






The Determination and Visualisation of Key Concepts Related to the Training of Chatbots

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Abstract. This study aims to identify and visualize key concepts related to chatbot training through bibliometric analysis. The analysis of 549 sources from Scopus revealed a significant increase in publications from 2018, with a surge in 2023 likely driven by ChatGPT's advent. We have identified four clusters of research areas. Those clusters are: (1) natural language processing; (2) application of natural language processing technologies in society; (3) application of machine learning for natural language processing; (4) chatbots in education and services. Central concepts were identified within each cluster. The results of our findings define natural language understanding, language modelling, controlled use of large language models in education, application of virtual assistants and diagnostic systems, and integration of chatbots into adaptive learning systems as the most prominent leading research directions. The same results offer implications for education, AI research, and organizational strategies for integrating conversational agents. Key concepts are possible to integrate into curriculum development and future research in natural language processing.

Keywords: Chatbot Training · Natural Language Processing · Machine Learning · Bibliometric Analysis

1 Introduction

Recently, there has been a rapid growth in interest and research in the field of creating and training chatbots. Leading IT companies such as Google, Microsoft, Meta (Facebook), and OpenAI are actively working on developing chatbots. In particular, the ChatGPT project from OpenAI [17] has gained widespread recognition.

In the mentioned research, two main groups of tasks can be distinguished: (1) teaching (instruction and learning) students; (2) building chatbots – “question-answer” systems that train their models on data obtained from the user.

Chatbots as natural language artificial intelligence systems have a huge potential to improve the efficiency and quality of various types of human activity by automating routine processes, providing intellectual support to users, providing personalised training, etc. [18, 19]. Successful developments in this field can fundamentally change the nature of human interaction with computer systems in the future and increase work productivity

and education. At the same time, solving ethical and security problems is critical for implementing these technologies in the public interest.

Based on the search results on the DeepLearning.AI blog [11] from 2019–2023, the following practically solved tasks can be highlighted:

- since 2020, chatbots (Generative BST from Facebook and Google Meena) can be used for *short dialogues on general topics* [1, 2];
- since 2023, Microsoft has allowed the use of chatbots in Office 365 and Windows for *productivity improvement* [5];
- since 2020, chatbots are actively *applied in business* for customer service, sales, etc. [6];
- since 2023, Google and Microsoft have introduced chatbots into *search engines* [8].

Articles in the DeepLearning.AI blog also point out gaps in knowledge and open problems in this field: medical chatbots may provide *incorrect diagnoses* [3]; chatbots like BlenderBot 3 and Galactica may *exhibit bias, toxicity, and distort facts* [4]; the *high cost of deploying large language models* [7]; lack of transparency in chatbot models can raise *ethical questions* [9].

The **research aims** are the identification and visualisation of key concepts related to the training of chatbots.

2 Materials and Methods

According to the goal, the following main **research tasks** were identified:

1. Conduct a bibliometric analysis of sources on the issue of training chatbots to identify key research concepts.
2. Identify the most significant key concepts of the research and construct a map of their relationships.

The research methodology employed in this study comprises two main components: bibliometric analysis [16] and the utilisation of large language models (LLMs).

For the search, the scientometric database Scopus of the Elsevier publishing house was chosen as one of the largest abstract databases, which indexes more than 42 thousand periodicals and contains mostly high-quality scientific sources from technical, natural, medical and social sciences, which makes it representative for the analysis of publications on the issues of training chatbots at the intersection of several scientific fields. The balanced coverage of various scientific disciplines in Scopus provides the necessary completeness to identify key trends and directions of research in the chosen field [15].

A comprehensive bibliometric analysis was conducted on the search results on the research topic. This analysis served the following purposes:

1. Identify the chronological boundary from which a steady increase in publications on the research topic is observed.
2. Create a map of relationships between keywords, illustrating the interconnections and co-occurrences within the literature.
3. Cluster keywords into distinct groups, facilitating the identification of distinct themes or concepts within the research domain.

