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A Bibliometric Analysis for AI-Powered Chatbots

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ABSTRACT

The Elsevier Scopus database's bibliometric analysis of AI chatbots from 2004 to 2024 (20 years) is the subject of this study. The review discovered that this is highly recent literature by bibliographical examination of 915 Scopus-indexed papers, with over 98.46% of the relevant documents released after 2016. The contributions of institutional publications by affiliation showed that University of Toronto had the highest number of publications. In this bibliometric analysis, we examine the application of AI-powered chatbots across various domains, focusing on their potential for service enhancement and the challenges associated with their implementation in universities and higher education environment. By reviewing selected research articles, we identify trends, patterns, and key contributors in this expanding field. Notably, AI chatbots offer numerous advantages, such as efficiently handling user inquiries, which are relevant across multiple sectors. We ensure the scientific validity of the study and provide a concise analysis of the existing literature. This bibliometric analysis aims to contribute to the knowledge base and facilitate discussions and planning for the effective deployment of AI chatbots in different sectors and also in university environment in future. In conclusion, this study provides actionable advice on how to use AI chatbots to maximize their beneficial effects and create supportive settings across various industries in the future to legislators, business executives, and technology developers.

Keywords: Artificial Intelligence (AI), Bibliometric. Chatbots, Universities

1 INTRODUCTION

Universities are with increasing concern realizing the role of artificial intelligence-chatbot based services being incorporated into their structures to improve services delivery to students as well as increasing the experience of learning [1]. The chatbots have the potential of giving students quick and individual responses to their questions which reduced the time that they will be confined to spend time waiting in large queues or spending several rounds to have their problems addressed [2].

To address student queries at the university-level, Rule-Based Chatbots are used to provide a pathway for students those best answers their queries. Pattern design method is used in building a rule-based chatbot, i.e., APU Admin Bot for getting answers of keywords and phrases [3], [33]. These rule-based chatbots are deployed to trigger a pre-defined responses for respective words, phrases or certain actions that user takes through pattern recognition. Through this, administration and academic supports of them would reach to their doors in a second which shall boost the satisfaction amount to an elevated level at institution scale [4]. Placement of AI-based chatbots in learning environments, on the other hand, has been quite restricted. Augmented insight in higher education is about augmenting customer service, which is at the centre of student success.

Chatbots powered by AI have been deployed in multiple industries including e-commerce, online banking and most recently digital healthcare [5]. One of the markets that chatbots might target is students in universities/colleges, and they would offer personal services. Hence, desperately in need to scale and meet the students at a personal level university have started embedding AI chatbots who can respond to their questions and provide extended support. For example, Warwick University has developed AI chatbot prototypes as an ideal solution to assist its departments in the processes of activities [6].

This present bibliometric research will therefore synergies the results of previous research and developments of AI chatbot adopted not just by universities but also for other sectors and domains to determine the opportunities available, the emergent challenge and the trends anticipated in the future. This study aims to investigate the AI Chatbot research in general and its trends in the last 20 years, using a bibliometric approach to assist the research communities in understanding the present condition and predicting the dynamic changes that could occur in the field for prospects.

2 MATERIAL AND METHODS

Among the bibliometric databases, Scopus is the most used one in this study, as it corresponds to the international academic criterion. The search keywords were TITLE (“AI" OR "Artificial intelligence" OR "AI-powered" AND "Chatbot" OR "bot" OR "Virtual Assistant" OR "Conversational Agent” OR “AI Assistant” OR “Chat Assistant” OR “Interactive Agent” OR “AI Assistant”). We used Scopus for data collection because of database comprehensiveness. The first search results were screened with all the topic areas. The search query performed in Scopus brought out 915 articles. The collected data were further analyzed using three different applications: R software, VOS Viewer, Publish and Perish.

All data of this study were obtained from the Scopus database taken on July 3, 2024. Because it is the most searchable citation and abstract source of literature searches [8] and the "largest single abstract and indexing database ever built" [7], the Scopus database was selected.

Results and discussion section encompasses features such as authors, types of articles, authorized keywords, countries, and institutions that are associated with AI chatbot research. These include bibliometric measures like publication structure, productive countries, authors, and institution, significant articles, cited numbers, and author keyword feature. Moreover, co-authorship analysis involves the identification of the collaborative ties between countries/regions, self and other institutions, authors and collaborators [9]. Analyzing the social structures of the field, the study

explores the relationships between countries and organizations in the context of the Chatbot studies. National and institutional partnership networks are illustrated to accentuate the interconnectivity between partners.

