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A Worldwide Bibliometric Analysis of Publications on Artificial Intelligence and Ethics in the Past Seven Decades

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Abstract: Issues related to artificial intelligence (AI) and ethics have gained much traction worldwide. The impact of AI on society has been extensively discussed. This study presents a bibliometric analysis of research results, citation relationships among researchers, and highly referenced journals on AI and ethics on a global scale. Papers published on AI and ethics were recovered from the Microsoft Academic Graph Collection data set, and the subject terms included "artificial intelligence" and "ethics." With 66 nations' researchers contributing to AI and ethics research, 1585 papers on AI and ethics were recovered, up to 5 July 2021. North America, Western Europe, and East Asia were the regions with the highest productivity. The top ten nations produced about 94.37% of the wide variety of papers. The United States accounted for 47.59% (286 articles) of all papers. Switzerland had the highest research production with a million-person ratio (1.39) when adjusted for populace size. It was followed by the Netherlands (1.26) and the United Kingdom (1.19). The most productive authors were found to be Khatib, O. (n = 10), Verner, I. (n = 9), Bekey, G. A. (n = 7), Gennert, M. A. (n = 7), and Chatila, R., (n = 7). Current research shows that research on artificial intelligence and ethics has evolved dramatically over the past 70 years. Moreover, the United States is more involved with AI and ethics research than developing or emerging countries.

Keywords: AI; ethics; bibliometric analysis; citation analysis; worldwide trend

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1. Introduction

Artificial Intelligence (AI) has vastly disrupted people's daily lives and has had a profound effect on the way we live and work. Many "human" tasks can now be successfully performed by AI, and all sectors of the economy are being transformed by AI [1]. The question of whether AI is poised to disrupt or advance industries is of great debate. In recent years, there is escalating interest in the debate regarding AI's privacy and ethical issues [2]. It is imperative that we gain a comprehensive understanding of the AI and ethics landscape to determine the underlying mechanisms of the issues related to AI and ethics research. From a global vantage point, how countries contribute to the trajectories of AI and ethics research is of significance.

Studies have revealed an increasing willingness to utilize digital technology and Big Data in all industries [3]. Numerous industries in different sectors are expanding their investments in data-driven decision making and business analytics solutions to improve their performance and operations [4,5]. AI can apply human problem-solving behavior and skills to address complex real-world problems for better performance [6]. When leveraged critically, the development of AI can advance societal well-being and prevent risk [7].

Despite the advantages of AI applications, ethical concerns are still prevalent. Issues in regard to how we analyze, interpret, share, and replicate the data provided are frequently raised. The basis of this expanding attention on AI and ethics includes how it may affect human workers as technologies can increasingly execute jobs that were previously designated for humans, replacing a wide array of jobs [8–10]. Academia, governmental bodies, and private institutions have gained much traction in putting forward ethical principles, guidelines, statements, and various documents to provide direction on AI and ethics [11–13] due to malicious applications and abuses of AI. Therefore, ethical concerns regarding AI applications should not be dismissed.

AI has been identified as an emergent topic for empirical research [14]. Increasing concern regarding the impact of AI has prompted the emergence of the field of AI and ethics [15]. To the best of our knowledge, there has been scant research conducted on the discourse of AI and ethics research alone. In particular, the various strands of AI and ethics research have not been examined. This study sheds light on the global trends of AI and ethics research by utilizing bibliometric analyses. It is quintessential that we have an overall understanding on how different strands of research connect. To better understand the trend of publishing on this topic, we used the Microsoft Academic Graph database [16,17] to conduct analyses by the statistical method of the literature related to AI and ethics. By so doing, this study contributes to providing scholars new avenues for research on AI and ethics.

2. Methods

2.1. Literature Search

One of the ways to evaluate the academic publication of different countries is to present the total number of papers, the countries with the highest paper productivity, journals [18–21], and highly cited papers in tabular form, which can be utilized to investigate the worldwide trends of paper publications [22]. We chose papers related to AI and ethics recorded in the MAG in this bibliometric study. The literature search was not restricted to Science Citation Index Expanded and Social Science Citation Index Expanded. The research field included (Artificial intelligence) AND (ethics) and was refined to papers published from 1952 to 2021, without language limitations.

2.2. Data Analysis

To illustrate each country's research contribution and worldwide influence, we examined each country's publication production through descriptive statistics values such as the publication's sum of quantities, the sum of paper citations, the average number of paper citations, and the impact factor (IFs) [23]. All values correspond to the data included in the Microsoft Academic Graph, calculated as of 5 July 2021, including the sum of papers published, the number of papers cited, and the average number of papers cited. The quantity of citations in an article is often used to evaluate the influence of the academic study. The 2020 Journal Citation Reports of Clarivate Analytics were used to determine each journal's impact factor.

To extend the comparison between countries, we retrieved population [24], gross domestic product (GDP) [25], and Sustainable Development Report Score data from the International Monetary Fund (IMF), the United Nations (UN), and the Sustainable Development Report. To achieve a more sustainable future, the UN 2030 Agenda for Sustainable Development was adopted by all member states of the UN in 2015 [26]. The Sustainable Development Report measures each country's progress towards achieving the sustainable development goals (SDGs).

