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Artificial Intelligence Policy And Ethics: A Bibliometric Review And Future Research Directions

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ORIGINAL RESEARCH PAPER

Abstract

This study provides a comprehensive bibliometric analysis to analyze the academic studies conducted so far in the field of artificial intelligence (AI) policies and ethics. Using Scopus as a data source, the most cited core publications in these fields and the changing trends over time were identified. Collaborations and keywords between researchers and institutions were visualized through VOSviewer and a Python pyBibX library. The analysis reveals the importance of AI policies and ethics in academic studies, as well as the central role played by some countries in research. It attempts to identify a direction for future research by following the changing trends over time.

Keywords: Bibliometric analysis, Artificial intelligence, Policy, Ethics, Research trends, Collaboration

1 Introduction

Over the last two decades, significant technological advances driven by impressive breakthroughs in both software and hardware have reshaped our world. It has evolved from the Steam Age powered by steam engines to the Electric Age powered by generators to the revolutionary Information Age powered by computers. Artificial Intelligence (AI) has become indispensable in today's technology and is seen as a cornerstone for the technology of the future. Considering its various definitions, AI represents the study and use of theories, methods, technologies, and applications that aim to simulate, enhance, and extend human intelligence [1]. AI includes various methods that allow machines to mimic human intelligence and perform tasks that typically require human thinking [2]. AI has become a tool that can automatically perform work tasks and help make difficult decisions in various businesses and fields [3].

The importance of AI lies in its ability to enhance human capabilities and optimize business processes, which translates into improved efficiency and innovation [4], [5]. Organizations can use AI to leverage large amounts of data to increase their efficiency, which allows organizations to derive important insights, make decisions based on data-driven results, and predict future trends using AI. Moreover, AI has the potential to completely transform industries like healthcare, banking, manufacturing, education, and transportation by providing innovative solutions to complex problems and helping improve the overall standard of living [6].

AI is used in various fields such as natural language processing, computer vision, robotics, and data analytics [7]. AI enables machines to understand human language in the field of natural language processing and respond accordingly, making it possible to use virtual assistants and language translation systems [8, 9]. Computer vision uses AI algorithms to facilitate the interpretation and analysis of visual input, leading to improvements in facial recognition, object identification, and autonomous vehicles [10, 11, 12]. Moreover, the use of AI-enabled robotics has the ability to completely transform various industries by facilitating the creation of autonomous machines that can perform complex tasks with accuracy and efficiency [13, 14].

As AI technologies advance, policy and ethical implications are increasingly salient [15, 16]. Addressing concerns about privacy, bias, accountability, and transparency is critical to ensuring that AI systems are appropriately developed and implemented [17]. It is essential that policymakers and researchers work together to create systems that provide a balance between AI advances and ethical concerns [18]. This will help limit potential negative outcomes while ensuring that AI technologies have a positive impact for and on society [19].

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2 Approach

The aim of this study is to investigate the topic of "Artificial Intelligence, Policy and Ethics" using the Scopus Index database.

2.1 Data Analysis

This article uses bibliometric analysis to examine literature on AI, policy, and ethics. Bibliometric analysis is a method that applies some mathematical and statistical methods to analyze scientific data. Data such as authors, themes, cited authors, and cited sources are examined in a statistical way. This methodology allows us to understand the general framework and future directions of a particular field by analyzing the statistical results of the data.

2.2 Data Collection

The research was conducted on 20.06.2024 by searching the keywords "artificial intelligence, policy, ethics" in the "article title, abstract, keywords" fields in the database. In the research, a progressive order from the most recent scientific studies to the oldest was taken into account. The analysis was carried out with a bibliometric approach. The terms "artificial intelligence, policy, ethics" were used as keywords in the research. The specified keywords resulted in a dataset consisting of 802 records in Scopus that covered the entire scope of this scientific research. These studies were exported in CSV and BibTeX file formats to enable analysis and then analyzed using VOSviewer software to create network maps.

3 Scopus Database and Analysis of Acquired Data

Scopus, a database maintained by Elsevier, is a comprehensive resource that grants academics access to a diverse array of scientific literature. It also provides researchers with sophisticated tools for assessing articles, tracking research outcomes, and visualizing data. This platform offers a comprehensive collection of peer-reviewed journals, books, and conference publications. The content is regularly updated and developed to cater to the wide information requirements of scholars.

