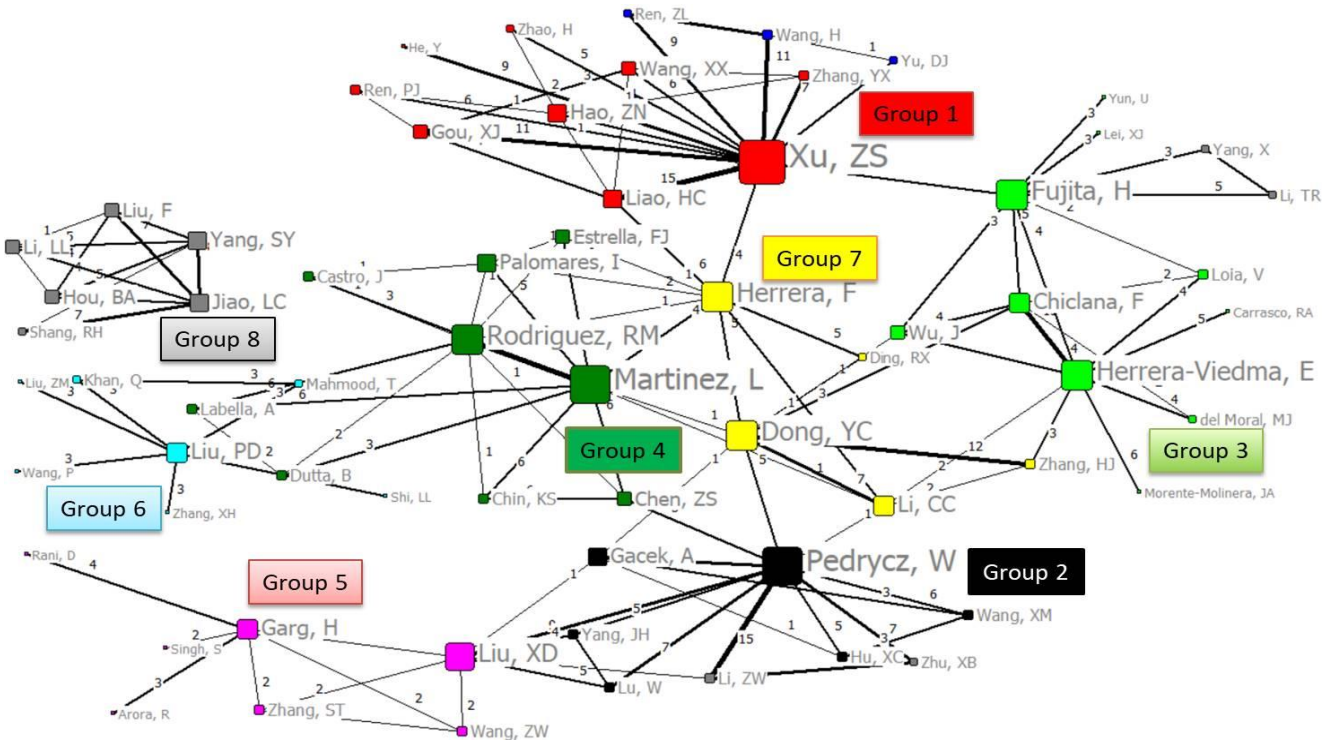

Figure 4. Main collaborative networks among authors.

Group 2 (black) is dominated by Pedrycz, W., who has collaborated with Li, Z.W. fifteen times, and is a crucial partner. Group 2 discusses fuzzy clustering [53], granular computing [54], information granularity [55,56], spatiotemporal data [57], and optimization [58]. The research area is focused on developing and optimizing algorithms for processing and analyzing large amounts of data with high accuracy and efficiency.

Group 3 (green) is co-led by Herrera-Viedma, E. and Fujita, H. Chiclana, F. plays the role of bridge between the authors and is an important betweenness centrality within the group. The research topics of Group 3 are group decision making, uncertainty, incomplete information, linguistic modeling, fuzzy set theory, and consensus measures, which belong to the research areas of computer science [59–61], engineering [62], and operations research management science [63].

Group 4 (dark green) is dominated by Martinez, L., who has collaborated with Rodriguez, R.M. fourteen times, and they have a strong co-operative relationship. Group 4 focuses on topics such as linguistics [64], consensus-reaching processes [65], group decision making [66,67], and computing [68,69]. Group 5 (pink) and Group 6 (blue) are hosted by Garg, H. and Liu, X.D., respectively. They collaborate relatively infrequently with other authors. The topics discussed include fuzzy set aggregation operators [70], emergency decision making [71], medical diagnosis [72], and data clustering [73–75]. Group 7 (yellow) is composed of Herrera, F. and Dong, Y.C. They play the role of betweenness centrality and co-operate with Group 1, Group 2, Group 3, and Group 4. They mainly discuss the feedback mechanism for reaching consensus in group decision making [76], personalized individual semantic analysis [77], consensus models and consensus-driven decision-making methods [78], and measurement and analysis methods for data complexity and overlapping issues [79,80]. Finally, Group 8 (gray) is an independent co-authored clique formed by Jiao, L.C. He and Yang, S.Y., Liu, F., Hou, B.A. and Li, L.L. are highly connected to each other. Their research areas include computer science [81–83], automation and control systems [84], engineering [85], science and technology, operations research management science, neurosciences and neurology, and telecommunications.

4.4. Affiliation Analysis

Affiliation analysis can assist researchers in understanding the global trends in AI and information processing and uncovering the dominant countries and organizations. The research achievements of the top contributing countries and organizations usually receive more attention and have a significant impact on the development of AI and information processing. Tables 2 and 3 list the top ten countries and organizations which have made significant contributions in terms of the number of published papers. The countries are China with 5631 articles, the USA with 1792 articles, Spain with 1032 articles, India with 1008 articles, and the other countries with less than 1000 articles; among them, China is at a leading position. In addition, Figure 5 is a relational network composed of countries and organizations to which the corresponding authors are affiliated, represented by blue and red nodes, respectively. From a macro perspective, the top ten contributing countries have numerous affiliated organizations that contribute to the number of publications. For instance, the number of publications from China depends largely on the Chinese Academy of Sciences, while in Spain, the University of Granada is a significant contributor. Similarly, the University of Technology Sydney in Australia, Centre National de la Recherche Scientifique (CNRS) and UDI-CE-French Research Universities in France, University of Alberta in Canada, and Consiglio Nazionale delle Ricerche (CNR) in Italy all have a significant impact on the number of papers published. In contrast, the number of papers published by affiliated organizations in other countries is more evenly distributed.

Table 2. Top ten contributing countries.

No.	Country	Publication Number	No.	Country	Publication Number
1	China	5631	6	Australia	557
2	USA	1792	7	France	538
3	Spain	1032	8	Canada	522
4	India	1008	9	Italy	499
5	England	851	10	Germany	481

Table 3. Top ten contributing organizations per country.

