DREXEL UNIVERSITY College of Computing & Informatics

CHI23 Hamburg, Germany | Hybrid April 23-28, 2023 reCHInnecting

# Investigating the **Synonyms** of **Conversational Agents** to Aid Cross-Disciplinary CA Research

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# Motivation

CHI23
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Designing conversational agents (CAs) involves cross-disciplinary efforts.

However, the **divergence of vocabulary on CAs** brings challenges in researching the full landscape of CA literature and sharing cross-disciplinary knowledge.

relational agent*
chatbot*
talkative bot*
animated agent*
text-based agent*
virtual assistant*
conversational interface*
virtual agent*
chatterbot*
personal assistant*
conversational agent*
virtual human*
intelligent agent*
digital assistant*
dialogue/dialog system*
conversational humanoid*
natural language interface*

# Overview of Project

**RQ1: What are the different terms** used to refer to the same underlying concept of conversational agents?

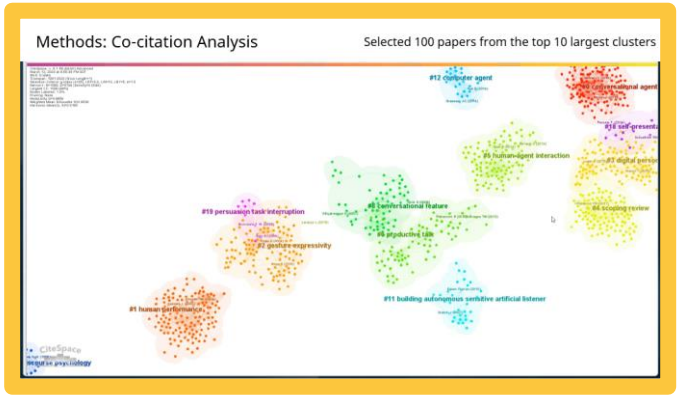
**RQ2: How do terms on CA and their usage differ** depending on their design characteristics and research areas?

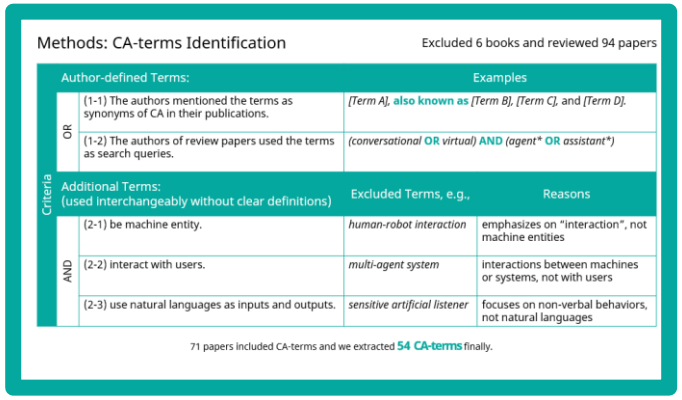
Collected **5,047 papers** from Web of Science Core Collection with a search query ***conversation* agent**** in *all fields.*

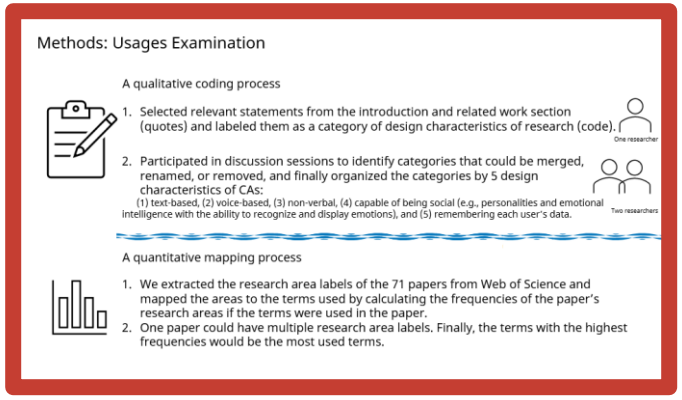
Identified **1,591 cited papers** forming **222 clusters** through a co-citation analysis with CiteSpace software.

Extracted **54 CA-terms** from selected **100 papers** through stratified sampling method from the top ten largest clusters.