We measured countries' productiveness by using the following formula:

$$\frac{\text{publication numbers}}{\text{million populace}} \quad (1)$$

$$\frac{\text{publication numbers}}{\text{GDPs}} \quad (2)$$

$$\frac{\text{publication numbers}}{\text{SDG Score}} \quad (3)$$

In discussing the relationship between researchers, we use R's supplementary package "visNetwork" [27] and Microsoft PowerBI to visualize the relationship between researchers and establish a social network according to the amount of cooperative publishing, forming a huge academic network map. Figure 1 below represents the bibliometric process implemented in this study.

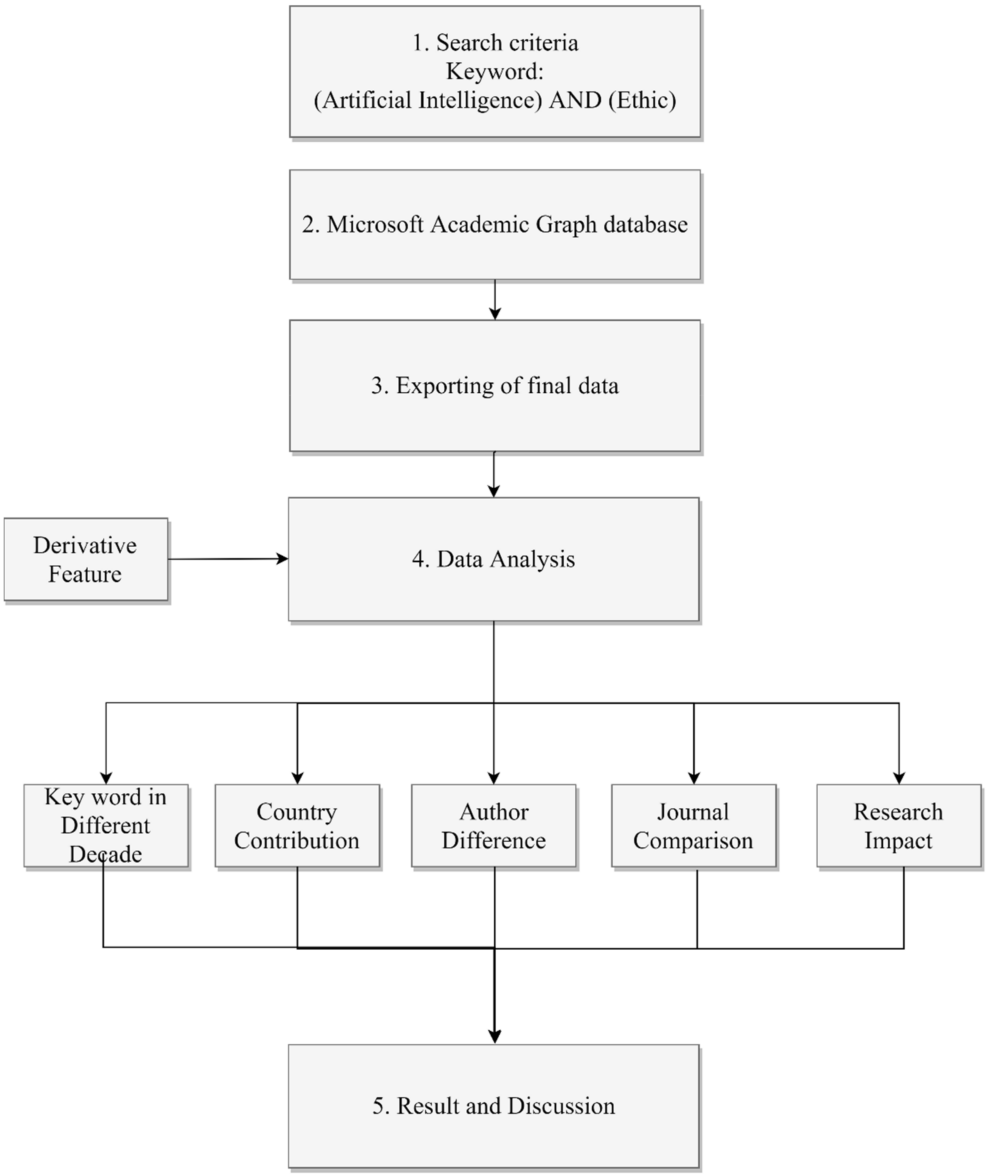

Figure 1. Research Framework flow chart.

3. Results

3.1. Worldwide Trends of Academic Publication

In the last seven decades, about 1585 published papers were contained within the MAG index. Sixty-six countries worldwide have contributed to AI and ethics research (Figure 2). North America is the place with the most papers published, followed by Western Europe and East Asia. Only one country published more than 100 articles, and 11 countries published more than ten articles. A total of 166 papers related to artificial intelligence

and ethics were published before 1990, 147 papers were published between 1990 and 1999, 453 papers were published in the first decade of the 21st century, and the number of publications increased between 2010 to 2019, to 720 papers (Figure 3).