Country No.	China	USA	Spain	India	England
1	Chinese Academy of Sciences	University of California System	University of Granada	Indian Institute of Technology System	University of London
2	Sichuan University	University of Texas System	Universitat Politecnica de Valencia	National Institute of Technology	Imperial College London
3	Xidian University	University System of Georgia	Universidad de Jaén	Vellore Institute of Technology	University of Manchester
4	Zhejiang University	State University System of Florida	Universidad Politecnica de Madrid	Thapar Institute of Engineering and Technology	De Montfort University
5	University of Electronic Science and Technology of China	Georgia Institute of Technology	University of Seville	Anna University	University of Oxford
6	Xi'an Jiaotong University	State University of New York System	University of the Basque Country	Indian Statistical Institute	University College London
7	Tsinghua University	University of Illinois System	Universidad de Malaga	VIT Vellore	University of Nottingham
8	Harbin Institute of Technology	Carnegie Mellon University	Universidad Carlos III de Madrid	Anna University Chennai	University of Sheffield
9	Northwestern Polytechnical University	Massachusetts Institute of Technology (MIT)	Universitat Politecnica de Catalunya	Indian Statistical Institute Kolkata	University of Granada
10	Huazhong University of Science and Technology	Pennsylvania Commonwealth System of Higher Education	Universitat d'Alacant	Shanmugha Arts, Science, Technology and Research Academy	University of Southampton
Country No.	**Australia**	**France**	**Canada**	**Italy**	**Germany**
1	University of Technology Sydney	Centre National de la Recherche Scientifique (CNRS)	University of Alberta	Consiglio Nazionale delle Ricerche (CNR)	Technical University of Munich
2	University of Sydney	UDICE—French Research Universities	Concordia University—Canada	University of Salerno	Helmholtz Association
3	University of New South Wales Sydney	Université Paris-Saclay	Université de Montreal	Sapienza University Rome	University of Erlangen Nuremberg
4	Queensland University of Technology (QUT)	Université de Toulouse	University of Waterloo	University of Trento	Max Planck Society
5	Monash University	Institut Mines- Télécom (IMT)	University of British Columbia	University of Naples Federico II	Ruprecht Karls University Heidelberg
6	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Sorbonne Université	University of Toronto	University of Padua	Karlsruhe Institute of Technology
7	University of Queensland	INRAE	University of Calgary	University of Bologna	Technical University of Darmstadt
8	Deakin University	Université de Rennes	Toronto Metropolitan University	University of Pisa	Leipzig University
9	Chinese Academy of Sciences	Université de Lorraine	University of Quebec	Polytechnic University of Milan	Ulm University
10	University of Adelaide	Centre National de la Recherche Scientifique (CNRS)	Western University (University of Western Ontario)	Polytechnic University of Turin	University of Munich

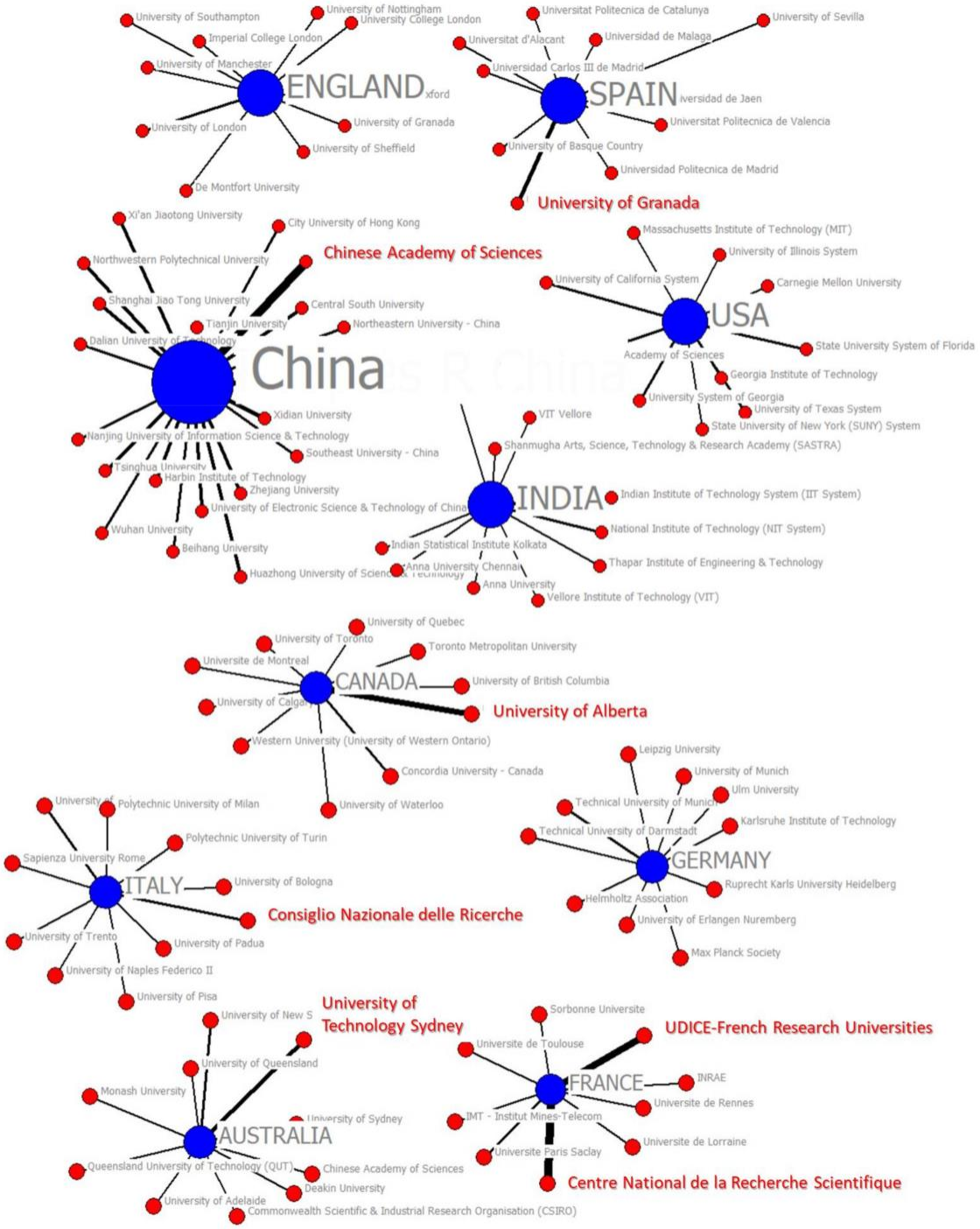

Figure 5. The main contributing networks among countries and organizations.

4.5. Keyword Analysis

Keywords are condensed and important indicators of the core content of a paper, which can fully represent its research topic. Frequency information of keywords can show the key characteristics of researchers in this field when they use a certain keyword to discuss issues. By measuring the frequency information of keywords that appear in large numbers, we can understand the topics and research directions most researchers in this field are concerned about. The entire intellectual landscape of co-occurring keywords within the studied field is illustrated in Figure 6. It displays the keywords of research topics in the past 10 years in the form of a word cloud. This is an intuitive data overview that describes frequently occurring keywords in the text, with font sizes proportional to the frequency of

their occurrences. This figure shows that "Deep learning", "Machine learning", "Feature extraction", "Natural language processing", and "Classification" are the keywords taking notable positions. Furthermore, it is observed that "Neural network", "Optimization", "Big data", "Fuzzy", and "Decision making" are the more commonly discussed theories and techniques. The keywords "Image", "Data", "Design", "Management", and "Decision" represent different application areas.