For scientific mapping analysis, several software was used which include VOS Viewer, Publish and Perish, and R-software were used because they have extensive features for quantitative data analysis in scientometrics and bibliometrics. Due to their free and open-source nature, these tools offer several advantages, such as integrated data visualization, huge statistical algorithms and high-quality numerical routines [10].

This work aims to achieve an evaluation for each area of research publications published and discover consequent investigative research areas for future development This way, the study aims to add to the body of knowledge enhances the field of AI chatbot research.

Figure 1 shows the process used for a bibliometric analysis on chatbots, focusing on articles from the Scopus database. The search covered all time frames and languages, with keywords targeting terms like "AI," "Artificial Intelligence," and various synonyms for chatbots, such as "Virtual Assistant" and "Conversational Agent." A total of 915 records were identified, all of which were deemed relevant and included for analysis without any exclusions. The data extraction was conducted on 25 July 2024, resulting in 915 records for the final bibliometric analysis.

3 RESULTS AND DISCUSSION

The bibliometric methodology shows the application of a statistical method in revealing the publishing outcomes as well as the patterns when in postulating the gap, remedy, and active areas of study in offering some input to the research community. The documents were collected between the years 2004 and 2024, and 915 outcomes were found considering factors such as document type, source type, annual increment, languages, subjects, keywords, authorship, and citation count. The results are explained in more detail in the following specific subsections.