4. Determine key research concepts based on the frequency and importance of specific keywords.

VOSviewer 1.6.20 [10] was used for the bibliometric analysis. VOSViewer is a software tool designed to construct and visualise bibliometric networks. This study employed VOSViewer to generate co-occurrence networks of keywords and concepts from the collected publications. These networks visually represent the relationships and interconnections between different topics, allowing for the identification of prominent themes and clusters [13]. The generated co-occurrence networks were analysed to identify related topics and concept clusters. These clusters were interpreted and labelled based on their content, providing insights into the key areas and themes relevant to the issue of training chatbots.

3 Experiments

To complement the bibliometric analysis, state-of-the-art LLMs were employed [14] to generate assumptions about cluster names (Appendix A). The rationale behind this approach is as follows:

1. LLMs like GPT 4.0 are trained on vast amounts of textual data, enabling them to develop a deep understanding of language, context, and the relationships between words and concepts. By providing the LLM with the keywords within each cluster obtained from the bibliometric analysis, it can leverage its language understanding capabilities to propose potential cluster names or labels that capture the underlying concepts represented by those groups of keywords.
2. The LLM can analyse the semantic relationships between the keywords, identify common themes or ideas, and generate cluster names that summarise or encapsulate the broader concepts associated with each group. This process is valuable when the keyword clusters are not easily interpretable or need more descriptive or meaningful labels.

4 Results

To determine the works where the key research concepts of “training” and “chatbots” are mentioned, a search was conducted in the Scopus database [12] on November 18, 2023. Documents were selected in which the words “chatbot” and “training” simultaneously appeared in the titles, abstracts, and keywords. The total number of documents is 549, and the distribution of documents by years is presented in Fig. 1.

The keywords that are most frequently encountered include Chatbot (244), Chatbots (221), Artificial Intelligence (126), Natural Language Processing Systems (90), and Natural Language Processing (90). Alphabetical ordering of keywords allows determining which ones differ only in number (singular and plural) and consolidating them into singular forms:

- Chatbots is the plural form of Chatbot;
- Conversational Agents is the plural form of Conversational Agent;
- Convolutional Neural Networks is the plural form of Convolutional Neural Network;

- Customer Services is the plural form of Customer Service (Customer-service);
- Dialogue Generations is the plural form of Dialogue Generation;
- Humans is the plural form of Human;
- Large Language Models is the plural form of Large Language Model;
- LSTM is an abbreviation for Long Short-term Memory;
- Machine-learning is a synonym for Machine Learning;
- Mobile Applications is the plural form of Mobile Application;
- NLP is an abbreviation for Natural Language Processing (NAatural Language Processing);
- NLU is an abbreviation for Natural Language Understanding;
- Reinforcement Learnings is the plural form of Reinforcement Learning;
- Virtual Assistants is the plural form of Virtual Assistant.

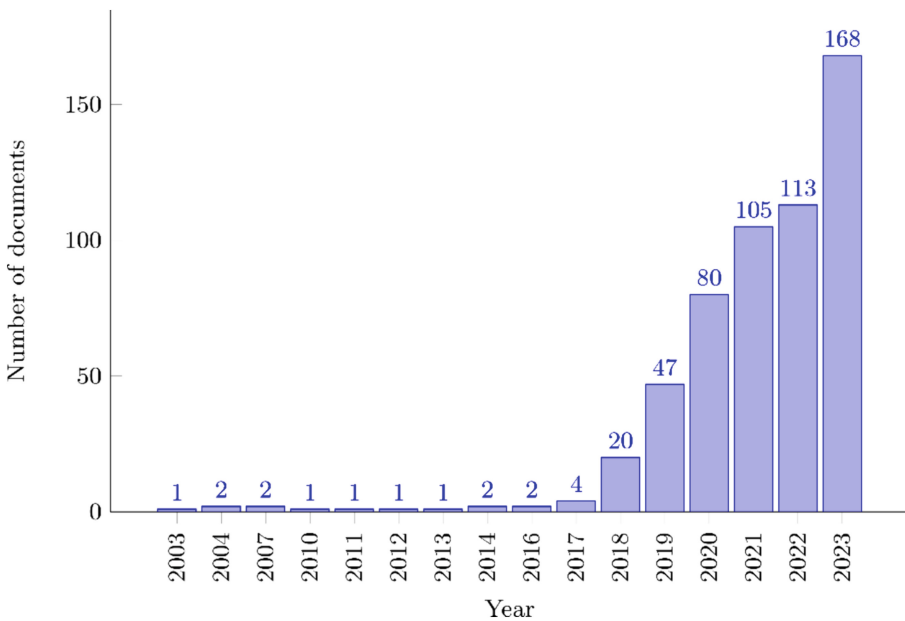


Fig. 1. Distribution of search results by year.