Figure 6. Co-occurring keywords.

Further, to enable researchers to understand the development trajectory and trends of the topic of AI and information processing and gain insight into the research focus in various periods, this study adopted two years as the benchmark and divided it into five stages, which were used to display the keywords related to the research on AI and information processing in each stage, as shown in Figure 7. Among them, the top three keywords with high word frequency in each stage are as follows: in the first stage (2012–2013), they are "Classification", "Ontology", and "Data mining"; in the second stage (2014–2015), they are "Data mining", "Classification", and "Ontology"; in the third stage (2016–2017), they are "Natural language processing", "Machine learning", and "Feature selection". Observing the number of occurrences of keywords with high word frequency in the third stage, the font size of the word cloud seems to be relatively average. Keywords in the fourth stage (2018–2019) were replaced by "Deep learning" as the most high-frequency keyword, followed by "Machine learning" and "Feature extraction". In the fifth stage (2020–2021), "Deep learning" was still the primary keyword, followed by "Feature extraction" and "Machine learning". According to the analysis results, among the research topics related to AI and information processing, between 2012 and 2021, the topic of "Natural language processing" continued to arouse discussions in the academic community. Noteworthily, the research topics of "Classification" and "Data mining" received more attention from the academic community between 2012 and 2015. The research topic of "Machine learning" was often discussed between 2016 and 2021. The research topic of "Data mining" was continuously researched between 2012 and 2017, but after 2018, "Data mining" was ignored due to the rise of emerging topics such as "Deep learning", "Feature extraction", and "Image segmentation", while the degree of discussion declined. Between 2018 and 2021,

the research topics of "Deep learning" and "Feature extraction" grew explosively and have been highly discussed in recent years.

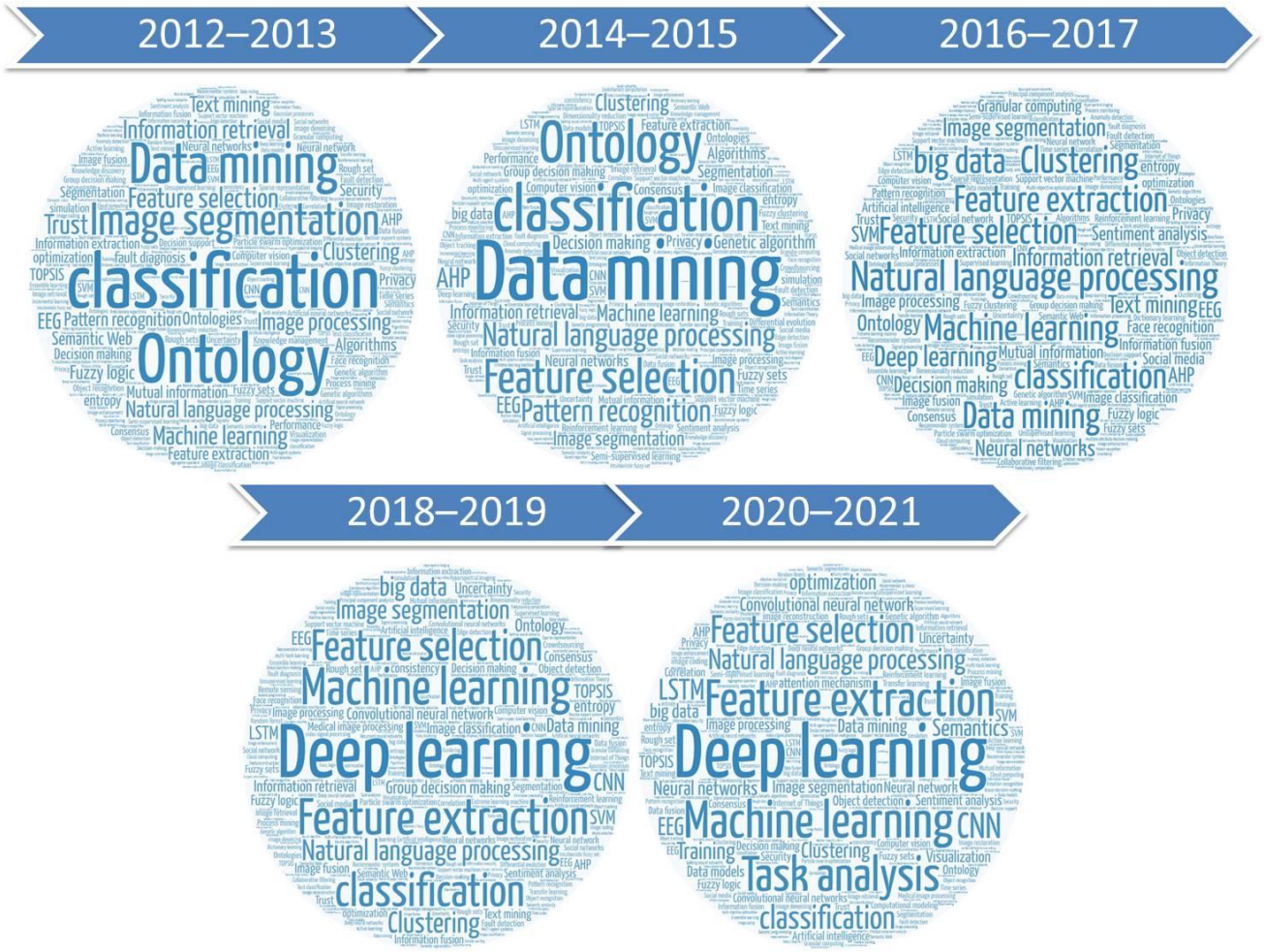

Figure 7. Timeline analysis of co-occurring keywords.

Figure 8 shows the ten most cited keywords from 2012 to 2021, their relative frequency represented by the percentage, and their active years indicated by the red line. It can be seen from Figure 8 that the keyword "Natural language processing" has the longest burst time and "Deep learning" has the highest relative frequency. The keyword "Classification" was active between 2012 and 2018, when discussing topics such as feature selection and extraction, interpretability, imbalance issues, and incremental and online learning. "Deep learning" and "Feature extraction" emerged as important research topics in the past four years. "Deep learning" was focused on the structure and optimization of deep neural networks and their applications in various domains, while "Feature extraction" was used to discuss issues related to representation methods, domain adaptation, and unsupervised learning. The use of the keyword "Feature selection" increased dramatically in 2016 and declined after 2019, reflecting the interest in developing analytical techniques for AI and information processing. The keyword "Image segmentation" was widely used in 2021, reflecting the application of AI in various practical cases, such as medical image segmentation, image processing and analysis, visual effects, and computer vision. The discussion of the keyword "Data mining" matured between 2012 and 2016 and has been replaced by emerging topics.