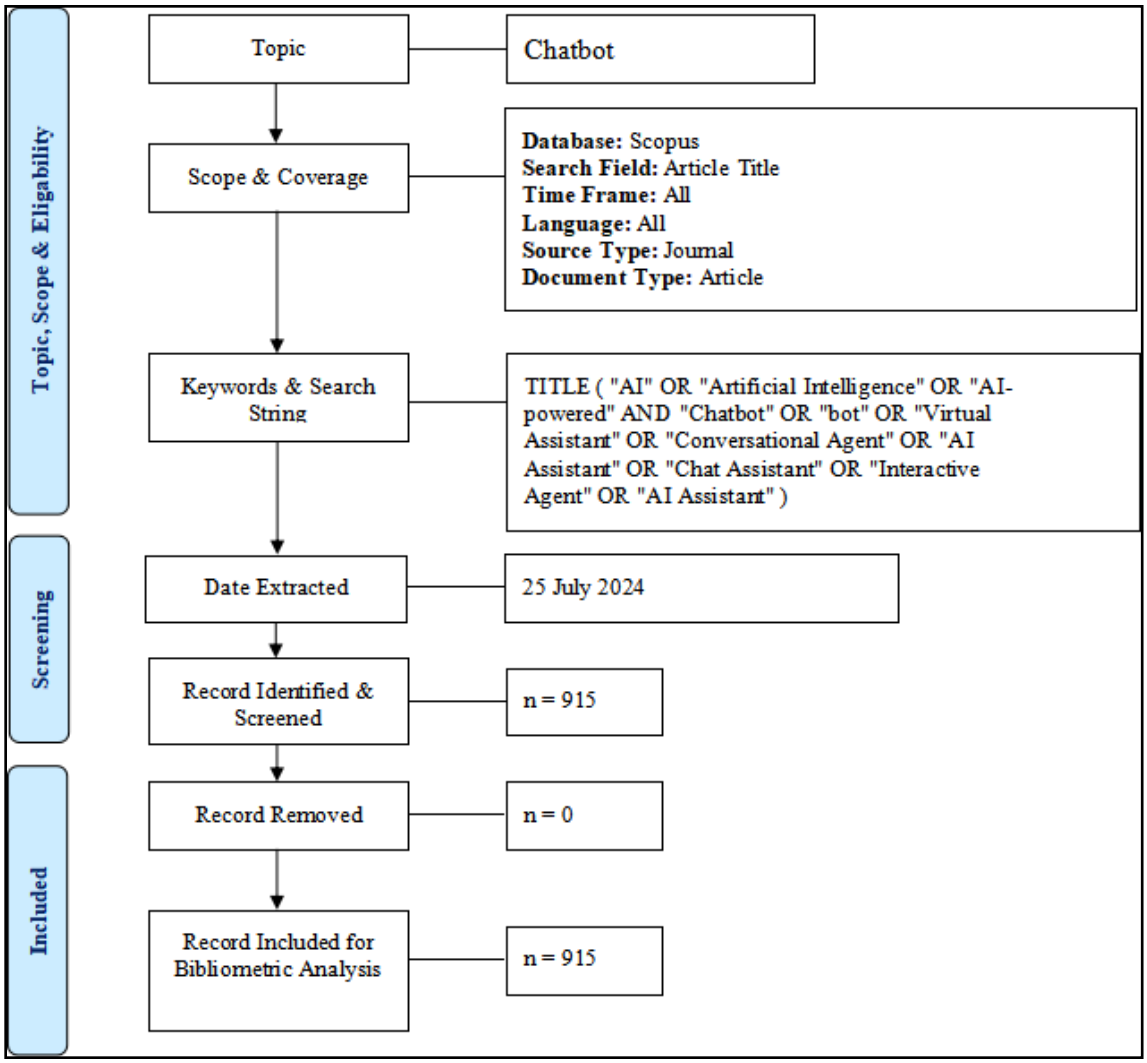

Figure 1: PRISMA Flow Diagram, Source: Adapted from [31] and [11]

3.1 Document and Source Types

Eleven publications—including an article, book chapter, conference paper, review, letter, note, editorial, book, erratum, short survey, and conference review—published in academic journals about AI chatbots were uncovered during this study. According to Table 1, articles accounted for 43.72% of publications, while conference papers made up 41.86%. In the meantime, the combined representation of the other document is around 15%. Conference reviews and short surveys had the lowest percentages, at 0.11% and 0.22%, respectively. The document type is detailed in Table 1.

Table 1: Document types

Document Type	Total Publications (TP)	Percentage (%)
Article	400	43.72%
Conference Paper	383	41.86%
Book Chapter	33	3.61%
Letter	33	3.61%
Note	26	2.84%
Review	22	2.40%
Editorial	8	0.87%
Book	4	0.43%
Erratum	3	0.33%
Short Survey	2	0.22%
Conference Review	1	0.11%
TOTAL	**915**	**100.00%**

Based on Table 2, Journals have the largest representation at 53.66%, and then conference proceedings at 34.21%. Together, books, book series and trade publications account for 12.13%.

Table 2: Source types

Source Type	Total Publications (TP)	Percentage (%)
Journal	491	53.66%
Conference Proceeding	313	34.21%
Book Series	81	8.85%
Book	27	2.95%
Trade Journal	3	0.33%
TOTAL	**915**	**100.00%**

3.2 Trend of Publication by Year

The 915 Scopus-indexed papers that have been published in the past 20 years show how much and how quickly the field of AI chatbot expertise has grown. In 2004, García-Serrano A. M., Martínez P. and Hernández J. Z. released the first study examining AI chatbots under the title "Using AI techniques to support advanced interaction capabilities in a virtual assistant for e-commerce." [12]. The interest in AI chatbot was low until 2016, only 14 documents were published but then from 2016, the number of documents published increased to undefined Half of this body of knowledge was produced in the period 2016–2024 which is 98.47%, which may indicate that this is a quickly emerging field.