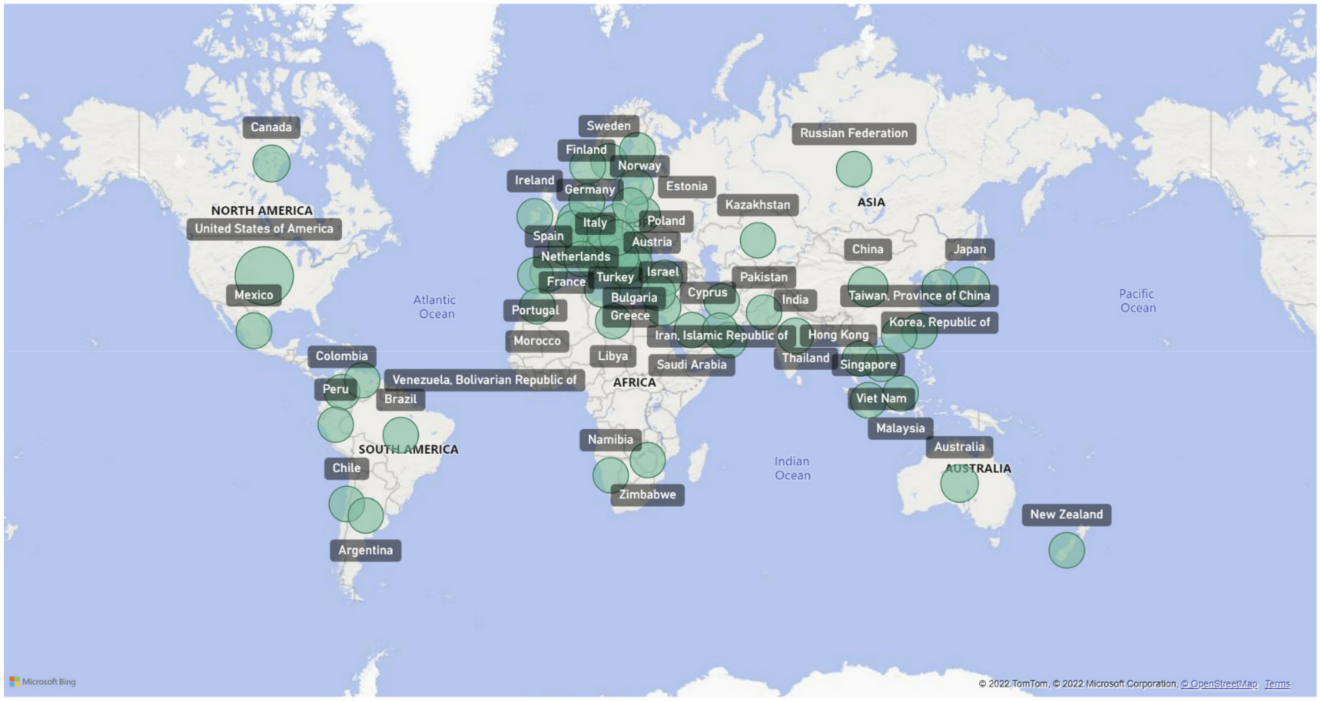

Figure 2. World map of paper production by countries and regions.

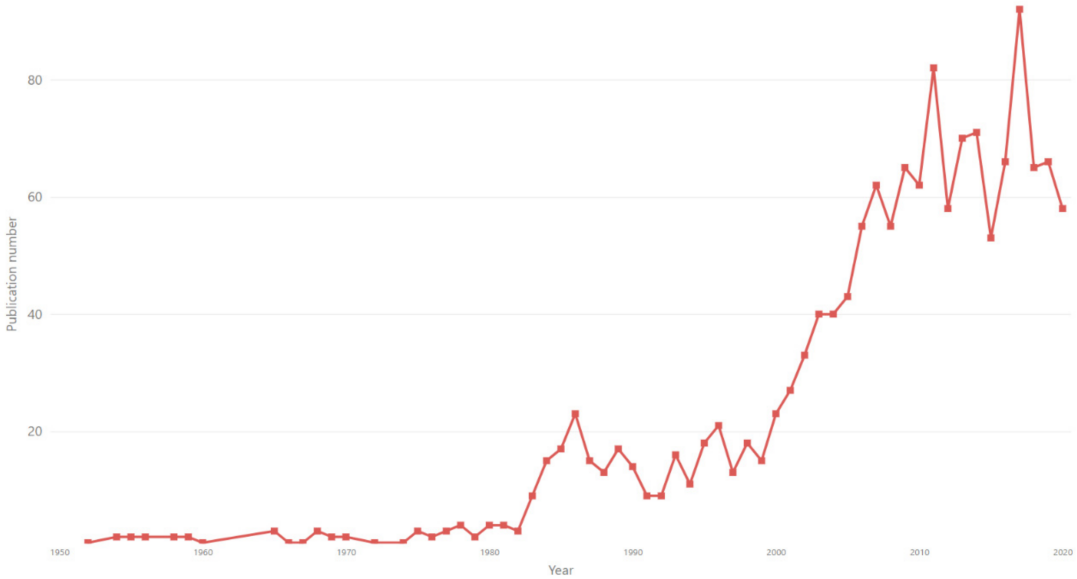

Figure 3. Worldwide publication on AI and ethics from 1950–2020.