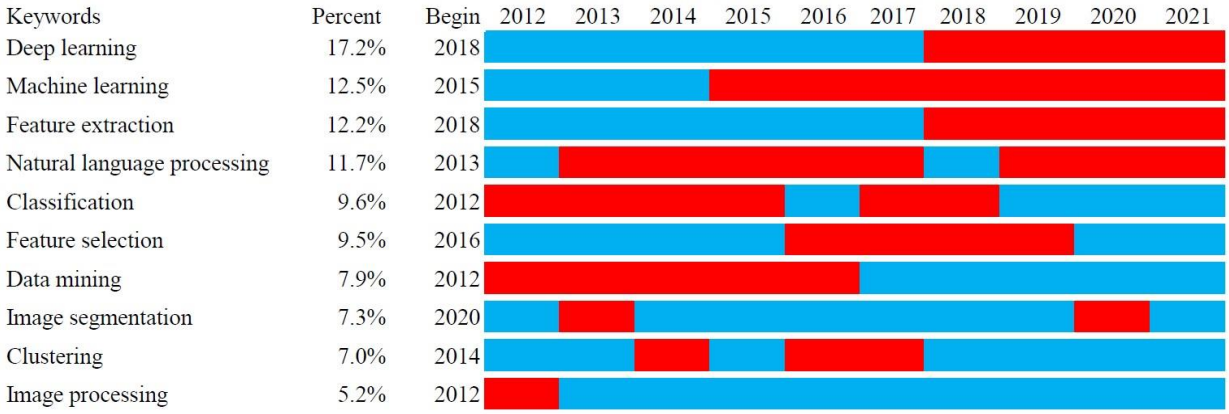

Figure 8. The most cited keywords (red line).

4.6. Research Areas and Applications Analysis

Through a comprehensive analysis of research areas and applications, this study presented a systematic overview of the advancements made in the field of AI and information processing. This overview provides researchers with a clear understanding of the various research areas, critical issues, and future directions for development. Previous research on the advancement of AI and information processing has been widely explored in engineering, operations research and management science, automation control systems, neurosciences and neurology, imaging science and photographic technology, mathematics, telecommunications, robotics, chemistry, and instruments and instrumentation. Notably, publications from these research areas have heavily increased in the past ten years, with engineering, in particular, having the highest number of publications, indicating that AI and information processing is an important applied technique. Figure 9 provides the main representative research areas.

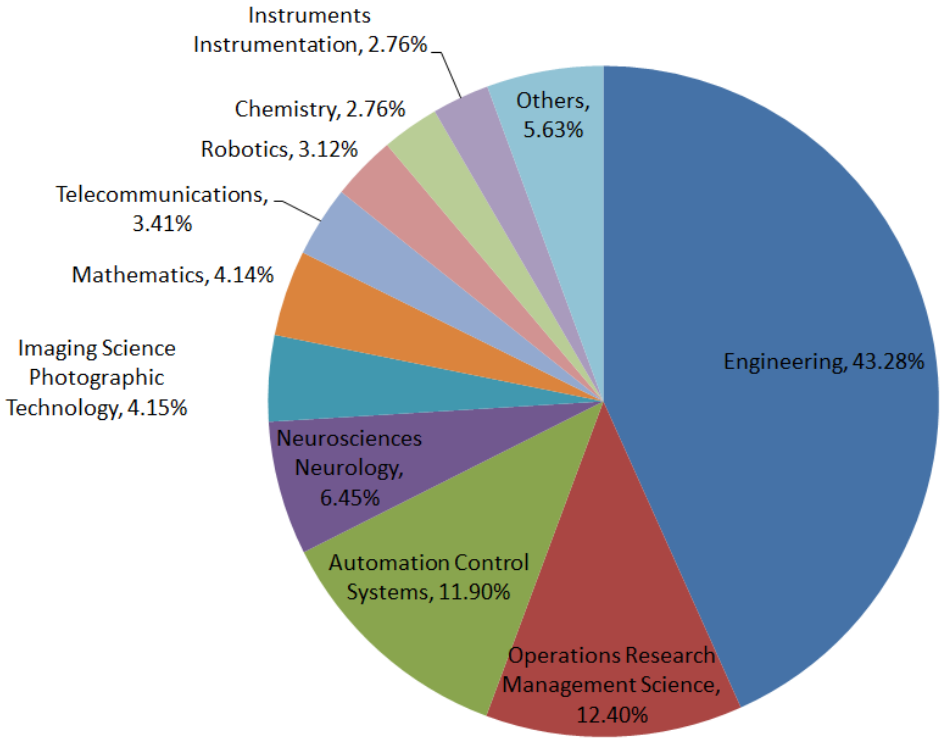

Figure 9. Publication number in representative research areas.

Furthermore, this study explores the representative applications in the present research areas. Table 4 displays the representative applications in the ten areas. (1) In the Engineering area, information processing, systems, decision support, computer engineering, knowledge management, control systems, manufacturing, and sensors are widely studied and implemented. (2) Meanwhile, in the Operations Research and Management Science area, decision-making techniques assist enterprises in making informed decisions in complex operational environments. Fuzzy arithmetic methods handle fuzzy and uncertain data. Project management techniques improve project efficiency and success rates. Classification methods categorize and analyze different types of data, and quality control measures are implemented to ensure product and service quality. Big data techniques process large datasets, and supply chain management methods optimize supply chain processes to achieve efficient logistics and operational management. (3) Regarding the Automation Control Systems area, researchers utilize advanced technologies and methods such as fuzzy methods, robotics, smart sensors, etc. to implement automation control system applications in different fields such as process control, environmental monitoring, manufacturing, energy management, and Industry 4.0. The findings contribute to improving efficiency in production and manufacturing processes and promoting the application and development of automation control systems. (4) In the Neurosciences and Neurology area, researchers explore advanced technologies and methods such as cognitive architecture, neurorobotics, EEG, and emotion research to study and apply neuroscience and neurology in related fields. These studies contribute to a better understanding of brain function and related functionalities in the fields of neuroscience and neurology, with potential applications in clinical medicine, brain–computer interfaces, and cognitive science. (5) In the Imaging Science and Photographic Technology area, medical imaging plays a crucial role in developing imaging tools for medical diagnosis and treatment. Image classification methods automatically analyze and process images, while geophysical imaging detects underground resources and is used to conduct earthquake research. These studies contribute to the advancement of various application fields in imaging science and photographic technology, including medicine, Earth science, remote sensing, UAV systems [86], and super-resolution [87]. (6) Researchers in the Mathematics area apply various approaches to explore and apply mathematical techniques. These approaches describe and analyze the behavior of complex systems, process and analyze large datasets, solve real-world problems through optimization, develop soft sensors for measurements, and address uncertainties and ambiguities using fuzzy set theory. (7) Telecommunications has been an emerging research area in recent years. It mainly discusses mobile communication (such as 5G, 6G, and the Internet of Things) and wireless networks (such as network traffic control, packets, and antennae). (8) Researchers in the Robotics area focus on developing robotic systems that can operate autonomously, automate various tasks, and provide services in diverse areas such as healthcare, logistics, manufacturing, and transportation. (9) In the Chemistry area, through the development of innovative monitoring methods and optimization algorithms, researchers aim to enhance the performance of chemical processes, reduce costs, and minimize environmental impact. (10) The Instruments and Instrumentation area involves the development of techniques and methodologies for detecting faults or anomalies in instruments, systems, or processes. Autoencoders, which are a type of artificial neural network, are used for data compression and reconstruction tasks and have applications in signal processing, data analysis, and anomaly detection.