3.1 Scopus Data

Some visual results provided by Scopus from the search are shared here. Figure 1 above shows the distribution

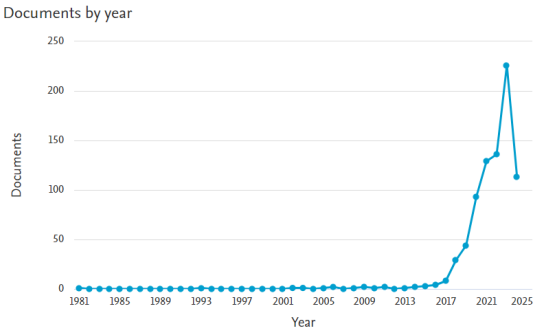

Figure 1. Table of Documents Per Year

of data obtained by searching Scopus using the specified keywords "artificial intelligence, politics, ethics" by year.

Accordingly, until 2014, the number of studies that focused on these topics together in the fields of abstract, title and keyword was almost only 0, 1 or 2. 3 studies were conducted in 2015, 4 in 2016 and 8 in 2017. The number of studies increased to 29 in 2018, 44 in 2019 and 93 in 2020. The number of studies, which was 129 in 2021, increased to 228 in 2023. This graph shows us that this field is increasingly attracting more attention and is gaining more sweat in scientific studies. Figure 2 below shows the sources with the most publications by year and the change in the number of publications by year. Accordingly, Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes InBioinformatics, which has been published since 2010, and Nature, which joined it in 2011, have been the sources that have published on the subject since the beginning. These sources were followed by Science and Engineering Ethics in 2017 and ACM International Conference Proceeding Series in 2018. In 2020, this topic appeared in AI and Society publications, and in 2023, it became the source with the most publications

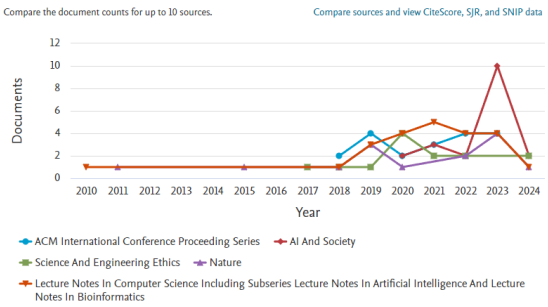

Figure 2. Table of Documents per Year by Source

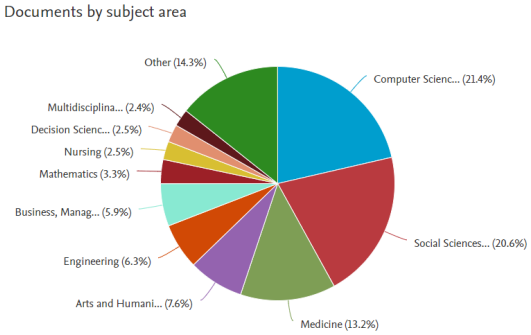

Figure 3. Table of Documents by Subject Area

on this subject. Figure 3 above presents the classification of published studies according to their fields. Accordingly, the field with the most studies was Computer Science with 319 studies. This field is closely followed by Social Sciences with 310 studies. These fields are followed by Medicine with 194, Arts and Humanities with 114, Engineering with 95 studies, Business, Management and Accounting with 88 studies, and Mathematics with 51 studies. Studies in other fields have an average of 21 percent of the total area.

This distribution demonstrates the pervasive nature of AI, ethics, and policy across disciplines, demonstrating their role in advancing research in this area and contributing to various areas of knowledge. The distribution of

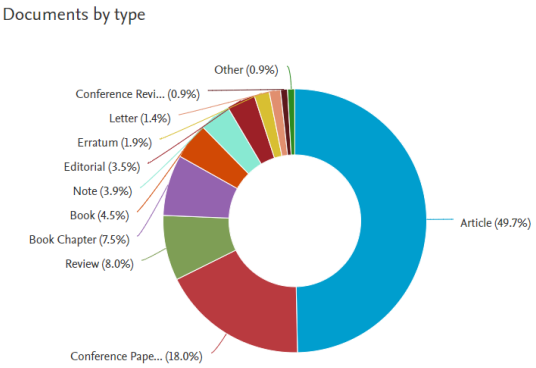

Figure 4. Table of Documents by Type

studies by document type is seen in Figure 4. Accordingly, approximately 50 percent of the total publications, with 404 publications, are in the "Article" type. This type is followed by the "Conference Paper" type with 145 publications and approximately 18 percent. 64 "Review" types constitute 8 percent. This is followed by the "Book Chapter" type with a similar number and percentage. Other types constitute the remaining approximately 15 percent. This distribution reveals the diversity of the types of studies conducted.