Examined usages of CA-terms in terms of **5 design characteristics** and **20 research areas**

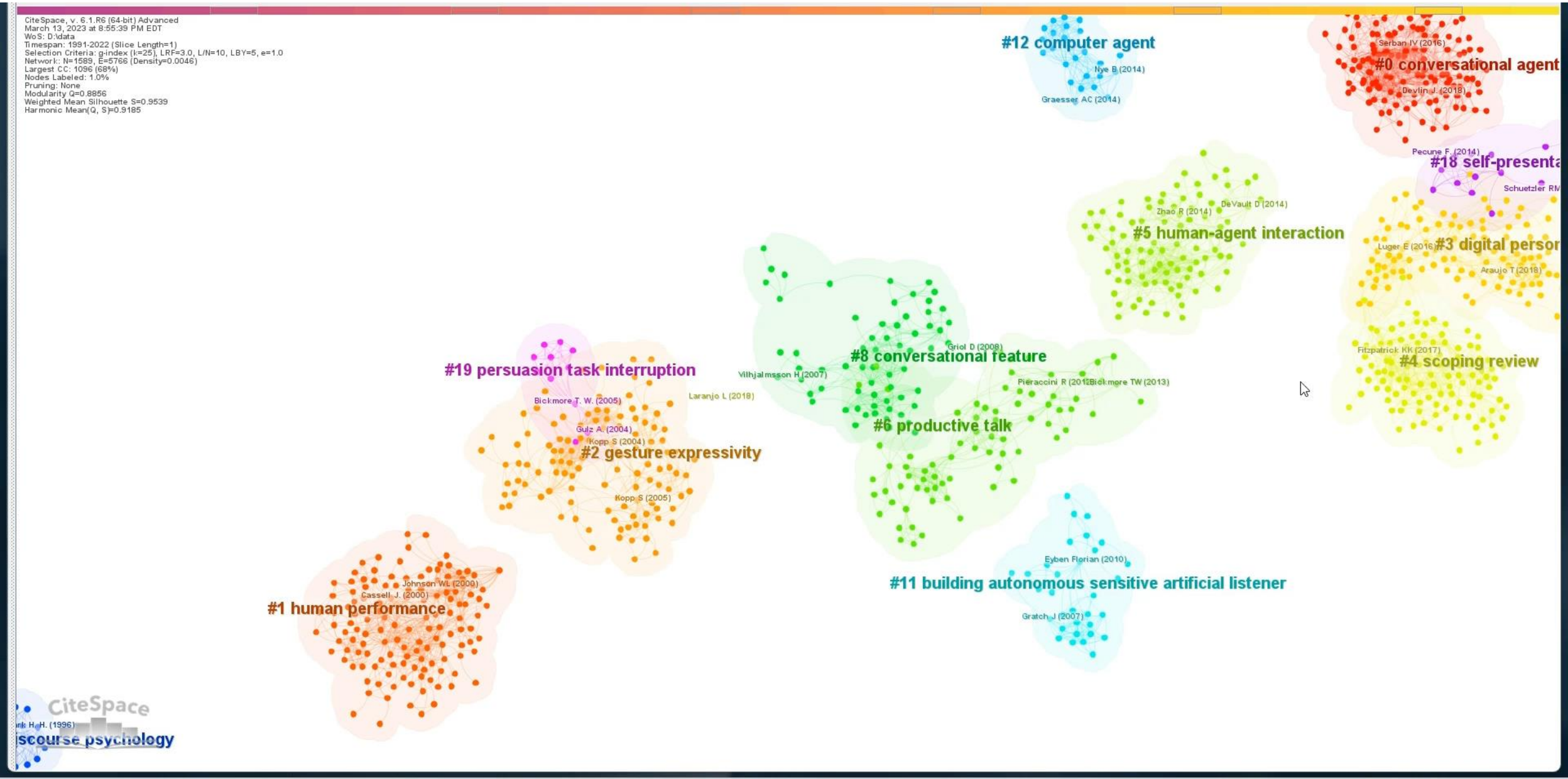


# Methods: Co-citation Analysis

Selected 100 papers from the top 10 largest clusters



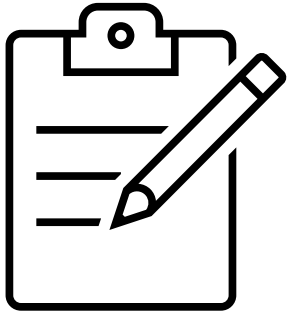
# Methods: CA-terms Identification

Excluded 6 books and reviewed 94 papers

| Criteria | | Author-defined Terms: | Examples | |
|---|---|---|---|---|
| | OR | (1-1) The authors mentioned the terms as synonyms of CA in their publications. | *[Term A],* **also known as** *[Term B], [Term C],* and *[Term D].* | |
| | OR | (1-2) The authors of review papers used the terms as search queries. | *(conversational* **OR** *virtual)* **AND** *(agent** **OR** *assistant*)* | |
| | | Additional Terms: (used interchangeably without clear definitions) | Excluded Terms, e.g., | Reasons |
| | AND | (2-1) be machine entity. | *human-robot interaction* | emphasizes on “interaction”, not machine entities |
| | AND | (2-2) interact with users. | *multi-agent system* | interactions between machines or systems, not with users |
| | AND | (2-3) use natural languages as inputs and outputs. | *sensitive artificial listener* | focuses on non-verbal behaviors, not natural languages |