Table 4. Representative applications of research areas.

Research Areas	Applications
Engineering	Information process Systems Decision support Computer engineering Knowledge management Control systems Manufacturing Sensors
Operations Research and Management Science	Decision making Fuzzy arithmetic Project management Classification Quality control Big data Supply chain management
Automation Control Systems	Process control Fuzzy approach Robotics Environmental monitoring Manufacturing Smart sensors Energy management Industry 4.0
Neurosciences and Neurology	Cognitive architecture Neurorobots Electroencephalography Emotion
Imaging Science and Photographic Technology	Medical imaging Image classification Geophysical imaging
Mathematics	Systems modeling Data science Optimization Soft sensors Fuzzy sets
Telecommunications	Mobile computing Internet of Things Wireless sensor networks
Robotics	Autonomous Automatization Service robotics
Chemistry	Chemical process monitoring Operational optimization
Instruments and Instrumentation	Fault detection Autoencoders

5. Discussion of Gaps and Opportunities

The development of AI and information processing is an interesting topic for research and academics. The emerging areas of AI and information processing in practice show the development of software and data science. The findings of this study have identified the most publishing journals and the explosive growth period. In particular, these findings found that the publications fall into computing, software, systems, and intelligence journals. Our works have also determined information pertinent to the publication journals that AI

and information processing researchers can use for paper acquisition and publication. The papers on AI and information processing domains are well documented for methodology, records, and experiment data.

The scholarly analysis shows in which countries the authors or groups of authors work together on their publications. A supportive network of close authors allows them to share documents and experiences in AI and information processing research. This mechanism brings the advantages of extensive research into AI and information processing topics and other subjects. It also helps bring about a complete revision of the papers. The author analysis conducted in this study also provided information about the authors' organizations and research interests (e.g., the topics of decision making and fuzzy sets). This finding implies a strong network of scholars in this field.

This paper analyzes the contribution of countries and institutions to AI and information processing publications. Scholars shape the research paths in Asia, Europe, and America. Countries in these regions have made a major contribution to academia and the industry pertinent to AI and information processing. The findings show that institutions and scholars are vital in supporting the use and development of AI and information processing technology. The key experts in China, the USA, and Spain are much involved in AI and information processing research. Their research outcomes have a significant influence on shaping policy for AI and information processing development and application. These contributions show the change and development in economics and society.

In terms of keyword analyses, the findings determined the main keywords related to the field of AI and information processing in the time period between 2012 and 2021. Notably, the study found that new keywords are used over time. The keyword analyses also show increasing and decreasing trends in five-stage periods. The connectivity among keywords during the analysis periods is varied. The relations between AI and information processing, algorithms, neural networks, programming, learning, computation, and mathematics are fortified. It can be seen that the central value of AI and information processing lies in the technologies that help develop AI and information processing applications. According to keyword co-occurrence timeline analyses, the latest technologies are related to deep learning, machine learning, and feature extraction. These keywords show the highest value and are expected to play an important role in the field of AI and information processing in the near future.

Some key research areas apply AI and information processing, and several research groups have been working in computer science and engineering relevant to AI and information processing. This development also occurs in the telecommunications and mathematics areas. More generally, the research areas pertinent to AI and information processing have contributed to wide and practical applications to make things work. Some typical applications include power systems, medicine, robots, decision support, communication, environmental protection, and vehicle routing. It can be seen that the application of AI and information processing in service sectors is still scarce. Moreover, AI applications in human life are vital, where there is enormous potential. From looking over published papers in this area, it can be seen that the extant published papers are still technology oriented. Hence, it is important to strike a proper balance between the development and application of AI and information processing in various sectors.

6. Conclusions

In recent years, the applications of AI and information processing have become increasingly extensive, encompassing fields such as electric vehicles, the AlphaGo Go software, robots, smart homes, and intelligent monitoring systems. Machine learning and deep learning are the core technologies that underpin these applications. To implement these technologies, vast amounts of data, algorithms, and information processing technologies, such as cloud computing and big data analyses, are necessary components in AI systems. Information processing plays a crucial role in the realization of AI because information

processing forms the foundation of AI. As information processing technology continues to evolve, so does the potential of AI technology.

This paper provides a comprehensive and systematic review of 13,294 journal papers that focus on the topic of artificial intelligence and information processing, published from 2012 to 2021. Furthermore, this study uncovered key trends affecting AI and information processing progress by exploring the development of mainstream journals, author and country rankings, keyword evolution, and research field rankings in the past 10 years. Based on the analyses, we drew the following conclusions. (1) The statistical metadata analysis indicated a growing trend of publications on AI and information processing issues in mainstream journals over the past decade. (2) The author analysis revealed that Xu, Z.S. is the most prolific and cited researcher in this area, with the top ten contributing authors divided into eight collaborative networks. (3) The affiliation analysis identified China as the major contributor. (4) The keyword analysis highlighted the most commonly discussed theories and techniques, with "Deep learning" being frequently used, while "Deep learning" and "Feature extraction" were emerging research topics in recent years. (5) The research area and application analysis showed that Engineering was the main representative research area, with a wide range of applications.

This paper is a comprehensive summary and analysis of published papers on AI and information processing, offering valuable insights into current trends. Furthermore, it provides an important reference for researchers seeking to explore and expand upon the existing body of knowledge in AI and information processing, potentially leading to more robust approaches to prediction and management. By facilitating a better understanding of specific research needs, this paper has the potential to inspire innovative AI and information processing methods and algorithms, benefiting both researchers and practitioners in the field of AI and information processing. Overall, this paper makes a significant contribution to the advancement of AI and information processing studies and development.

Integrating AI and information processing is a promising potential and challenging area of research. Future research in this field can focus on applying machine learning, deep learning, and other statistical methods to solve complex information processing, such as optimization, neural networks, and mathematical modeling. By leveraging the immense computing power of AI, researchers can develop more efficient algorithms and expand the practical applications of mathematics. In addition, researchers can explore how AI and information processing can enhance the efficiency and accuracy of existing software and tools and provide more support and assistance to various industries. This investigation could lead to novel innovations and groundbreaking discoveries in the field. Moreover, there is an opportunity to explore the practical applications of AI and information processing in areas such as service and education, where its potential is waiting to be fully realized.