3.2 Bibliometric Analysis and Visualization of Results Obtained from VOSviewer

Bibliometric analysis is a methodological approach that applies quantitative analysis and statistics to written communication, such as publications. It is a method used to visualize and evaluate scholarly literature through mapping, to track the impact and dissemination of research through citations, and to uncover patterns of collaboration between authors and institutions. Bibliometric analysis can identify key trends in a field, productive authors, and the geographic distribution of research and resources. The technique has evolved to include complex network analyses that explore relationships among diverse scholarly outputs, and has spanned multiple disciplines. It is effective in understanding the state of scholarly work and the interactions within and among research fields, i.e., collaborative work [20].

3.3 VOSviewer

VOSviewer is a specialized tool designed for the purpose of generating and displaying bibliometric networks. These networks include citation, co-citation, bibliographic linkage, keyword co-occurrence, and co-authorship networks. This software is especially remarkable for its graphical visualization skills, which are essential for presenting massive bibliometric maps in a user-friendly manner. The use of network analysis is crucial in exploratory research since it enables researchers to uncover and visualize connections between different scientific outputs, such as publications, researchers, or thoughts in a specific topic [21].

The academic importance of VOSviewer lies in its capacity to facilitate initial investigations that can inform subsequent, more rigorous study. Researchers can utilize data visualization techniques to analyze co-occurrence data among papers sourced from Scopus, enabling them to identify patterns that may not be readily evident through conventional analysis methods. This not only expands the scope of investigation but also deepens the comprehension of the structure of a particular topic, highlighting the key participants, connections, and areas of focus [22].

In addition, VOSviewer has been included into diverse research procedures and has been utilized in research assessment and management settings. It assists in visualizing and analyzing scholarly activities and collaborations inside and between different fields of study. The program has a wide range of uses in several academic fields, making it a flexible tool for anyone who want to visually analyze scientific data. VOSviewer developers, who are associated with Leiden University's Centre for scientific and Technology Studies (CWTS), offer comprehensive courses that provide extensive training in scientific mapping methodologies. These courses emphasize the significance of the tool and its application in the wider field of research administration and evaluation [23].

3.4 VOSViewer- Co-occurrence of keywords and Bibliographic coupling of countries

Bibliometric analysis is a potent instrument in the complex realm of research, offering valuable insights by quantitatively evaluating academic literature. The visualizations of these studies can reveal the extent and distribution of knowledge across many disciplines, enhancing the understanding of intricate data. The next images and descriptions will explore this process in detail, demonstrating the capabilities of VOSviewer, a software that is used to map and visualize scientific landscapes by analyzing the frequency and co-occurrence of keywords. The following description outlines this technique.

The following image generated by VOSviewer, Figure 5, is used to determine the frequency of keywords in bibliometric analysis through a threshold value. Here, a threshold value of minimum 5 occurrences is set for a keyword to be considered in the analysis. Out of 4853 terms, only 364 of them meet this criterion, i.e. they occur at least 5 times in the analyzed dataset. The threshold value determination process is essential in bibliometric analysis as it allows focusing on the most relevant and frequent expressions and ensures that the resulting visualization accurately depicts the most critical data points.

This VOSviewer figure shows that the software will calculate the overall strength of association relationships between keywords that meet the predefined threshold. Keywords with the greatest overall link strength will be selected for further analysis. The selected number is fixed at 364, which is assumed to be the overall number of terms that meet the first criterion. The selection procedure plays an important role in discovering the most important and related terms in a dataset. These terms are essential for performing comprehensive bibliometric analysis and visualization.