3.2. AI and Ethics Research Publication Count by Country

We have compiled a table to present the current publication status of each country and rank the top 20 countries by publishing quantity. Articles only with registered countries in the MAG database will be classified. According to the calculation under this definition, the United States has the largest number of publications. A total of 286 papers have been published, accounting for 47.59%, followed by The United Kingdom which has a total of 80 papers, accounting for 13.31%. Third is China, which has published 56 papers, accounting for 9.32%, and fourth is Japan, which has published 51 papers, accounting for

8.49%. According to the grouping of nominal gross national income per capita defined by the World Bank, except for Brazil, China, India, Mexico, and Russia, which have upper-middle-income economies, all other countries and regions have high-income economies. According to the ranking in Table 1, the top 20 countries accounted for 95.9% of the world's research publications.

Table 1. Publication and Citation Analysis with Top 20 Productive Countries.

Nations	Paper Publish Number	%	Citing Articles	Average Citations	Population (in Millions)	Number of Articles Per Million Inhabitants	GDP (US $1000B)	Number of Articles Per GDP (US $1000B)	SDG Score	Articles Per SDG Score
United States of America	286	47.59%	11,599	40.556	329.48	0.87	209.37	1.366	76.01	3.763
United Kingdom of Great Britain and Northern Ireland	80	13.31%	1608	20.100	67.2	1.19	27.08	2.954	79.97	1
China	56	9.32%	47	0.839	1443.5	0.04	147.23	0.38	72.06	0.777
Japan	51	8.49%	320	6.275	125.67	0.41	50.65	1.007	79.85	0.639
Germany	37	6.16%	379	10.243	83.17	0.44	38.06	0.972	82.48	0.449
Italy	31	5.16%	794	25.613	59.64	0.52	18.86	1.644	78.76	0.394
Australia	29	4.83%	846	29.172	25.68	1.13	13.31	2.179	75.58	0.384
Spain	23	3.83%	312	13.565	47.33	0.49	12.81	1.795	79.46	0.289
Netherlands	22	3.66%	336	15.273	17.41	1.26	9.12	2.412	81.56	0.27
Canada	20	3.33%	84	4.200	38.01	0.53	16.43	1.217	79.16	0.253
France	16	2.66%	110	6.875	67.29	0.24	26.03	0.615	81.67	0.196
Switzerland	12	2.00%	338	28.167	8.61	1.39	7.48	1.604	80.1	0.15
Poland	7	1.16%	8	1.143	37.96	0.18	5.94	1.178	80.22	0.087
India	7	1.16%	5	0.714	1347.12	0.01	26.23	0.267	60.07	0.117
Mexico	6	1.00%	6	1.000	126.01	0.05	10.76	0.558	69.13	0.087
Russian Federation	5	0.83%	9	1.800	146.2	0.03	14.84	0.337	73.75	0.068
Turkey	4	0.67%	5	1.250	83.61	0.05	7.2	0.556	70.38	0.057
Brazil	4	0.67%	5	1.250	211.82	0.02	14.45	0.277	71.34	0.056
Korea, Republic of	3	0.50%	10	3.333	51.78	0.06	16.31	0.184	78.59	0.038
Saudi Arabia	2	0.33%	4	2.000	35	0.06	7	0.286	66.3	0.03

Abbreviations: GDP (Gross domestic product).

A total of 48,735 citations were made in these 1585 papers. The average number of citations per paper was 30.75. The United States, Australia, and Switzerland were the three countries with the highest number of citations, with average citations of 40.75, 29.17, and 28.17, respectively. Additional comparisons were made in proportion to the current situation in different countries. First, the number of publications was adjusted for population data. Dividing the number of publications by the population showed that Switzerland had the highest publications per million inhabitants, at 1.39, followed by the Netherlands at 1.26 and the UK at 1.19. Second, the number of paper publications was adjusted for GDP data by dividing the number of publications by the GDP (in 1000 billion). The highest ratio was the UK at 2.954, followed by the Netherlands at 2.412 and Australia at 2.179. Third, the number of publications was adjusted by SDG Scores data by dividing the number of papers published by the SDG score. The highest ratio of papers divided by SDG score was in the United States at 3.763, followed by the UK at 1 and China at 0.777.

3.3. Journal Publishing Comparison

In the past 70 years, 1072 papers have been published in 732 journals, of which 596 are journals included in SCI and SSCI. As Table 2 all journals, only one journals published more than 50 papers, and six journals published more than ten papers. Among all journals, 476 journals published only one paper.

Table 2. Top 10 SCI & SSCI Journals Publishing AI and Ethics Articles.

Journal Names	Articles	%	Total Citation	Mean Citation Per Article	Journal Impact Factor	Impact Factor without Journal Self Cites	5-Year Impact Factor
IEEE Robotics and Automation Magazine	63	10.57%	632	10.0317	3.591	3.466	4.615
The International Journal of Robotics Research	33	5.54%	18	0.5455	4.703	4.479	6.397
AI Magazine	21	3.52%	338	16.0952	1.627	1.56	1.742
Industrial Robot: An International Journal	17	2.85%	335	19.7059	1.123	0.911	1.287
Advanced Robotics	12	2.01%	9	0.75	1.247	1.184	1.215
Communications of The ACM	12	2.01%	474	39.5	6.988	6.844	6.064
International Journal of Social Robotics	9	1.51%	279	31	2.516	2.108	3.168
Connection Science	8	1.34%	39	4.875	1.042	1	1.191
Journal of the Royal Society of Medicine	8	1.34%	159	19.875	5.238	3.905	3.405
Kybernetes	7	1.17%	20	2.8571	1.754	1.498	1.47

Abbreviations: AI, artificial intelligence; IF, impact factor.