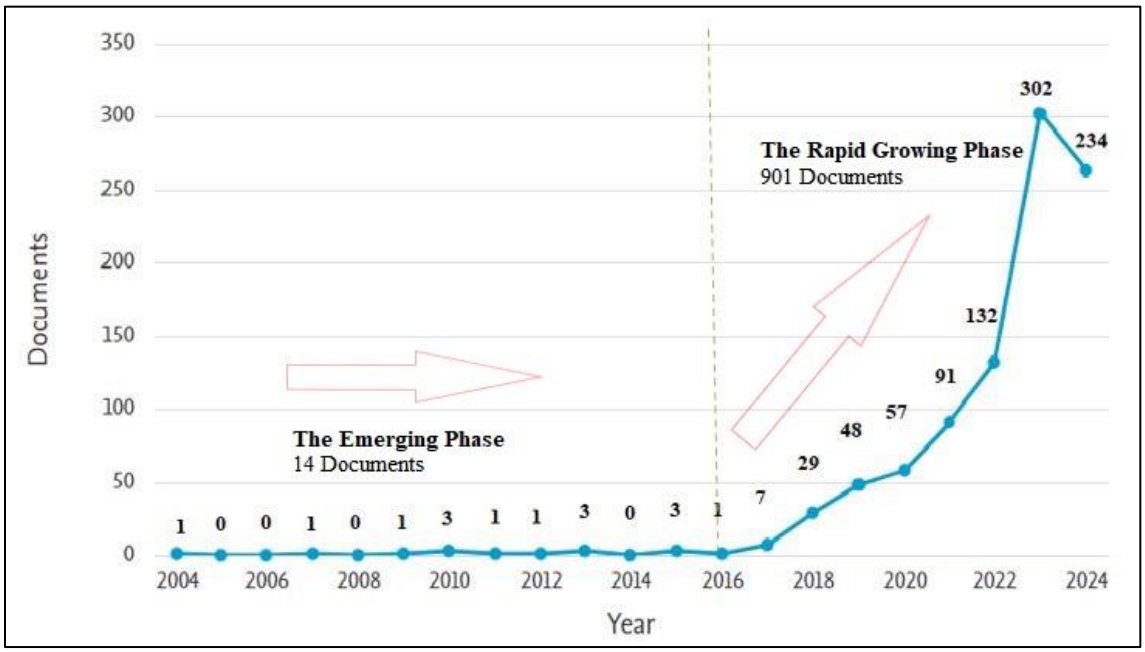

Figure 2: The growth of published papers related to AI chatbots (until 25 July 2024)

The surge in publications on chatbots starting in 2017 can be attributed to a few key factors. Around this time, breakthroughs in artificial intelligence, especially in natural language processing and machine learning, made chatbots far more capable and versatile. This progress coincided with major tech companies launching popular chatbot platforms like Facebook Messenger bots, Google Assistant, and Amazon Alexa, which quickly captured public interest and industry adoption. As chatbots became widely used in areas like customer service, healthcare, and e-commerce, researchers took a keen interest in exploring their effectiveness, challenges, and potential applications. This convergence of technological advancement and practical use cases drove the significant increase in research from 2017 onwards.

3.3 Documents Languages

The sets of data collected have also been analyzed to determine the documents languages that have been published. Table 3 show that most of the writings in the University about AI chatbot are in English. What is also worth mentioning is that publications were also made in Spanish, German, Turkish, Japanese, Croatian, French, Korean, Portuguese, and Russian for some reason. The least used languages for publishing were Croatian, French, Korean, Portuguese, and Russian, at 0.11% each.

Table 3: Publications Languages

Language	Total Publications (TP)*	Percentage (%)
English	897	97.50%
Spanish	8	0.86%
German	5	0.54%
Turkish	3	0.33%
Japanese	2	0.22%
Croatian	1	0.11%
French	1	0.11%
Korean	1	0.11%
Portuguese	1	0.11%
Russian	1	0.11%
TOTAL	**920**	**100.00%**

3.4 Subject Area

Table 4 shows the findings for the research subject area. The largest number of publications were classified in the field of Computer Science with 528 or 57. 70% of the total. “Engineering” takes second with 25.90%, “Social Science” third with 22.73%, and “Medicine” fourth with 21.31%. Other subject areas occupation was less than 13% of the total publications such as mathematics, business management and accounting, physics and astronomy, arts and humanities, energy, psychology, environmental science, economics, econometrics and finance, materials science and neuroscience.

Table 4: Subject Area

Subject Area	Total Publications (TP)	Percentage (%)
Computer Science	528	57.70%
Engineering	237	25.90%
Social Sciences	208	22.73%
Medicine	195	21.31%
Decision Sciences	120	13.11%
Mathematics	117	12.79%
Business, Management and Accounting	98	10.71%
Physics and Astronomy	42	4.59%
Arts and Humanities	41	4.48%
Energy	38	4.15%
Psychology	35	3.83%
Environmental Science	23	2.51%
Economics, Econometrics and Finance	16	1.75%
Materials Science	16	1.75%
Neuroscience	16	1.75%

3.5 Most Influential Institutions

The top 11 universities in the world for AI chatbot research are depicted in Figure 3. With 23 publications, the University of Toronto is the most significant organization. University of Toronto Faculty of Medicine comes in second with 17 articles. Furthermore, St. Michael's Hospital, Toronto, Monash University, McMaster University, and Unity Health Toronto shares the same number of publications which is 9. Figure 3 shows the trend of AI chatbot publications among institutions.