This is a network visualization map created using VOSviewer, showing the connections between various terms in a bibliometric dataset. The most prominent and fundamental nodes, such as "artificial intelligence" and "ethics", symbolize the keywords that appear most frequently and therefore have the most importance within the scientific topic under study. The lines connecting the nodes represent the co-occurrence of terms in the same articles and indicate thematic connections. The proximity of the nodes indicates a higher degree of correlation in the literature and implies the existence of subfields or focused research areas within

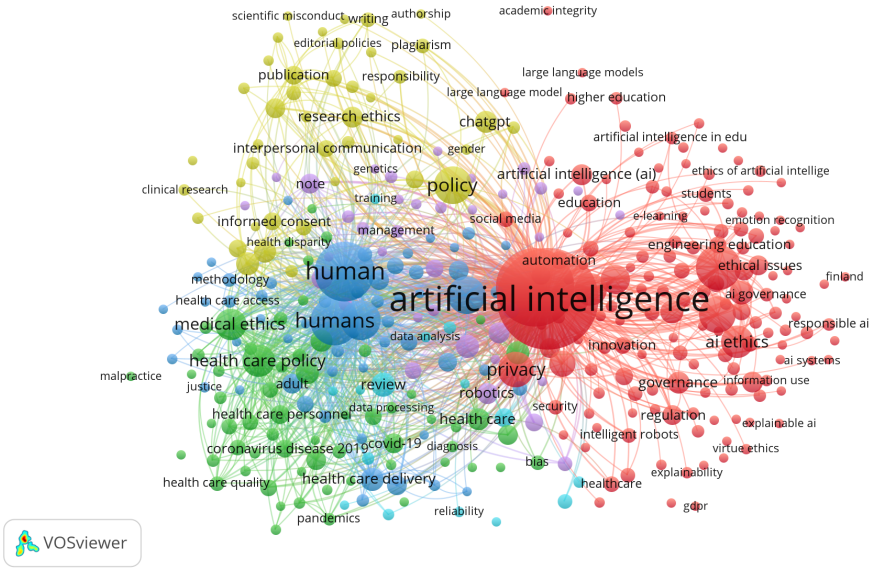

Figure 5. Network Visualization

broader themes. In this network, the word "artificial intelligence" was used 571 times, "ethics" 348 times, and "human/s" 332 times in total, making them the most used words. The word "ethical technology" was examined, which was used 115 times. The other words were used less than 100 times.

The first group, in the Figure 5, is represented by the color red. Among the words in this group, "artificial intelligence, ethical technology, AI ethics, philosophical aspects, privacy" are among the notable words. This group is followed by the second group, represented by the word "human" and shown in blue. Here, "human, humans, machine learning" are the most used words. This group is followed by the third group, represented by green and containing words such as "health care policy, medical ethics, public health". These are followed by the fourth group, represented by the word "policy" and colored yellow. In this group, words such as "research ethics, chatgpt, medical research, practice guideline", which are related to all other groups, attract attention. The image illustrates a bibliometric network visualization, specifically an overlay visualization,