Among the journals with Impact factor, IEEE Robotics & Automation Magazine has published 63 papers, accounting for 10.57%. The second is The International Journal of Robotics Research, which has published 33 papers, accounting for 5.54%. The third is AI Magazine, which published 21 papers, accounted for about 3.52%.

3.4. Role of AI and Ethics across Disciplines

The role of AI and ethics could have a negative influence on policy since it frequently dismisses ethical concerns related to prejudice, information asymmetry, and the ramifications of digital interactions in the twenty-first century.

While AI and ethics has become an important topic in AI research, it has spanned a variety of disciplines. In Table 3 we can see that since the 1980s, the disciplines of engineering and computer science have remained the top disciplines for AI and ethics research. It is worthy to note that the exploration of AI and ethics in sociology research has increased incrementally. Sociology became the second most widely covered discipline in AI and ethics research from 2020 to 2021. As the inequalities embedded in our society have become more prevalent, there is a need to examine AI and ethics research from the vantage points of sociology. In our social interface, our research disciplines have become "technologically" fused.

The keywords that have topped the keyword research include robotics, robot, and curriculum. From the top keyword list, there is a clear link to the discipline of engineering. The COVID-19 pandemic has also spurred the keyword Coronavirus disease 2019. Results are presented in Table 4.

Table 3. AI and Ethics keyword analysis with disciplines.

Year	1950~1954	1955~1959	1960~1964	1965~1969	1970~1974	1975~1979	1980~1984	1985~1989	1990~1994	1995~1999	2000~2004	2005~2009	2010~2014	2015~2019	2020~2021
Rank1	Computer science	Computer science	Medicine	Engineering	Computer science	Computer science	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering
Rank2	Psychology	Engineering	–	Computer science	Engineering	Psychology	Computer science	Computer science	Computer science	Computer science	Computer science	Computer science	Computer science	Computer science	Sociology
Rank3	–	Psychology	–	–	–	Engineering	Medicine	Medicine	Psychology	Sociology	Psychology	Psychology	Psychology	Sociology	Computer science
Rank4	–	–	–	–	–	Medicine	Sociology	Psychology	Sociology	Medicine	Sociology	Sociology	Sociology	Political science	Psychology
Rank5	–	–	–	–	–	Political science	–	Political science	Medicine	Economics	Medicine	Medicine	Medicine	Psychology	Political science
Rank6	–	–	–	–	–	Sociology	–	Sociology	Business	Psychology	Mathematics	Political science	Political science	Medicine	Medicine
Rank7	–	–	–	–	–	–	–	–	Mathematics	–	–	Business	Philosophy	Business	–

Table 4. AI and Ethics keyword analysis without disciplines.

Year	1950~1954	1955~1959	1960~1964	1965~1969	1970~1974	1975~1979	1980~1984	1985~1989	1990~1994	1995~1999	2000~2004	2005~2009	2010~2014	2015~2019	2020~2021
Rank1	Alternative medicine	Computer technology	MEDLINE	Curriculum	Public opinion	Alternative medicine	Robotics	Robotics	Robotics	Robotics	Robotics	Robotics	Robotics	Robotics	Robotics
Rank2	–	Technological revolution	–	Scientific discovery	Terminology	Emerging technologies	Robot	Robot	Curriculum	Robot	Robot	Robot	Robot	Robot	Robot
Rank3	–	–	–	–	–	Human rights	Automation	Alternative medicine	Expert system	Curriculum	Curriculum	Curriculum	Curriculum	Roboethics	Deep learning
Rank4	–	–	–	–	–	–	Computer technology	Automation	Documentation	Pedagogy	Artificial life	Creativity	Roboethics	Deep learning	Social robot
Rank5	–	–	–	–	–	–	Creativity	Acquired immunodeficiency syndrome (AIDS)	Robot	Alternative medicine	Creativity	Ethical issues	Human–robot interaction	Curriculum	Curriculum
Rank6	–	–	–	–	–	–	Curriculum	Cognitive science	Artificial life	Evidence-based medicine	Natural language processing	Health care	Social robot	Social robot	Coronavirus disease 2019 (COVID-19)
Rank7	–	–	–	–	–	–	Engineering management	Curriculum	Automation	Artificial life	Consciousness	Human–robot interaction	Multidisciplinary approach	Automation	Health care
Rank8	–	–	–	–	–	–	Expert system	Expert system	Computer technology	Automation	Emerging technologies	Informatics	Automation	Autonomy	Machine ethics
Rank9	–	–	–	–	–	–	Health informatics	Living systems	Creativity	Engineering management	Information science	Machine ethics	Pedagogy	Human–robot interaction	Multidisciplinary approach
Rank10	–	–	–	–	–	–	Informatics	Medical ethics	Engineering management	Health technology	Information system	Multidisciplinary approach	Creativity	Health care	Sustainability
Rank11	–	–	–	–	–	–	Information science	Artificial life	Health care	Information system	Terminology	Pedagogy	Health care	Creativity	Emerging technologies
Rank12	–	–	–	–	–	–	Natural language processing	Engineering management	Health informatics	Autonomy	Alternative medicine	Automation	Knowledge management	Machine ethics	Human–robot interaction
Rank13	–	–	–	–	–	–	Pedagogy	Environmental ethics	Information system	Deep learning	China	Civilization	Machine ethics	Multidisciplinary approach	Ai ethics
Rank14	–	–	–	–	–	–	Terminology	Health care	Natural language processing	Health care	Computer technology	Health informatics	Terminology	Knowledge management	Autonomy
Rank15	–	–	–	–	–	–	Medical imaging	Pedagogy	Environmental ethics	Expert system	Multidisciplinary approach	Knowledge management	Autonomy	Sustainability	Medical ethics