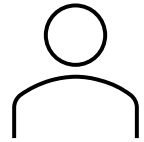
71 papers included CA-terms and we extracted **54 CA-terms** finally.

# Methods: Usages Examination



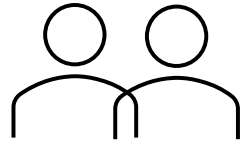
A qualitative coding process

1. Selected relevant statements from the introduction and related work section (quotes) and labeled them as a category of design characteristics of research (code).

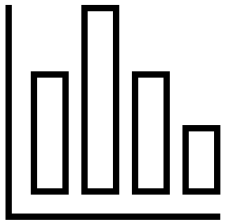


One researcher

2. Participated in discussion sessions to identify categories that could be merged, renamed, or removed, and finally organized the categories by 5 design characteristics of CAs:
   (1) text-based, (2) voice-based, (3) non-verbal, (4) capable of being social (e.g., personalities and emotional intelligence with the ability to recognize and display emotions), and (5) remembering each user's data.



Two researchers



A quantitative mapping process

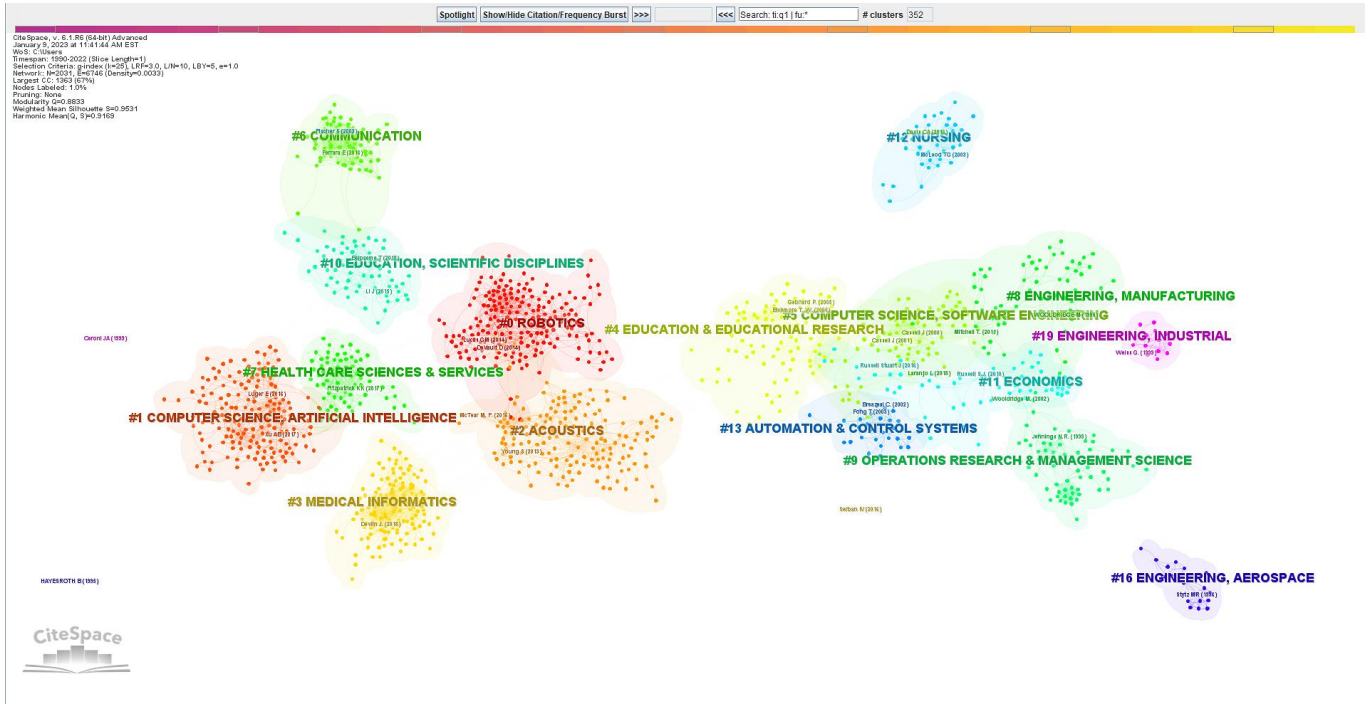
1. We extracted the research area labels of the 71 papers from Web of Science and mapped the areas to the terms used by calculating the frequencies of the paper's research areas if the terms were used in the paper.
2. One paper could have multiple research area labels. Finally, the terms with the highest frequencies would be the most used terms.