The found documents were exported in CSV [20, p. 30] and BibTeX formats. In the CSV file, plural and abbreviated keywords were replaced with their singular forms.

For bibliometric analysis, VOSviewer 1.6.20 [10] was used: *Create... → Create a map based on bibliographic data → Read data from bibliographic database file → Scopus*). The map was created with the following parameters: analysis type – co-occurrence; unit of analysis – all keywords; counting method – full counting. VOSviewer automatically groups keywords into clusters based on their semantic proximity and visualises the results on a map, using different colours to indicate individual clusters.

The total number of keywords is 3705, and it can be reduced to 58 by discarding those that appear fewer than 12 times. The term “article” was also excluded from the selected words as it is not specific to the search query.

The constructed map (Table 1) is presented in Fig. 2.

Table 1. Distribution of keywords by clusters.

Keyword	Cluster	W_{Links}	$W_{Total\ link\ strength}$	$W_{Occurrences}$	$S_{Avg.\ pub.\ year}$	$S_{Avg.\ citations}$	$S_{Avg.\ norm.\ citations}$	Significance
classification (of information)	1	37	122	24	2021.2083	3.7917	0.5908	3
training data	1	36	120	27	2021.1111	12.8519	1.8358	3
speech processing	1	36	102	26	2020.4615	9.4231	1.1619	1
performance	1	36	88	24	2021.5833	6.2917	1.02	2
semantics	1	34	90	18	2020.7222	8.8333	0.9379	
dialogue systems	1	33	96	23	2020.4348	8.4348	1.0096	
natural language understanding	1	32	123	32	2020.9375	6.0938	0.8055	3
computational linguistics	1	32	114	33	2020.1515	16.1515	2.0909	6
text processing	1	31	97	16	2021.25	4.4375	0.6438	
long short-term memory	1	30	113	24	2020.7917	4.8333	0.6383	
state of the art	1	29	54	14	2021.0714	4.0714	0.5852	
language model	1	28	61	14	2021.9286	3.5	0.6501	2
question answering	1	28	60	12	2021.1667	1.4167	0.2476	
information retrieval	1	27	51	12	2020.4167	9.3333	0.9633	
embeddings	1	24	53	13	2020.8462	7.5385	0.6933	
reinforcement learning	1	23	52	15	2020.0667	9.0667	1.1396	
response generation	1	17	37	12	2020.75	11.5833	1.343	
artificial intelligence	2	52	452	126	2021.3333	9.8571	1.8428	6
conversational agent	2	47	203	50	2020.18	18.68	1.9112	1
human	2	37	266	60	2022.1167	15.7667	2.7326	2
adult	2	29	117	17	2021.9412	17	2.3017	
training	2	29	84	22	2021.7727	16.7273	3.5069	2
male	2	27	94	13	2021.4615	23.3846	3.0896	1
medical education	2	27	66	12	2022	3.5833	0.557	

(continued)

Table 1. (continued)