3.5. Most Cited Papers and Publish Distribution

Table 5 shows the top ten cited papers. According to the MAG record, the most cited paper was published in Annals of Surgery in 2004, which has a very high citation count of 1267. Table 6 presents the situation and distribution of papers' citations. One way to measure the impact of each paper is through citation analysis, which calculates the number of citations as the paper's impact. Of the 1585 AI and ethics research publications, 43 papers were cited 50 times or more which is about 2.71%, and 60 papers were cited 100 times or more, about 3.79%. A total of 51.17% of papers were cited zero times.

Table 5. Top 10 Cited Papers on AI and ETHICS.

Title	AuthorName	Country/Region	VenueName	Year	Citation Count
Robotic surgery: a current perspective	Anthony R. Lanfranco	United States of America	Annals of Surgery	2004	1267
All models are wrong: reflections on becoming a systems scientist	John D. Sterman	United States of America	System Dynamics Review	2002	1266
Engineering Education and the Development of Expertise	Thomas A. Litzinger	–	Journal of Engineering Education	2011	566
Biomimetics—Using nature to inspire human innovation	Yoseph Bar-Cohen	United States of America	Bioinspiration & Biomimetics	2006	453
Going digital: a look at assumptions underlying digital libraries	David N. L. Levy	United States of America	Communications of the ACM	1995	410
Prolegomena to any future artificial moral agent	Colin Allen	United States of America	Journal of Experimental and Theoretical Artificial Intelligence	2000	359
Surgical robotics: the early chronicles: a personal historical perspective	Richard M. Satava	United States of America	Surgical Laparoscopy Endoscopy and Percutaneous Techniques	2002	335
Exoskeletons and robotic prosthetics: a review of recent developments	Robert Bogue	–	Industrial Robot: An International Journal	2009	320
Complexity Theory in Organization Science: Seizing the Promise or Becoming a Fad?	Bill McKelvey	United States of America	Emergence	1999	311
Control: A perspective	Karl Johan Åström	–	Automatica	2014	270

Abbreviation: AI, artificial intelligence; ACM, Association for Computing Machinery.

Table 6. Citation Distribution.

No.	Number of Citations	Number of Papers	%
1	0	811	51.17%
2	1–10	534	33.69%
3	11–50	137	8.64%
4	51–100	43	2.71%
5	>100	60	3.79%

3.6. Author Collaboration Relationship Analysis

We analyzed and visualized each author's publication and collaboration relationship using the R package "visNetwork." Only authors who had published a minimum of three papers are displayed on the network visualization map (Figure 4). The circle size is set based on the number of papers published by each author as the primary reference, and the line between the two authors represents the line of cooperation between them. Different colors represent collaboration clusters among different authors, while the same color indicates more frequent and closer collaboration. In the network visualization map, you can see that the authors with the highest number of publications are Oussama Khatib (n = 10), Igor M. Verner (n = 9), George A. Bekey (n = 7), Michael A. Gennert (n = 7), and Raja Chatila (n = 7).