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References

1. Zhang, S.; Yao, L.; Sun, A.; Tay, Y. Deep learning based recommender system: A survey and new perspectives. *ACM. Comput. Surv.* **2019**, *52*, 1–38. [CrossRef]
2. Mushtaq, S.; Islam, M.M.; Sohaib, M. Deep learning aided data-driven fault diagnosis of rotatory machine: A comprehensive review. *Energies* **2021**, *14*, 5150. [CrossRef]

3. Li, G.; Xie, S.; Wang, B.; Xin, J.; Li, Y.; Du, S. Photovoltaic power forecasting with a hybrid deep learning approach. *IEEE Access* **2020**, *8*, 175871–175880. [CrossRef]
4. Bagatur, T.; Onen, F. Computation of design coefficients in ogee-crested spillway structure using GEP and regression models. *KSCE J. Civ. Eng.* **2016**, *20*, 951–959. [CrossRef]
5. Al-Roomi, A.R.; El-Hawary, M.E. Universal functions originator. *Appl. Soft Comput.* **2020**, *94*, 106417. [CrossRef]
6. Mendyk, A.; Pacławski, A.; Szafraniec-Szczęsny, J.; Antosik, A.; Jamróz, W.; Paluch, M.; Jachowicz, R. Data-driven modeling of the bicalutamide dissolution from powder systems. *AAPS PharmSciTech* **2020**, *21*, 1–9. [CrossRef]
7. Karaci, A.; Ozkaraca, O.; Acar, E.; Demir, A. Prediction of traumatic pathology by classifying thorax trauma using a hybrid method for emergency services. *IET Signal Process.* **2020**, *14*, 754–764. [CrossRef]
8. Sejnowski, T.J. The unreasonable effectiveness of deep learning in artificial intelligence. *Proc. Natl. Acad. Sci. USA* **2020**, *117*, 30033–30038. [CrossRef]
9. Wang, J.; Wang, D.; Wang, S.; Li, W.; Song, K. Fault diagnosis of bearings based on multi-sensor information fusion and 2D convolutional neural network. *IEEE Access* **2021**, *9*, 23717–23725. [CrossRef]
10. Chang, Y.C.; Chang, K.H.; Meng, H.M.; Chiu, H.C. A novel multi-category defect detection method based on the convolutional neural network method for TFT-LCD panels. *Math. Probl. Eng.* **2022**, *2022*, 6505372. [CrossRef]
11. Amerini, I.; Anagnostopoulos, A.; Maiano, L.; Celsi, L.R. Deep learning for multimedia forensics. *Found. Trends Comput. Graph. Vis.* **2021**, *12*, 309–457. [CrossRef]
12. Chang, Y.C.; Chang, K.H.; Zheng, C.P. Application of non-dominated sorting genetic algorithm to solving bi-objective scheduling problem of printed circuit board. *Mathematics* **2022**, *10*, 2305. [CrossRef]
13. Chang, K.H. Integrating subjective-objective weights consideration and a combined compromise solution method for handling supplier selection issues. *Systems* **2023**, *11*, 74. [CrossRef]
14. Chang, K.H. A new emergency-risk-evaluation approach under spherical fuzzy-information environments. *Axioms* **2022**, *11*, 474. [CrossRef]
15. Wen, T.C.; Chang, K.H.; Lai, H.H. Integrating the 2-tuple linguistic representation and soft set to solve supplier selection problems with incomplete information. *Eng. Appl. Artif. Intell.* **2020**, *87*, 103248. [CrossRef]
16. Desjardins-Proulx, P.; Poisot, T.; Gravel, D. Artificial intelligence for ecological and evolutionary synthesis. *Front. Ecol. Evol.* **2019**, *7*, 402. [CrossRef]
17. Popova, O.; Romanov, D.; Drozdov, A.; Gerashchenko, A. Citation-based criteria of the significance of the research activity of scientific teams. *Scientometrics* **2017**, *112*, 1179–1202. [CrossRef]
18. Chang, K.H.; Chung, H.Y.; Wang, C.N.; Lai, Y.D.; Wu, C.H. A new hybrid Fermatean fuzzy set and entropy method for risk assessment. *Axioms* **2023**, *12*, 58. [CrossRef]
19. Wen, T.C.; Chung, H.Y.; Chang, K.H.; Li, Z.S. A flexible risk assessment approach integrating subjective and objective weights under uncertainty. *Eng. Appl. Artif. Intell.* **2021**, *103*, 104310. [CrossRef]
20. Sharma, N.; Sharma, H.; Sharma, A. An effective solution for large scale single machine total weighted tardiness problem using lunar cycle inspired artificial bee colony algorithm. *IEEE/ACM Trans. Comput. Biol. Bioinform.* **2019**, *17*, 1573–1581. [CrossRef]
21. Finkel, J.; Webber, R.J.; Gerber, E.P.; Abbot, D.S.; Weare, J. Learning forecasts of rare stratospheric transitions from short simulations. *Mon. Weather Rev.* **2021**, *149*, 3647–3669. [CrossRef]
22. Vierlboeck, M.; Nilchiani, R.R.; Edwards, C.M. The Pandemic Holiday Blip in New York City. *IEEE. Trans. Comput. Social Syst.* **2021**, *8*, 568–577. [CrossRef] [PubMed]
23. Khalilpourazari, S.; Khalilpourazary, S.; Özyüksel Çiftçioğlu, A.; Weber, G.W. Designing energy-efficient high-precision multi-pass turning processes via robust optimization and artificial intelligence. *J. Intell. Manuf.* **2021**, *32*, 1621–1647. [CrossRef]
24. de Carvalho, V.R.; Özcan, E.; Sichman, J.S. Comparative analysis of selection hyper-heuristics for real-world multi-objective optimization problems. *Appl. Sci.* **2021**, *11*, 9153. [CrossRef]
25. Feng, Z.K.; Niu, W.J.; Liu, S. Cooperation search algorithm: A novel metaheuristic evolutionary intelligence algorithm for numerical optimization and engineering optimization problems. *Appl. Soft Comput.* **2021**, *98*, 106734. [CrossRef]
26. Pan, H.; Yang, X. Intelligent recommendation method integrating knowledge graph and Bayesian network. *Soft Comput.* **2023**, *27*, 483–492. [CrossRef]
27. Ma, Z.; Xin, C.; Zheng, H. Construction of a teaching system based on big data and artificial intelligence to promote the physical health of primary school students. *Math. Probl. Eng.* **2021**, *2021*, 9777862. [CrossRef]
28. Nayak, J.; Naik, B.; Dinesh, P.; Vakula, K.; Rao, B.K.; Ding, W.; Pelusi, D. Intelligent system for COVID-19 prognosis: A state-of-the-art survey. *Appl. Intell.* **2021**, *51*, 2908–2938. [CrossRef]
29. Shrestha, A.; Mahmood, A. Review of deep learning algorithms and architectures. *IEEE Access* **2019**, *7*, 53040–53065. [CrossRef]
30. Abd Elaziz, M.; Dahou, A.; Abualigah, L.; Yu, L.; Alshinwan, M.; Khasawneh, A.M.; Lu, S. Advanced metaheuristic optimization techniques in applications of deep neural networks: A review. *Neural. Comput. Appl.* **2021**, *33*, 14079–14099. [CrossRef]
31. Talpur, N.; Abdulkadir, S.J.; Alhussian, H.; Hasan, M.H.; Aziz, N.; Bamhdi, A. A comprehensive review of deep neuro-fuzzy system architectures and their optimization methods. *Neural. Comput. Appl.* **2022**, *34*, 1837–1875. [CrossRef]
32. Minaee, S.; Kalchbrenner, N.; Cambria, E.; Nikzad, N.; Chenaghlu, M.; Gao, J. Deep learning-based text classification: A comprehensive review. *ACM. Comput. Surv.* **2021**, *54*, 1–40. [CrossRef]