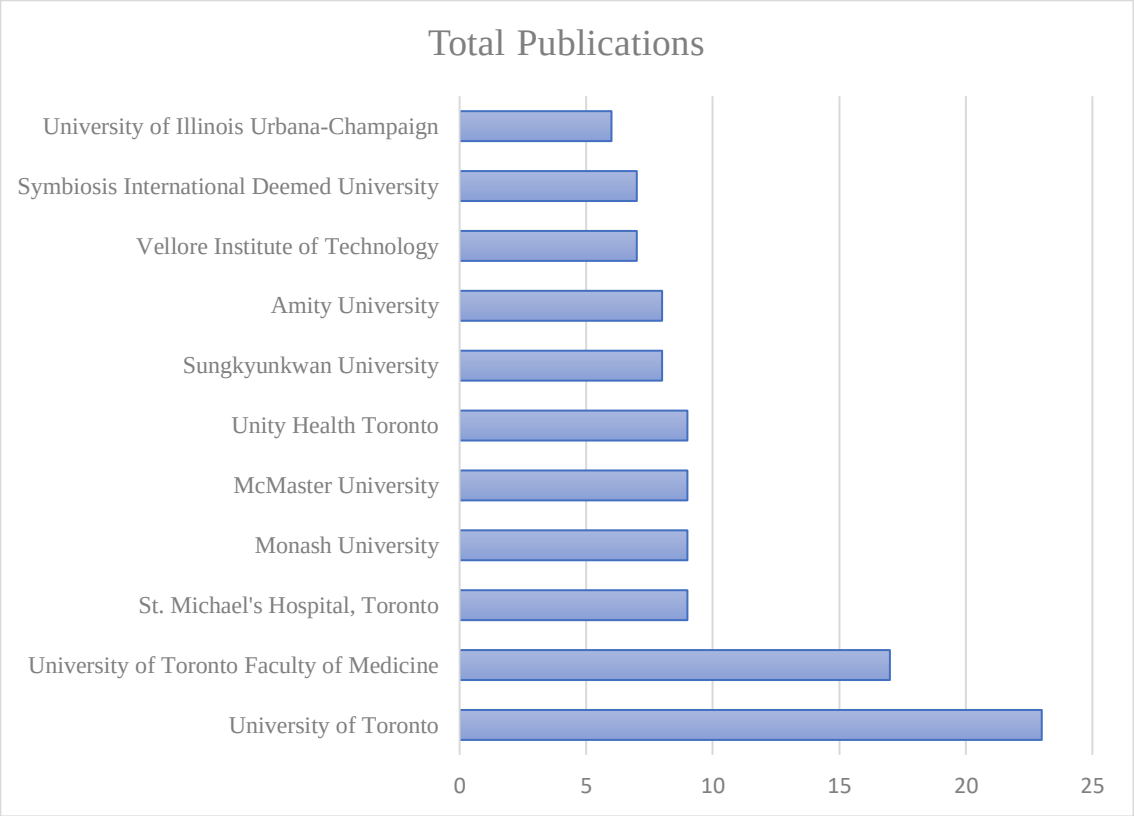

Figure 3: Publications by Institutions

The University of Toronto's strong presence in chatbot research is driven by a few key factors. As a top-tier research institution with a focus on technology and AI, it has access to significant resources and funding dedicated to advancing artificial intelligence. Plus, Toronto is a major hub for AI innovation, attracting talent and encouraging collaboration between universities, industries, and research centers. With specialized research facilities like the Vector Institute, which is dedicated to AI and machine learning, the university has a solid foundation for producing impactful research. This dynamic ecosystem likely plays a big role in Toronto's leadership in chatbot-related studies.

3.6 Citation Analysis

As of July 3rd, 2024, Table 5 displays the citation metrics for the papers that were retrieved. The citation metric for the data that was extracted from the Scopus database was determined using Harzing's Publish or Perish software. The number of citations together with their citations annually, citations per work, and citations per author are all included in the brief description. There were 915 publications totalling 11989 citations, or an average of 599.45 per year, about AI chatbots. 13.10 citations were made to each paper, and the overall h-index and g-index for all the publications were 52 and 93.

Table 5: Citation Metrics

Metrics	Data
Reference date	03/07/2024
Publication years	2004-2024
Citation years	20 (2004-2024)
Papers	915
Citations	11989
Citations/year	599.45
Citations/paper	13.10
Citations/author	4616.98
Papers/author	339.40
Authors/paper	3.77
Hirsch h-index	52
Egghe g-index	93

Table 6 below lists the 17 articles that have been cited the most. The most cited paper to date, with 525 total citations, is [13] with titled "Frontiers: Machines vs. humans: The impact of artificial intelligence chatbot disclosure on customer purchases" [13]. [14] and [15], with their respective articles titled "Real conversations with artificial intelligence: A comparison between human-human online conversations and human-chatbot conversations" and "Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum" [14], come next.