Keyword	Cluster	W_{Links}	$W_{Total\ link\ strength}$	$W_{Occurrences}$	$S_{Avg.\ pub.\ year}$	$S_{Avg.\ citations}$	$S_{Avg.\ norm.\ citations}$	Significance
female	2	26	101	16	2021.375	22.6875	2.6942	
controlled study	2	26	76	15	2022.2	9.2	1.6989	1
health care	2	26	67	15	2021.4	3.6	0.51	
mental health	2	25	56	13	2021.3846	22.6154	2.2811	
chatgpt	2	24	124	35	2023	4.8	1.4989	2
education	2	24	77	19	2021.1053	12.4211	3.3792	1
covid-19	2	23	47	13	2021.9231	3.5385	0.884	
review	2	19	70	12	2021.9167	34.25	3.3067	2
large language model	2	19	50	12	2023	2.9167	0.9108	2
natural language processing	3	54	505	100	2021.28	6.29	1.1837	6
natural language processing systems	3	52	484	90	2020.7667	5.5667	0.6711	3
machine learning	3	50	276	51	2021.4314	8.9412	1.0081	
deep learning	3	46	265	56	2021.1429	5.6607	0.6799	
natural languages	3	42	235	40	2021.5	4.1	0.6042	
language processing	3	37	165	25	2022.56	1.6	0.5094	2
learning algorithms	3	37	153	26	2021.0769	3.4231	0.4283	
virtual assistant	3	35	67	15	2021.0667	13.3333	1.5093	3
user interfaces	3	29	61	14	2020.8571	8.9286	1.7491	2
convolutional neural network	3	26	53	12	2020.9167	6.4167	0.7242	
query processing	3	24	82	14	2021.1429	1.4286	0.3373	
diagnosis	3	24	53	13	2021.5385	9.8462	1.3824	2
chatbot	4	56	1065	365	2021.137	6.3014	0.901	6
learning systems	4	46	223	43	2020.2326	7.186	0.4899	3
students	4	42	176	38	2020.9737	8.2105	0.9839	
e-learning	4	35	128	37	2020.8378	5.0541	0.6268	
learn+	4	27	53	13	2021.7692	3.9231	0.6622	2
sales	4	26	64	17	2021	5.5882	0.6926	
human computer interaction	4	26	53	14	2019.8571	6.0714	0.5181	

(continued)

Table 1. (continued)

Keyword	Cluster	W_{Links}	$W_{Total\ link\ strength}$	$W_{Occurrences}$	$S_{Avg.\ pub.\ year}$	$S_{Avg.\ citations}$	$S_{Avg.\ norm.\ citations}$	Significance
knowledge based systems	4	26	51	13	2019.5385	15.5385	0.7796	2
personnel training	4	25	62	18	2020.8889	6.5556	1.4229	1
curricula	4	24	58	12	2021	9.5833	2.41	3
customer service	4	24	49	15	2021.2	4.2667	0.4819	1
engineering education	4	24	46	12	2020.75	4.5833	0.4115	

Table 1 uses the following notations [20, pp. 6, 38]:

- keyword: a term defined by the author or indexing system, characteristic of a publication;
- cluster: the number of the group of keywords;
- W_{Links} : the number of links of a keyword with other keywords;
- $W_{Total\ link\ strength}$: the total strength of the links of a keyword with other keywords (in this case, the number of publications where two terms occur together);
- $W_{Occurrences}$: the number of documents in which a keyword occurs;
- $S_{Avg.\ Pub.\ Year}$: the average publication year of the documents in which a keyword occurs;

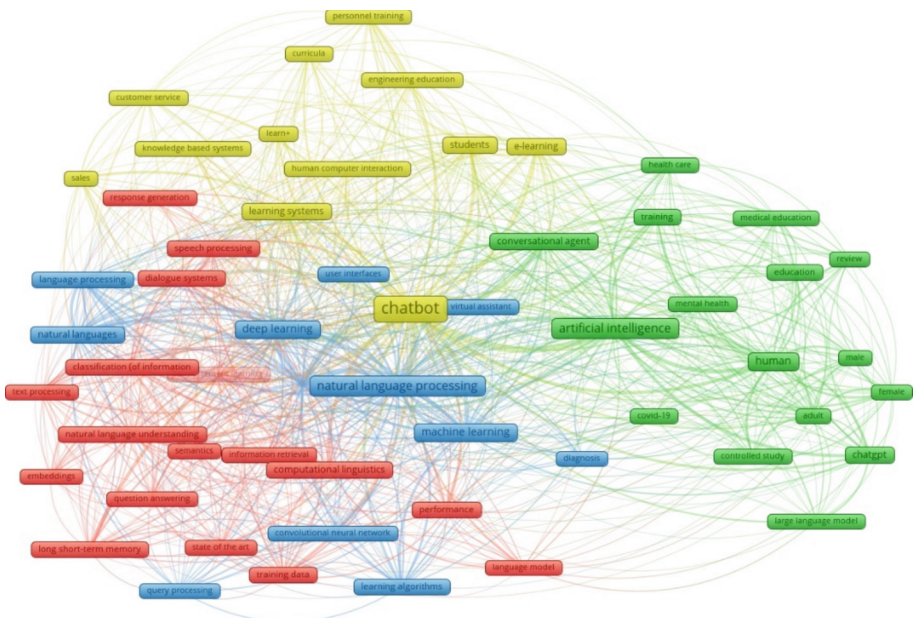


Fig. 2. Keyword relationship map.