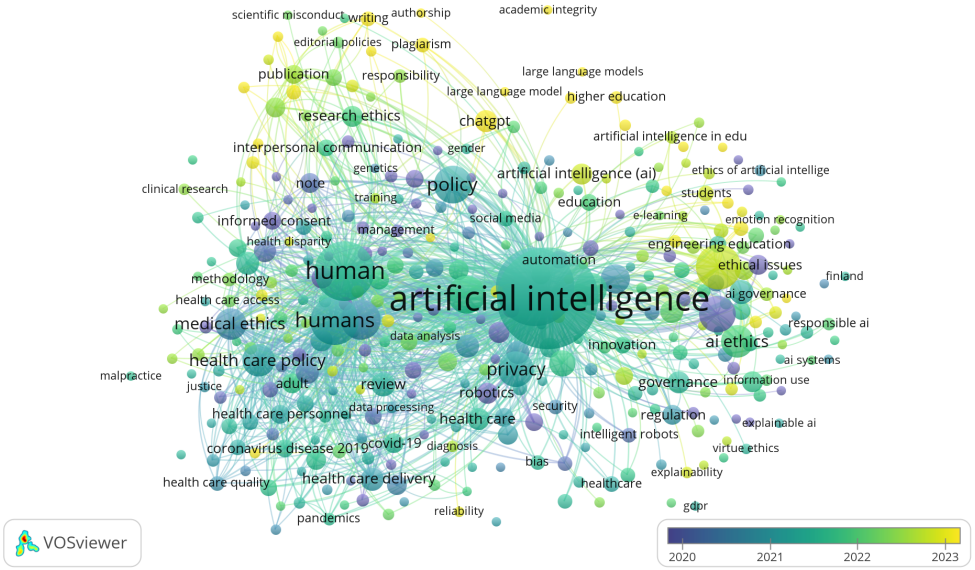

Figure 6. Overlay Visualization

where each node symbolizes a keyword. The node's size corresponds to the keyword's frequency in the dataset, and the lines connecting the nodes represent co-occurrence associations. The colors are most likely associated with distinct years or time intervals, indicating the progression of subjects throughout time. For example, prominent concepts such as "artificial intelligence," "ethics," "human/s" and "policy" indicate that these are major topics in the discipline. The relationships between these concepts and other keywords demonstrate interconnected fields of research.

The network's color overlay reflect the historical evolution of study focus from year to year. In Figure 6, the color change from purple to green and yellow shows us the change of keywords over the years. Accordingly, while words such as "philosophical aspect, research, law, robotics, morality" were used in early 2020, "ethics, artificial intelligent, human, data privacy" became some of the words that started to be seen more in 2021. Looking at 2023 and beyond, the words "ethical technology, chatgpt, human-centric, plagiarism, algorithmics, trust-worthy ai" started to be used more.

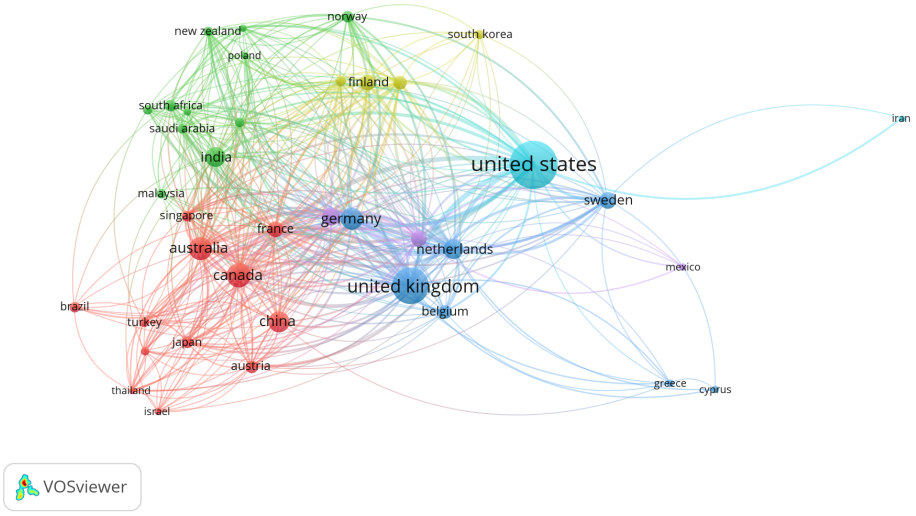

Figure 7. Distribution of Connections Between Countries - Network Visualization

Each node in Figure 7 represents a country, and the size of the node is likely to be proportional to the volume of publications or degree of activity. In determining the bibliographic coupling between countries, 41 countries with a minimum of 5 publications were used, out of 110 countries that met this requirement. The lines serve as indicators of the strength of collaboration or relationships; the thicker and more numerous the lines, the stronger the connections. The presence of central nodes, such as the United States, the United Kingdom, Canada, and India, suggests that these countries are important hubs in the network and are likely to have a greater volume of international collaboration or output. The United States has the most publications, with 238, and the United Kingdom the second most, with 142.

Figure 8 has been widely used to represent transnational collaboration based on academic papers or similar data over time. Colors on the lines and nodes can represent different years and show the progression of coupling over time. Cooler colors represent more recent years, warmer colors represent older years. Countries with a central geographic location and significant influence, such as the United States, the United Kingdom, and Canada, often play a major role in large and deep-rooted international bibliographic coupling. In addition, technologically advanced countries such as India, China, and Japan have also seen growth in coupling on these issues after 2022.