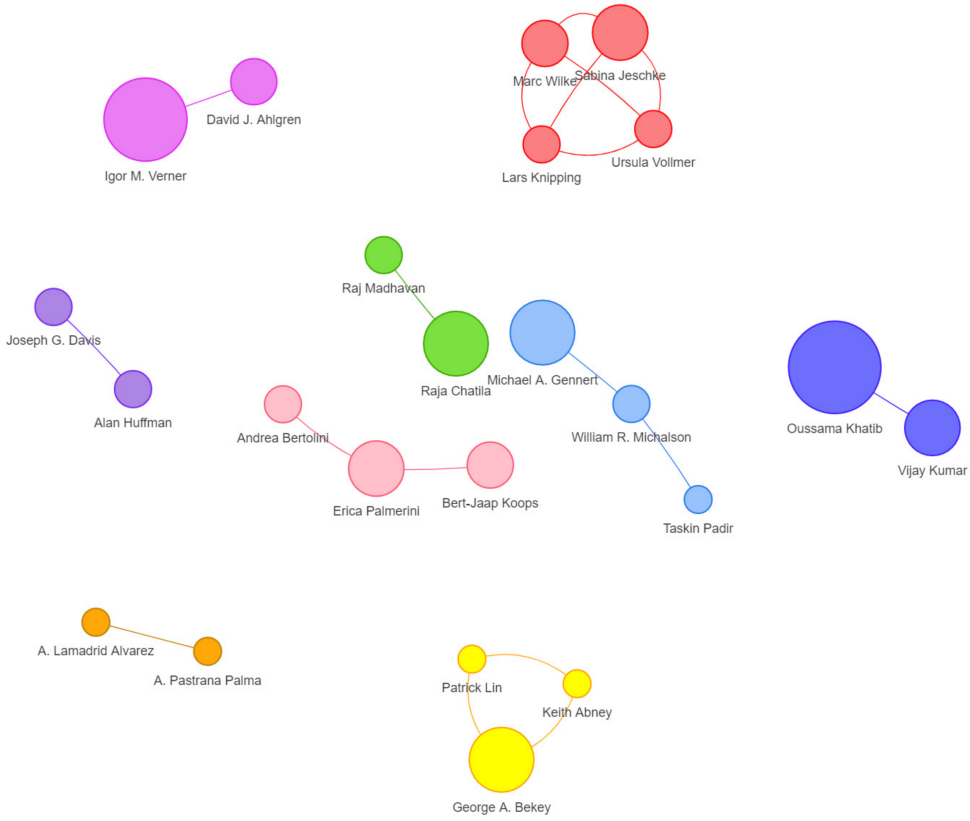

Figure 4. Authorship collaboration network visualization map.

3.7. Institutions Collaboration Relationship Analysis

We used Microsoft Power BI's Network Navigator Chart to visualize the network, which includes research that has been submitted by institutions. The node size is set according to the weighted number of papers published by each research institution as the primary reference, and the line between two research institutions represents the collaboration between them. The different colors represent collaborative clusters between different research institutions, while the same color represents more frequent and tighter collaborations. In the grouping process, research units that have published at least six papers are included in the calculation. After a preliminary screening of 554 research institutions, the remaining 306 research institutions are those that have published more than six papers. The samples were grouped into 57 groups through cluster analysis, and the final appearance is shown in Figure 5. Group 48 is the largest publishing group among all groups, with Johns Hopkins University, Technische Universität München, Heidelberg University, Imperial College London, and Harvard University as the core, and the color is PowderBlue. The second largest group is Group 23; this group is mainly composed of the National University of Distance Education, the Charles III University of Madrid, the University of Zaragoza, and the University of Applied Sciences Stuttgart; the color is Lavender.

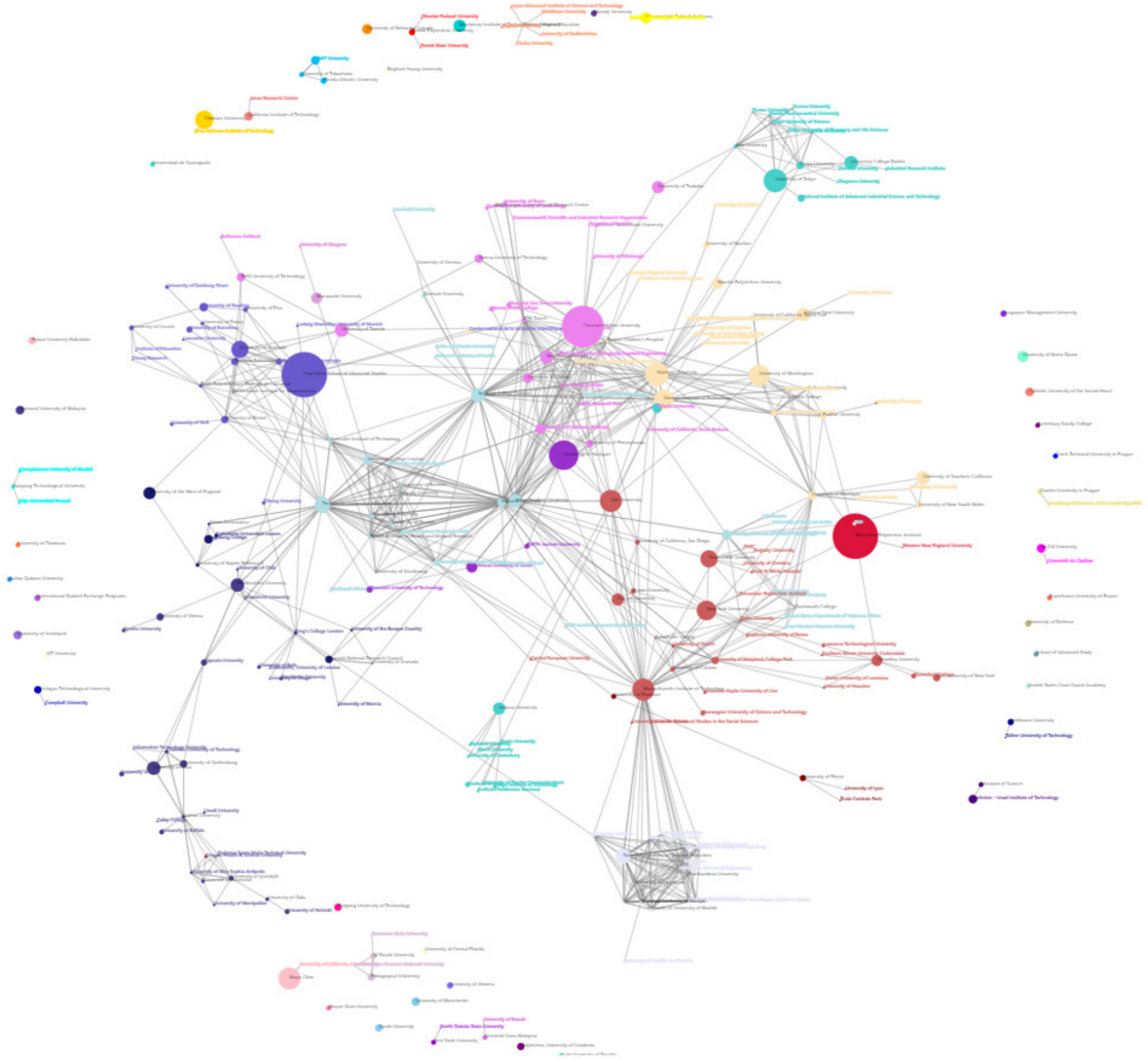

Figure 5. Network visualization map of collaborations between institutions.