- $S_{Avg. Citations}$: the average number of citations received by the documents in which a keyword occurs;
- $S_{Avg. Norm. Citations}$: the average normalised number of citations received by the documents where a keyword occurs;
- significance: calculated as the sum, where for each keyword, 2 is chosen if it has the highest value in the column (cells in bold values), and 1 if it has the value that precedes the highest one (cells in italic values).

In Appendix A, the results of using generative chatbots ChatGPT (GPT 3.5), Bing (GPT 4.0, 3 modes), Claude 2, and Google Bard to determine cluster names are presented (Table 2).

Table 2. Names of keyword clusters.

No	Suggestions from chatbots	Chosen name
1	Advanced Language Processing and AI Applications (A.1); Language Processing and Information Retrieval (A.2); Natural Language Processing (NLP) (A.3); Natural Language Understanding and Generation (A.4); Natural Language Processing Applications (A.5); Technical NLP (A.6)	Natural Language Processing (A.3)
2	AI in Healthcare and Social Context (A.1); AI in Healthcare and Education (A.2); Artificial Intelligence (A.3); Artificial Intelligence and Health Care (A.4); Conversational AI and Impacts (A.5); Applications of NLP (A.6)	Application of natural language processing technologies in society (A.6, A.5, A.1)
3	Core Technologies in Natural Language Processing and Machine Learning (A.1); Machine Learning and User Interaction (A.2); Machine Learning (A.3); Natural Language Processing and Machine Learning: (A.4); Core AI and ML Techniques (A.5); Machine Learning and Deep Learning for NLP (A.6)	Application of machine learning for natural language processing (A.6, A.4)
4	Educational and Service-oriented AI Applications (A.1); AI in Education and Customer Service (A.2); Learning Systems (LS) (A.3); Chatbot and Education (A.4); AI for Training and Customer Service (A.5); Chatbots and Learning Systems (A.6)	Chatbots in education and services (A.1, A.2, A.4, A.5)

Involved LLMs generated several variants of names and descriptions of clusters based on analysing keywords that are part of them. For each cluster, all options proposed by the models are listed with the designations A.1, A.2, etc.

5 Discussion

The selection of the final names of the clusters presented in the “Chosen name” column of Table 2 was carried out through careful analysis and critical evaluation by the authors of all proposals generated by different models. The critical selection criteria were meaningfulness, clarity, and brevity of the names while at the same time maximally comprehensive coverage of the key terms in the clusters.

The chosen names of the clusters not only summarise their content but also logically reflect the main directions of research in the field of chatbot training revealed by the results of the bibliometric analysis: (1) basic methods of natural language processing; (2) application of appropriate technologies in various spheres of social activity; (3) the use of machine learning as a leading tool for the development of natural language data processing systems; (4) the range of key applications of chatbots, in particular in the educational and service industries.

Thus, the final choice of cluster names was the result of combining the capabilities of LLMs with the authors’ expert opinion. It is based on precise, well-founded positions aimed at avoiding uncertainties in the interpretation of the obtained results.

The map of keyword relationships with a significance of at least 1 is shown in Fig. 3. This map allows us to analyse the relationships between the study’s central concepts and visualise the leading directions within each cluster.

This map focuses on the most important keywords, selected according to the principle of maximum and pre-maximum values of selected indicators (number of connections, total weight of connections, number of mentions in publications, average years of the year of publication, citations, etc.). Visualising the most significant terms and their interrelationships makes it possible to identify priority areas in each of the researched areas and outline promising directions for future scientific research.