Table 6: Most Cited Papers

Rank	Author(s)	Title	Year	Cites	Cites per Year
1	X. Luo, S. Tong, Z. Fang, Z. Qu	Frontiers: Machines vs. humans: The impact of artificial intelligence chatbot disclosure on customer purchases [13]	2019	525	105
2	J.W. Ayers, A. Poliak, M. Dredze, E.C. Leas, Z. Zhu, J.B. Kelley,	Comparing Physician and Artificial Intelligence Chatbot Responses to	2023	518	518

	D.J. Faix, A.M. Goodman, C.A. Longhurst, M. Hogarth, D.M. Smith	Patient Questions Posted to a Public social media Forum [14]			
3	J. Hill, W. Randolph Ford, I.G. Farreras	Real conversations with artificial intelligence: A comparison between human-human online conversations and human-chatbot conversations [15]	2015	506	56.22
4	P. Lee, S. Bubeck, J. Petro	Benefits, Limits, and Risks of GPT-4 as an AI Chatbot for Medicine.[16]	2023	482	482
5	M. Ashfaq, J. Yun, S. Yu, S.M.C. Loureiro	I, Chatbot: Modeling the determinants of users' satisfaction and continuance intention of AI-powered service agents.[17]	2020	389	97.25
6	T. Nadarzynski, O. Miles, A. Cowie, D. Ridge	Acceptability of artificial intelligence (AI)-led chatbot services in healthcare: A mixed-methods study.[18]	2019	351	70.2
7	K.-C. Yang, O. Varol, C.A. Davis, E. Ferrara, A. Flammini, F. Menczer	Arming the public with artificial intelligence to counter social bots.[19]	2019	284	56.8
8	C. Stokel-Walker	AI bot ChatGPT writes smart essays — should academics worry? [20]	2022	247	123.5
9	V. Taecharungroj	"What Can ChatGPT Do?" Analyzing Early Reactions to the Innovative AI Chatbot on Twitter [21]	2023	190	190
10	M. Milne-Ives, C. de Cock, E. Lim, M.H. Shehadeh, N. de Pennington, G. Mole, E. Normando, E. Meinert	The Effectiveness of Artificial Intelligence Conversational Agents in Health Care: Systematic Review [22]	2020	187	46.75
11	S. Borau, T. Otterbring, S. Laporte, S. Fosso Wamba	The most human bot: Female gendering increases humanness perceptions of bots and acceptance of AI [23]	2021	99	33

12	L. Xu, L. Sanders, K. Li, J.C.L. Chow	Chatbot for Health Care and Oncology Applications Using Artificial Intelligence and Machine Learning: Systematic Review [24]	2021	157	52.33
13	E. Pantano, G. Pizzi	Forecasting artificial intelligence on online customer assistance: Evidence from chatbot patents analysis [25]	2020	124	31
14	J.-S. Chen, T.-T.-Y. Le, D. Florence	Usability and responsiveness of artificial intelligence chatbot on online customer experience in e-retailing [26]	2021	128	42.67
15	U. Bharti, D. Bajaj, H. Batra, S. Lalit, S. Lalit, A. Gangwani	Medbot: Conversational artificial intelligence powered chatbot for delivering tele-health after covid-19 [27]	2020	110	27.5
16	Y. Cheng, H. Jiang	Customer–brand relationship in the era of artificial intelligence: understanding the role of chatbot marketing efforts [28]	2022	108	54
17	P.K. Agarwal	Public Administration Challenges in the World of AI and Bots [29]	2018	100	16.67

3.7 Co-occurrence Network

Two terms in the chatbot field are important in the context of international academic standards: "artificial intelligence" and "conversational agents". Figure 4 summarizes the co-occurrence analysis of networks published between 2004 and 2024. Its importance is shown by the size and arrangement of the corresponding nodes.

The study shows that there are four distinct clusters, represented by the hues red, blue, green, and yellow. Keyword co-occurrence analysis's basic tenet is that terms that appear frequently in several articles may have a thematic relationship between them [30]. The co-occurrence data map is produced using "Author Keywords," which are located in the title and abstract search fields of published publications. We employed the methods for co-occurrence analysis that was previously reported by [31].