4. Discussion

Bibliometrics analysis can analyze articles, books, and other publications which are frequently used in library and information science. Thus, it comprises a collection of approaches to assess scientific documents in areas such as science and technology studies [21]. The outcomes from the bibliometric analysis provide us with data regarding research action patterns over the long term and measure the quantified result of individual researchers, affiliations, journals, institutions, and nations. Other areas of analysis incorporate the fields of interest, the country's published contributions, the top journals, author collaboration relationships, paper citation analysis, publication growth situations, and most-cited papers in the specified research field.

Bibliometric research uses quantitative methods to conduct statistical analysis in order to explore the current state of research, measure the degree of impact of research from different aspects, and demonstrate the overall global patterns of the field. Utilizing bibliometric analysis enables us to explore the subtleties of a particular field's evolutionary history while drawing out the emerging areas of study [22]. Such a research method can guide us to grasp how AI and ethics research has evolved. Most importantly, it can help us determine potential avenues of future research.

This study reviewed the current status and trends of artificial intelligence and ethics research. In total, scholars from 66 countries contributed to the publishing of papers related

to artificial intelligence and ethics. The United States published the most papers among all nations and in all countries. American researchers published 80% of the top ten most cited papers. In terms of average citations per article, the United States is also the best performer of all countries, with an average of 40.75 citations per paper. After adjusting for population size, Switzerland had the highest rate of any country with 1.39 papers published per million inhabitants. Adjusted using the GDP, the UK had the highest rate, at 0.0295 papers. AI and ethics are topics that have been paid more and more attention in recent years and will continue to receive attention in the future.

According to the Sustainable Development Report, in this study, we found that the United States had a much higher percentage of articles on sustainability than other countries, indicating that the United States pays more attention to the development of AI and ethics than to that of sustainable development. The United Kingdom has a ratio of 1, which means that the degree of concern is approximately the same. However, China, Japan, Germany, and other countries are more concerned about sustainable development than AI and ethics.

In this study, we also found that most countries that study artificial intelligence and ethics are medium-high and highly developed countries. The United States has the most published papers and citations, which means that American scholars have a certain degree of influence in AI and ethics. It is worth noting that China's performance ranks in the top three in terms of publication volume, with 56 papers published, but it does not perform well in the average number of citations, at only 0.84 citations. Another country worth mentioning is Switzerland. Switzerland has only 12 publications, but the average number of citations is 28.17 times, and each paper is cited relatively often.

Among the cited articles in the past 70 years, the results are mostly related to biomedical, scientific, and technological engineering fields. The top ten most cited papers are within the fields of medical biology and scientific and technical engineering. The medical and biological journals are Annals of Surgery, Bioinspiration & Biomimetics, Surgical Laparoscopy Endoscopy and Percutaneous Techniques, and Emergence. The journals related to science and technology engineering are System Dynamics Review, Journal of Engineering Education, Communications of the ACM, Journal of Experimental and Theoretical Artificial Intelligence, Industrial Robot: An International Journal, and Automatica. The research and development of AI and ethics are also generally mostly applied within the fields of medical, scientific, and technological engineering, so these articles have received higher citations.

How the impact of AI and ethical research will benefit different countries, cultures, populations, and races is currently uncertain. In future research, we hope to explore beyond the context of countries, and consider people and race, further increasing the complexity of our research. In this way, the literature on AI and ethics can be made more abundant.

This study is the first to attempt to focus on the bibliometric analysis of artificial intelligence and ethics. This study still has limitations. First, in this study, we only used the MAG database to search for publications, and papers not included in the MAG were not counted. Second, there is a possibility of bias due to the number of citations recorded by MAG.

5. Conclusions

In today's turbulent times, the implications of understanding the realms of AI and ethics research are imperative. Tracing back to see how AI and ethics research has evolved over the years can benefit us in foreseeing future trends. Although AI research has gained significant traction since the 1990s, this study has illustrated the actual output of AI and ethics research across the world. The results of the study show that AI and ethics research spans across multiple disciplines. The results also indicate that the majority of AI and ethics research has been conducted in the discipline of engineering. Since the 1980s, it has remained the discipline with the highest coverage of AI and ethics. Specifically, this research demonstrates that engineering-related AI applications continue to be plagued by ethical issues.

With the most published research articles, the United States and the United Kingdom lead AI and ethics research, accounting for 61% of all publications. Australia, Switzerland, and Italy also have considerable influence. It is interesting to note that those more engaged in AI and ethics are from highly developed countries. Our findings contribute to enriching the discussion of AI and ethics by thoroughly examining various aspects of AI and ethics research to understand why it is focused in a particular discipline. This study contributes to the emerging agenda on the evolution of AI and ethics research.

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