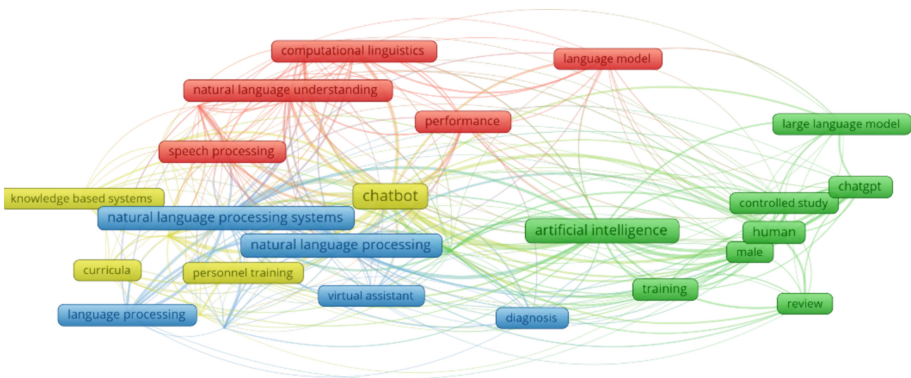


Fig. 3. Link map of the most significant keywords.

This approach allows for detail and deepens the conclusions made on the basis of the general map of keywords, focusing directly on the central concepts of training chatbots as leading agents of artificial intelligence.

6 Conclusions

1. Bibliometric analysis of 549 sources from the Scopus database on the issue of training chatbots provided the opportunity to:
 - a. identify the lower chronological limit (2018) from which a steady increase in the number of publications on training chatbots is observed;
 - b. suggests that the significant increase in the number of works in 2023 (55 more than in 2022) is likely due to the availability of ChatGPT in open access and the related hype about the large language models and chatbots;
 - c. group sources on training chatbots into 4 clusters: (1) natural language processing; (2) application of natural language processing technologies in society; (3) application of machine learning for natural language processing; (4) chatbots in education and services.
2. To identify the most significant keywords in each cluster, the keywords with the highest and next highest values for the following indicators were determined: the number of links, the total strength of links, the number of documents with the given keyword, and the averages for publication year, citations, and normalised citations. The significance of the selected keywords was then calculated from 1 to 6:
 - a. in the first cluster (natural language processing), the most significant are seven keywords (41%): computational linguistics (6), natural language understanding (3), performance (2), language model (2), and speech processing (1);
 - b. in the second cluster (application of natural language processing technologies in society), the most significant are ten keywords (63%): artificial intelligence (6), large language model (2), chatgpt (2), human (2), training (2), review (2), conversational agent (1), controlled study (1), education (1), and male (1);
 - c. in the third cluster (application of machine learning for natural language processing), the most significant are six keywords (50%): natural language processing (6), natural language processing systems (3), virtual assistant (3), language processing (2), user interfaces (2), and diagnosis (2);
 - d. in the fourth cluster (chatbots in education and services), the most significant are seven keywords (58%): chatbot (6), learning systems (3), curricula (3), learn+ (2), knowledge-based systems (2), personnel training (1), and customer service (1).
3. During the analysis of the keyword map, it was found that the third cluster (application of machine learning for natural language processing) has certain intersections with the content of the first (natural language processing) and second (application of natural language processing technologies in society) clusters. This is because machine learning methods, particularly deep learning, are fundamental tools for developing natural language processing systems and their applications. Therefore, some key terms of the third cluster, such as natural language processing, virtual assistants, neural networks, etc., are closely related to the concepts of the other clusters. This testifies to the close integration of various research areas in the single scientific field of creating intelligent

conversational agents. Further analysis of intersections between clusters can become a promising direction of future scientific research for a clearer demarcation of subject areas.