3.5 pyBibX

pyBibX is a Python package that use Artificial Intelligence to improve bibliometric analysis, which is an essential tool in scientific research. This tool offers valuable insights into current research trends, identifies influential researchers, and evaluates the effect of scientific publications. Conventional approaches to bibliometric analysis frequently require significant effort and consume a considerable amount of time. The integration of Artificial Intelligence can significantly enhance accuracy and efficiency. With the increasing

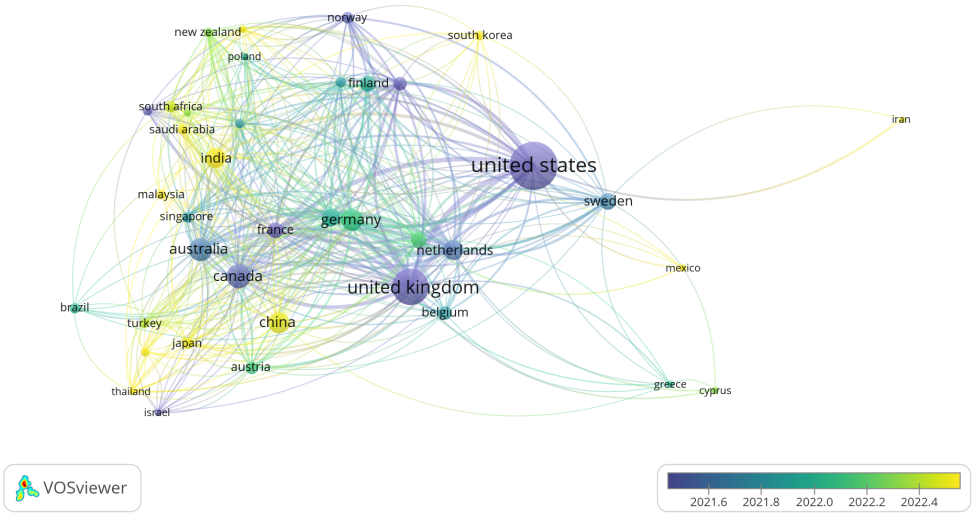

Figure 8. Distribution of Connections Between Countries - Overlay Visualization

number of scientific publications, there is an urgent requirement for sophisticated bibliometric systems that can effectively manage large amounts of data. Artificial intelligence (AI) techniques efficiently analyze vast datasets in an unbiased manner, providing researchers with unparalleled insights. These findings contribute to funding decisions, assist in strategic planning, and influence policies aimed at promoting scientific research. Therefore, the creation of an AI-driven bibliometric analysis tool holds great potential for providing significant advantages to the scientific community and society as a whole[24].

pyBibX is a freely available library for conducting bibliometric and scientometric analyses. It makes use of data from Scopus, WoS, and PubMed. The prominent characteristics of this system include its network capabilities, which encompass Citation, Collaboration, and Similarity Analysis. In addition, the library integrates AI functionalities such as Embedding vectors, Topic Modeling, Text Summarization, and other common Natural Language Processing activities. Additionally, it seamlessly connects with chatGPT. The library currently combines bibliographic sources by using the DOI and preprocessed Title columns for deduplication. This work introduces a tool that distinguishes itself from pyBibX in two distinct manners: firstly, it provides users with the ability to customize instructions for preprocessing databases, and secondly, it conducts deduplication for a user-defined number of columns, taking into account similarity as well as DOI and Title [25].

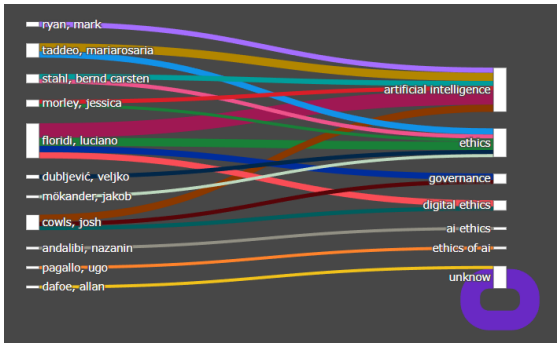

Figure 9. Sankey Diagram of authors and keywords

Sankey diagrams are a visual depiction that illustrates the movement or connection of something. Figure 9 displayed a diagram illustrating the top 20 authors and phrases that were either often used or had significant links among the papers analyzed.