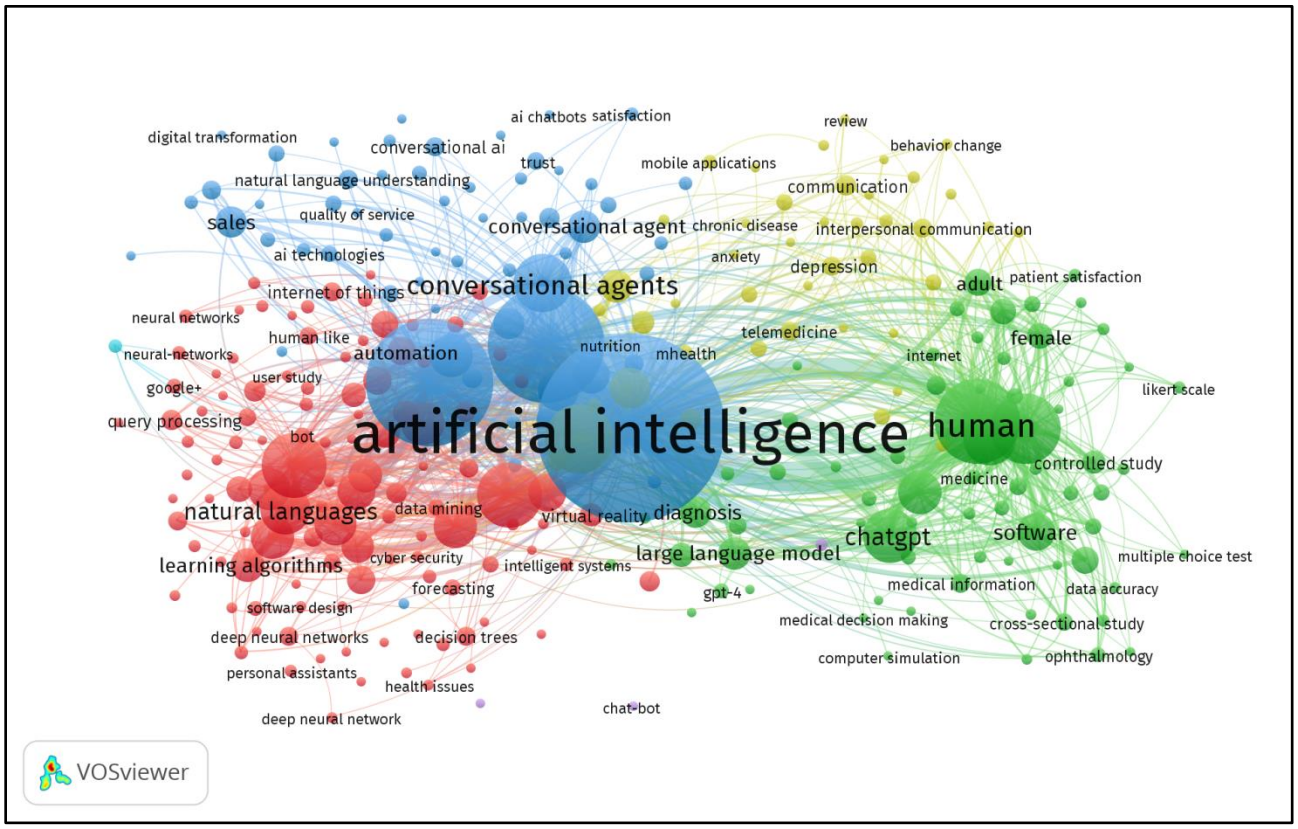

Figure 4: Co-occurrence Network

4 CONCLUSION

A bibliometric analysis of the present research agenda's theme, AI Chatbot, is rated in this document. 915 papers from 2004 to 2024 are included in the Scopus database, according to an analysis of 915 documents. The pattern demonstrated a steady growth in publications, from 1 paper in 2004 to 234 in 2024. From 2004 to 2015, the average number of publications was 1, but from 2016 to 2024, it sharply increased to 113 publications annually. This spike in publications was noted during the designated period. The majority of the documents in this count were published as conference proceedings and journal articles, accounting for 34.21% and 53.66%, respectively. The language percentage of English used in these publications is 97.50%. Furthermore, University of Toronto is the most influential institution, followed by University of Toronto Faculty of Medicine and St. Michael's Hospital, Toronto.

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