33. Chen, L.C.; Chang, K.H.; Yang, S.C. Integrating corpus-based and NLP approach to extract terminology and domain-oriented information: An example of US military corpus. *Acta Sci. -Technol.* **2022**, *44*, e60486. [CrossRef]
34. Chen, L.C.; Chang, K.H. A novel corpus-based computing method for handling critical word ranking issues: An example of COVID-19 research articles. *Int. J. Intell. Syst.* **2021**, *36*, 3190–3216. [CrossRef]
35. Hirschberg, J.; Manning, C.D. Advances in natural language processing. *Science* **2015**, *349*, 261–266. [CrossRef]
36. Li, J.; Sun, A.; Han, J.; Li, C. A survey on deep learning for named entity recognition. *IEEE Trans. Knowl. Data Eng.* **2022**, *34*, 50–70. [CrossRef]
37. Fahimnia, B.; Sarkis, J.; Davarzani, H. Green supply chain management: A review and bibliometric analysis. *Int. J. Prod. Econ.* **2015**, *162*, 101–114. [CrossRef]
38. Nita, A.; Hartel, T.; Manolache, S.; Ciocanea, C.M.; Miu, I.V.; Rozylowicz, L. Who is researching biodiversity hotspots in Eastern Europe? A case study on the grasslands in Romania. *PLoS ONE* **2019**, *14*, e0217638. [CrossRef]
39. Maditati, D.R.; Munim, Z.H.; Schramm, H.J.; Kummer, S. A review of green supply chain management: From bibliometric analysis to a conceptual framework and future research directions. *Resour. Conserv. Recycl.* **2018**, *139*, 150–162. [CrossRef]
40. Ganbat, T.; Chong, H.Y.; Liao, P.C.; Wu, Y.D. A bibliometric review on risk management and building information modeling for international construction. *Adv. Civ. Eng.* **2018**, *2018*, 8351679. [CrossRef]
41. Moon, S.; Shin, Y.; Hwang, B.G.; Chi, S. Document management system using text mining for information acquisition of international construction. *KSCE J. Civ. Eng.* **2018**, *22*, 4791–4798. [CrossRef]
42. Zhou, X.; Wang, L.; Liao, H.; Wang, S.; Lev, B.; Fujita, H. A prospect theory-based group decision approach considering consensus for portfolio selection with hesitant fuzzy information. *Knowl. -Based Syst.* **2019**, *168*, 28–38. [CrossRef]
43. Song, C.; Wang, L.; Hou, J.; Xu, Z.; Huang, Y. The optimized GRNN based on the FDS-FOA under the hesitant fuzzy environment and its application in air quality index prediction. *Appl. Intell.* **2021**, *51*, 8365–8376. [CrossRef]
44. Gao, J.; Xu, Z.; Liang, Z.; Liao, H. Expected consistency-based emergency decision making with incomplete probabilistic linguistic preference relations. *Knowl. -Based Syst.* **2019**, *176*, 15–28. [CrossRef]
45. Lin, M.; Zhan, Q.; Xu, Z. Decision making with probabilistic hesitant fuzzy information based on multiplicative consistency. *Int. J. Intell. Syst.* **2020**, *35*, 1233–1261. [CrossRef]
46. Gou, X.; Xu, Z.; Liao, H.; Herrera, F. Consensus model handling minority opinions and noncooperative behaviors in large-scale group decision-making under double hierarchy linguistic preference relations. *IEEE T. Cybern.* **2020**, *51*, 283–296. [CrossRef]
47. Liao, H.; Tang, M.; Qin, R.; Mi, X.; Altalhi, A.; Alshomrani, S.; Herrera, F. Overview of hesitant linguistic preference relations for representing cognitive complex information: Where we stand and what is next. *Cogn. Comput.* **2020**, *12*, 25–48. [CrossRef]
48. Song, C.; Xu, Z.; Zhang, Y.; Wang, X. Dynamic hesitant fuzzy Bayesian network and its application in the optimal investment port decision making problem of "twenty-first century maritime silk road". *Appl. Intell.* **2020**, *50*, 1846–1858. [CrossRef]
49. Liao, H.; Mi, X.; Xu, Z. A survey of decision-making methods with probabilistic linguistic information: Bibliometrics, preliminaries, methodologies, applications and future directions. *Fuzzy Optim. Decis. Mak.* **2020**, *19*, 81–134. [CrossRef]
50. Gou, X.; Xu, Z.; Wang, X.; Liao, H. Managing consensus reaching process with self-confident double hierarchy linguistic preference relations in group decision making. *Fuzzy Optim. Decis. Mak.* **2021**, *20*, 51–79. [CrossRef]
51. Zheng, Y.; Xu, Z.; He, Y. A novel weight-derived method and its application in graduate students' physical health assessment. *Int. J. Intell. Syst.* **2021**, *36*, 200–236.
52. Liu, Q.; Wu, H.; Xu, Z. Consensus model based on probability k-means clustering algorithm for large scale group decision making. *Int. J. Mach. Learn. Cybern.* **2021**, *12*, 1609–1626.
53. Li, Z.; Liu, X.; Dai, J.; Chen, J.; Fujita, H. Measures of uncertainty based on Gaussian kernel for a fully fuzzy information system. *Knowl. -Based Syst.* **2020**, *196*, 105791.
54. Wang, D.; Nie, P.; Zhu, X.; Pedrycz, W.; Li, Z. Designing of higher order information granules through clustering heterogeneous granular data. *Appl. Soft Comput.* **2021**, *112*, 107820.
55. Zhou, Y.; Ren, H.; Li, Z.; Pedrycz, W. Anomaly detection based on a granular Markov model. *Expert Syst. Appl.* **2022**, *187*, 115744.
56. Zhu, X.; Pedrycz, W.; Li, Z. A development of hierarchically structured granular models realized through allocation of information granularity. *IEEE Trans. Fuzzy Syst.* **2020**, *29*, 3845–3858. [CrossRef]
57. Zhu, X.; Pedrycz, W.; Li, Z. Development and analysis of neural networks realized in the presence of granular data. *IEEE Trans. Neural Netw. Learn. Syst.* **2019**, *31*, 3606–3619. [CrossRef]
58. Zhu, X.; Pedrycz, W.; Li, Z. A development of granular input space in system modeling. *IEEE Trans. Cybern.* **2019**, *51*, 1639–1650.
59. Taghavi, A.; Eslami, E.; Herrera-Viedma, E.; Ureña, R. Trust based group decision making in environments with extreme uncertainty. *Knowl. -Based Syst.* **2020**, *191*, 105168.
60. Morente-Molinera, J.A.; Wu, X.; Morfeq, A.; Al-Hmouz, R.; Herrera-Viedma, E. A novel multi-criteria group decision-making method for heterogeneous and dynamic contexts using multi-granular fuzzy linguistic modelling and consensus measures. *Inf. Fusion.* **2020**, *53*, 240–250.
61. Zuheros, C.; Martínez-Cámara, E.; Herrera-Viedma, E.; Herrera, F. Sentiment analysis based multi-person multi-criteria decision making methodology using natural language processing and deep learning for smarter decision aid. Case study of restaurant choice using TripAdvisor reviews. *Inf. Fusion.* **2021**, *68*, 22–36.
62. Wu, J.; Cao, M.; Chiclana, F.; Dong, Y.; Herrera-Viedma, E. An optimal feedback model to prevent manipulation behavior in consensus under social network group decision making. *IEEE Trans. Fuzzy Syst.* **2020**, *29*, 1750–1763.