4. The analysis of the map of relationships among the most significant keywords has provided insights into the leading research directions:
 - a. in natural language processing through computational linguistics, the focus is on natural language understanding, building language models, and speech recognition;
 - b. in the application of artificial intelligence technologies for natural language processing, there is a controlled use of large language models and chatbots (specifically ChatGPT) in education;
 - c. in the application of machine learning for natural language processing, the emphasis is on using virtual assistants, natural language user interfaces, and other natural language processing systems, particularly for diagnostic purposes;
 - d. in the application of chatbots in education and services, the focus is on using chatbots in learning systems and knowledge management systems for augmented and adaptive learning.
5. The results of the bibliometric analysis can be used:
 - in education:
 - a. identified priority areas of research in the field of training chatbots that can be used to develop course syllabuses, training programs for specialists in natural language processing and development of artificial intelligence systems;
 - b. identified key concepts can serve as a basis for the development of educational materials designed to highlight the most important concepts and technologies for creating conversational agents;
 - c. review of the applications of chatbots in the educational process outlines promising ways of their integration into systems of adaptive and personalised learning;
 - in scientific research:
 - a. mapping of the relationships of key concepts can serve as a basis for the formation of scientific hypotheses and the construction of conceptual models during the design of research;
 - b. the results of the analysis open perspectives for further bibliometric studies of dynamics and relationships in the subject field;
 - c. the identified priority directions determine the current vectors of future scientific research in artificial intelligence and its use in scientific research in social sciences.

The identified directions can be helpful for organisations when developing strategies for using artificial intelligence and integrating conversational agents into production.

Appendix A. Results of Applying Generative Chatbots to Determine Cluster Names

The query was created on November 30, 2023. It contained information about the number of clusters and keywords related to each cluster. Chatbot responses were expected to provide suggestions for the clusters' names and content. The chatbot prompt:

“There are 4 clusters of keywords related to chatbot training research:

Cluster 1: classification (of information), training data, speech processing, performance, semantics, dialogue systems, natural language understanding, computational linguistics, text processing, long short-term memory, state of the art, language model, question answering, information retrieval, embeddings, reinforcement learning, response generation.

Cluster 2: artificial intelligence, conversational agent, human, adult, training, male, medical education, female, controlled study, health care, mental health, chatgpt, education, covid-19, review, large language model.

Cluster 3: natural language processing, natural language processing systems, machine learning, deep learning, natural languages, language processing, learning algorithms, virtual assistant, user interfaces, convolutional neural network, query processing, diagnosis.

Cluster 4: chatbot, learning systems, students, e-learning, learn+, sales, human computer interaction, knowledge based systems, personnel training, curricula, customer service, engineering education.

Please suggest cluster names and brief descriptions for each of the 4 clusters based on the keywords.”

ChatGPT (GPT 3.5)

1. *Advanced Language Processing and AI Applications*: This cluster focuses on advanced language processing techniques and various AI applications related to text and speech. It encompasses topics like natural language understanding, computational linguistics, information retrieval, dialogue systems, and the utilisation of cutting-edge technologies such as long short-term memory (LSTM), embeddings, and reinforcement learning in language models and question answering systems.
2. *AI in Healthcare and Social Context*: This cluster centers around the applications of artificial intelligence in healthcare, mental health, and education with a focus on human interaction. It explores the use of conversational agents, particularly in medical education, mental health care, and addressing issues like COVID-19. Additionally, it touches on the gender aspect in AI studies by mentioning controlled studies with adults and gender variations.
3. *Core Technologies in Natural Language Processing and Machine Learning*: This cluster revolves around foundational technologies crucial in natural language processing and machine learning. It includes topics such as deep learning, machine learning algorithms, language processing, neural networks (like convolutional neural networks), query processing, and the development of virtual assistants and user interfaces.
4. *Educational and Service-oriented AI Applications*: This cluster focuses on AI applications in education, learning systems, and service-oriented domains. It highlights topics like e-learning, knowledge-based systems, human-computer interaction, customer service, and sales. It also touches upon the use of AI in student learning, engineering education, and personnel training, emphasising knowledge acquisition and application in various educational and service-based contexts.

Bing, Precise Mode (GPT 4.0)

1. *Language Processing and Information Retrieval*: This cluster focuses on the technical aspects of natural language understanding and computational linguistics. It includes topics such as speech processing, semantics, dialogue systems, text processing, language modeling, question answering, and reinforcement learning for response generation.
2. *AI in Healthcare and Education*: This cluster revolves around the application of artificial intelligence, particularly conversational agents like ChatGPT, in fields such as medical education, healthcare, and mental health. It also touches on demographic factors (male, female, adult) and current issues like COVID-19.
3. *Machine Learning and User Interaction*: This cluster is centered on machine learning, deep learning, and natural language processing systems. It also includes user interfaces and virtual assistants, indicating a focus on how users interact with these AI systems.
4. *AI in Education and Customer Service*: This cluster pertains to the use of AI systems like chatbots in educational settings (e-learning, engineering education, curricula) and customer service. It also includes topics related to human-computer interaction and knowledge-based systems.