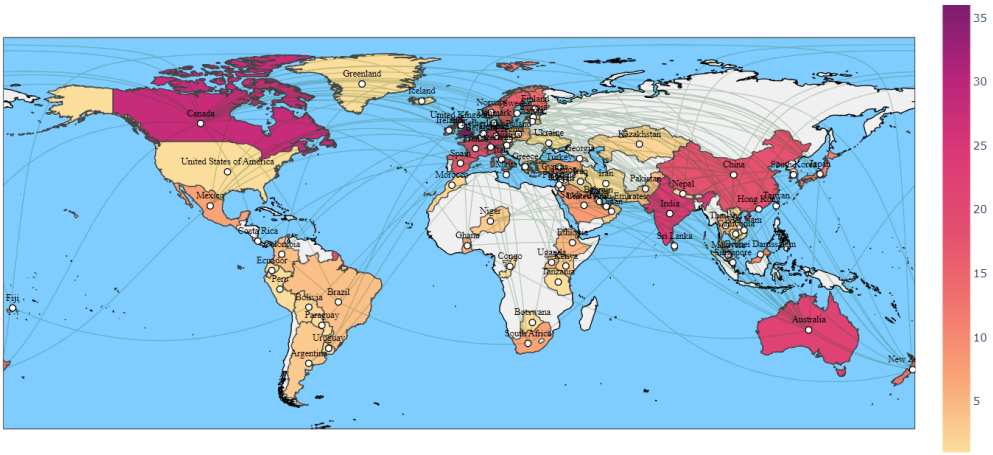

Figure 10. Collaboration Between Countries

This form of analysis, as in Figure 10, can be employed to evaluate the degree of collaboration across distinct nations in diverse scientific endeavors, such as scientific publications or research undertakings. For instance, it can furnish data regarding the countries that collaborate, the extent of their cooperation on specific subjects, and so on. These evaluations are crucial for formulating plans to enhance international research collaboration and for comprehending the global dissemination of scientific information. In the figure, the degree of cooperation between countries is represented by temperature colors.

4 Results and Discussion

During this research, we conducted a comprehensive analysis of the interrelated framework supporting research in artificial intelligence (AI) and ethics and policy. Choosing a bibliometric technique, we conducted a study by analyzing Scopus, a major database of scientific publications. We extracted relevant data by selecting specific keywords that aligned with our research focus. The use of Vosviewer software and the pyBibx library enabled the exploration of this data and revealed the complex networks of keywords and the global commonalities they contained.

When we examined the visualizations produced by Vosviewer, we noticed the prevalence of certain phrases such as “AI, policy” and “ethics”, which emphasized their importance in academic discussions. The analysis of the country collaboration network emphasized the strategic importance of the United States, the United Kingdom, and Canada, and emphasized their key roles as hubs for comprehensive scientific production and exchange. The shift from individual connections to density depiction provided a clearer understanding of the general patterns of international research collaboration.

Based on these observations, we can predict the path of future research and the patterns of international collaboration. This analysis highlights the need to use bibliometric approaches to measure the current state of academic progress. The findings of this study suggest that it would be useful to prioritize and emphasize growing areas where AI overlaps with other disciplines. In addition, it is suggested to encourage the formation of collaborative networks and support research projects that specifically address the gaps observed in less connected regions. The dynamic structure depicted in these graphical depictions is evidence of an ever-evolving scientific pursuit, where collaboration across disciplines and global cooperation are not only advantageous but also necessary for significant progress.

4.1 Limitations of the Study and Future Directions

Research limitations in bibliometric studies often arise from inherent limitations of the data sources. The databases used may not cover all relevant information, thus introducing potential biases. Another limitation is the reliance on keywords, which may miss subtleties in the study topics or may not capture emerging patterns that are not yet firmly established in the vocabulary. Future research could be improved by using other metrics, such as altmetrics, that take into account the impact of research on the Internet and social media platforms. This will provide a more comprehensive view of the impact of research. Furthermore, qualitative analyses have the potential to enhance the quantitative emphasis of bibliometric methods by capturing the essence and meaning behind statistical data.

5 Conclusion

Bibliometric analysis of AI ethical policy literature has shown that ethical issues have not kept up with the pace of AI development. It is essential to conduct more studies on ethics and ethical policies in the field of AI, which is advancing at a dizzying pace and where innovations are added every day. This is the way for the applications of technologies that we develop as humans to be truly beneficial for the benefit of society.

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