63. Xie, W.; Xu, Z.; Ren, Z.; Herrera-Viedma, E. A new multi-criteria decision model based on incomplete dual probabilistic linguistic preference relations. *Appl. Soft Comput.* **2020**, *91*, 106237.
64. Labella, A.; Rodriguez, R.M.; Martinez, L. Extending the linguistic decision suite FLINTSTONES to deal with comparative linguistic expressions with symbolic translation information. *J. Intell. Fuzzy Syst.* **2020**, *39*, 6245–6258.
65. Wang, R.; Chen, Z.S.; Shuai, B.; Chin, K.S.; Martínez, L. Site selection of high-speed railway station: A trapezoidal fuzzy neutrosophic-based consensual group decision-making approach. *J. Intell. Fuzzy Syst.* **2021**, *40*, 5347–5367.
66. Labella, A.; Rodríguez, R.M.; Martinez, L. A consensus reaching process dealing with comparative linguistic expressions for group decision making: A fuzzy approach. *J. Intell. Fuzzy Syst.* **2020**, *38*, 735–748.
67. Rodríguez, R.M.; Labella, Á.; Dutta, B.; Martínez, L. Comprehensive minimum cost models for large scale group decision making with consistent fuzzy preference relations. *Knowl. -Based Syst.* **2021**, *215*, 106780.
68. Romero, Á.L.; Rodríguez, R.M.; Martínez, L. Computing with comparative linguistic expressions and symbolic translation for decision making: ELICIT information. *IEEE Trans. Fuzzy Syst.* **2019**, *28*, 2510–2522.
69. Chen, Z.S.; Yang, L.L.; Rodríguez, R.M.; Xiong, S.H.; Chin, K.S.; Martínez, L. Power-average-operator-based hybrid multiattribute online product recommendation model for consumer decision-making. *Int. J. Intell. Syst.* **2021**, *36*, 2572–2617.
70. Garg, H. Sine trigonometric operational laws and its based Pythagorean fuzzy aggregation operators for group decision-making process. *Artif. Intell. Rev.* **2021**, *54*, 4421–4447.
71. Liu, X.D.; Wu, J.; Zhang, S.T.; Wang, Z.W.; Garg, H. Extended cumulative residual entropy for emergency group decision-making under probabilistic hesitant fuzzy environment. *Int. J. Fuzzy Syst.* **2022**, *24*, 159–179. [CrossRef]
72. Liu, X.; Wang, Z.; Zhang, S.; Garg, H. Novel correlation coefficient between hesitant fuzzy sets with application to medical diagnosis. *Expert Syst. Appl.* **2021**, *183*, 115–127. [CrossRef]
73. Wang, X.; Pedrycz, W.; Gacek, A.; Liu, X. From numeric data to information granules: A design through clustering and the principle of justifiable granularity. *Knowl. -Based Syst.* **2016**, *101*, 100–113. [CrossRef]
74. Li, T.; Zhang, L.; Lu, W.; Hou, H.; Liu, X.; Pedrycz, W.; Zhong, C. Interval kernel fuzzy c-means clustering of incomplete data. *Neurocomputing* **2017**, *237*, 316–331. [CrossRef]
75. Lu, W.; Chen, X.; Pedrycz, W.; Liu, X.; Yang, J. Using interval information granules to improve forecasting in fuzzy time series. *Int. J. Approx. Reason.* **2015**, *57*, 1–18. [CrossRef]
76. Zhang, H.; Zhao, S.; Kou, G.; Li, C.C.; Dong, Y.; Herrera, F. An overview on feedback mechanisms with minimum adjustment or cost in consensus reaching in group decision making: Research paradigms and challenges. *Inf. Fusion.* **2020**, *60*, 65–79. [CrossRef]
77. Zhou, Q.; Dong, Y.; Zhang, H.; Gao, Y. The analytic hierarchy process with personalized individual semantics. *Int. J. Comput. Intell. Syst.* **2018**, *11*, 451–468. [CrossRef]
78. Li, C.C.; Dong, Y.; Herrera, F. A consensus model for large-scale linguistic group decision making with a feedback recommendation based on clustered personalized individual semantics and opposing consensus groups. *IEEE Trans. Fuzzy Syst.* **2018**, *27*, 221–233. [CrossRef]
79. Li, C.C.; Dong, Y.; Xu, Y.; Chiclana, F.; Herrera-Viedma, E.; Herrera, F. An overview on managing additive consistency of reciprocal preference relations for consistency-driven decision making and fusion: Taxonomy and future directions. *Inf. Fusion.* **2019**, *52*, 143–156. [CrossRef]
80. Pascual-Triana, J.D.; Charte, D.; Andrés Arroyo, M.; Fernández, A.; Herrera, F. Revisiting data complexity metrics based on morphology for overlap and imbalance: Snapshot, new overlap number of balls metrics and singular problems prospect. *Knowl. Inf. Syst.* **2021**, *63*, 1961–1989. [CrossRef]
81. Feng, J.; Ye, Z.; Liu, S.; Zhang, X.; Chen, J.; Shang, R.; Jiao, L. Dual-graph convolutional network based on band attention and sparse constraint for hyperspectral band selection. *Knowl. -Based Syst.* **2021**, *231*, 107428. [CrossRef]
82. Liu, X.; Jiao, L.; Li, L.; Tang, X.; Guo, Y. Deep multi-level fusion network for multi-source image pixel-wise classification. *Knowl. -Based Syst.* **2021**, *221*, 106921. [CrossRef]
83. Shang, R.; Song, J.; Jiao, L.; Li, Y. Double feature selection algorithm based on low-rank sparse non-negative matrix factorization. *Int. J. Mach. Learn. Cybern.* **2020**, *11*, 1891–1908. [CrossRef]
84. Liu, X.; Li, L.; Liu, F.; Hou, B.; Yang, S.; Jiao, L. GAFNet: Group attention fusion network for PAN and MS image high-resolution classification. *IEEE Trans. Cybern.* **2021**, *52*, 10556–10569. [CrossRef] [PubMed]
85. Yang, M.; Jiao, L.; Liu, F.; Hou, B.; Yang, S.; Jian, M. DPFL-Nets: Deep pyramid feature learning networks for multiscale change detection. *IEEE Trans. Neural Netw. Learn. Syst.* **2021**, *33*, 6402–6416. [CrossRef]
86. Arshaghi, A.; Razmjooy, N.; Estrela, V.; Burdziakowski, P.; Nascimento, D.; Deshpande, A.; Patavardhan, P. Image transmission in UAV MIMO UWB-OSTBC system over Rayleigh channel using multiple description coding (MDC). In *Imaging and Sensing for Unmanned Aircraft Systems*; Institution of Engineering and Technology (IET): Stevenage, UK, 2020.
87. Deshpande, A.; Razmjooy, N.; Estrela, V.V. Introduction to computational intelligence and super-resolution. In *Computational Intelligence Methods for Super-Resolution in Image Processing Applications*; Springer: Cham, Switzerland, 2021; pp. 3–23.