Bing, Balanced Mode (GPT 4.0)

1. *Natural Language Processing (NLP)*: This cluster includes topics related to the processing of human language by computers. It covers a wide range of subfields such as computational linguistics, text processing, information retrieval, and question answering. The cluster also includes techniques such as embeddings, long short-term memory, and reinforcement learning.
2. *Artificial Intelligence (AI)*: This cluster includes topics related to the development of intelligent agents that can perform tasks that typically require human intelligence. It covers a wide range of subfields such as conversational agents, large language models, and chatbots. The cluster also includes topics related to health care, education, and COVID-19.
3. *Machine Learning (ML)*: This cluster includes topics related to the development of algorithms that can learn from data and make predictions or decisions. It covers a wide range of subfields such as deep learning, learning algorithms, and convolutional neural networks. The cluster also includes topics related to virtual assistants, user interfaces, and diagnosis.
4. *Learning Systems (LS)*: This cluster includes topics related to the development of systems that can learn from data and improve over time. It covers a wide range of subfields such as e-learning, personnel training, and customer service. The cluster also includes topics related to sales, human-computer interaction, and engineering education.

Bing, Creative Mode (GPT 4.0)

1. *Natural Language Understanding and Generation*: This cluster contains keywords related to the tasks and methods of natural language understanding and generation,

such as classification, dialogue systems, question answering, and response generation. It also includes keywords that indicate the performance and state of the art of these tasks, such as semantics, long short-term memory, embeddings, and reinforcement learning.

2. *Artificial Intelligence and Health Care*: This cluster contains keywords related to the applications and implications of artificial intelligence in health care, such as conversational agent, medical education, mental health, and covid-19. It also includes keywords that indicate the characteristics and challenges of these applications, such as human, adult, male, female, controlled study, review, and large language model.
3. *Natural Language Processing and Machine Learning*: This cluster contains keywords related to the general concepts and techniques of natural language processing and machine learning, such as natural language processing systems, machine learning, deep learning, learning algorithms, and convolutional neural network. It also includes keywords that indicate the interfaces and domains of these techniques, such as virtual assistant, user interfaces, query processing, and diagnosis.
4. *Chatbot and Education*: This cluster contains keywords related to the design and evaluation of chatbot systems for education, such as chatbot, learning systems, students, e-learning, learn +, and curricula. It also includes keywords that indicate the contexts and outcomes of these systems, such as sales, human computer interaction, knowledge based systems, personnel training, customer service, and engineering education.

Claude 2

1. *Natural Language Processing Applications*: This cluster focuses on various NLP applications like classification, speech processing, dialogue systems, question answering, etc. Central themes include semantics, computational linguistics, LSTMs, performance, and building practical natural language systems.
2. *Conversational AI and Impacts*: This cluster deals with conversational AI, its use in healthcare/education, and analysing its impacts. Key themes look at chatbots/assistants, how they interact with and impact humans, with analysis around ethics, proper training, and responsible AI.
3. *Core AI and ML Techniques*: This cluster covers fundamental AI and ML techniques like natural language processing, machine learning, deep learning, algorithms, etc. It focuses on the key technical methods and capabilities that power many AI systems.
4. *AI for Training and Customer Service*: The fourth cluster deals with leveraging AI for use cases like education/training and customer service. Central ideas look at e-learning, knowledge systems, training curriculums, human-computer interaction, and providing automation for repetitive customer service queries.

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1. *Technical NLP*: This cluster focuses on the technical aspects of natural language processing (NLP), including classification, training data, speech processing, semantics, dialogue systems, and language models.
2. *Applications of NLP*: This cluster focuses on the applications of NLP in various domains, including conversational agents, healthcare, education, and customer service.

3. *Machine Learning and Deep Learning for NLP*: This cluster focuses on the machine learning and deep learning techniques used in NLP.
4. *Chatbots and Learning Systems*: This cluster focuses on the development and evaluation of chatbots and other learning systems.

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