# Results and Conclusions

**RQ1: What are the different terms** used to refer to the same underlying concept of conversational agents?

**RQ2: How do terms on CA and their usage differ** depending on their design characteristics and research areas?

**Future Work:**




Results: 54 CA-terms

12 different ending words

| | | | |
|---|---|---|---|
| * system: 2 terms | * interface: 7 terms | * software: 1 term | * bot: 9 terms |
| * agent: 16 terms | * assistant: 4 terms | * butler: 2 terms | * human: 3 terms |
| * character: 5 terms | * avatar: 2 terms | * partner: 1 term | * companion: 2 terms |

On January 10, 2022, we collected **5,047 papers** from Web of Science Core Collection with a search query ***conversation* agent**** in *all fields*.

We identified 54 CA-terms and collected **519,513 papers** on March 2, 2022, with a **combined search query** for all fields.

Terms included with the "OR" operand as a search query for the data collection

conversation* agent*, virtual agent*, chat agent*, assistant agent*, artificial agent*, autonomous agent*, communicative agent*, dialogue agent*, digital agent*, embodied agent*, intelligent agent*, interface agent*, relational agent*, social agent*, synthetic agent*, text-based agent*, conversation* assistant*, digital assistant*, personal assistant*, virtual assistant*, digital butler*, virtual butler*, embodied human*, virtual human*, conversation* human*, virtual companion*, digital companion*, virtual avatar*, embodied avatar*, agent character*, virtual character*, animated character*, conversation* character*, embodied character*, bot, bots, chat robot*, chatbot*, social robot*, chatterbox*, chatterbot*, virtual conversation* partner*, dialog* system*, conversation* system*, conversational agent interface*, conversation* interface*, conversation* multimodal interface*, natural language interface*, voice user interface*, natural language user interface*, human language interface*, conversation* self-help software*

Results: CA-terms according to the CA Design Characteristics

| Text | Voice | Non-verbal behavior | Being social | Remembering users' data | |
|---|---|---|---|---|---|
| ● | ○ | ○ | ○ | ○ | text-based *, e.g., Messenger, Slack, Telegram |
| ● | ◑ | ○ | ○ | ○ | chatbot/chat bot/chatterbot/chatterbox/bot |
| ○ | ● | ○ | ○ | ○ | voice */spoken *, e.g., AT&T's How May I Help You |
| ◑ | ● | ◑ | ○ | ○ | conversational agent/* assistant/* butler, e.g., Siri |
| ○ | ○ | ● | ● | ○ | sensitive artificial listener/rapport agent (excluded) |
| ● | ● | ● | ◑ | ○ | embodied */animated */multimodal */* human/* character/*avatar/synthetic agent, e.g., SimSensei |
| ● | ○ | ○ | ● | ○ | social bot |
| ○ | ● | ○ | ● | ○ | social agent |
| ● | ● | ● | ● | ○ | relational agent |
| ● | ● | ● | ● | ● | * companion |

Terms were used to refer to any kinds of CAs: dialog/dialogue/conversational system, conversational/human language/natural language interface

Results: Disciplinary Differences on CA-term Use

| Research Areas | including *54 terms | The Most used CA-Terms within the areas based on 71 influential papers |
|---|---|---|
| Computer Science | 16 | ① conversational agent*, ② virtual agent*, ③ dialogue/dialog system*, ④ chatbot*, ⑤ virtual human* |
| Engineering | 23 | ① conversational agent*, ② dialogue/dialog system*, ③ virtual agent*, ④ animated agent*, ⑤ chatterbot* |
| Psychology | 19 | ① chatbot*, ② conversational agent*, ③ animated agent*, ④ chatterbot* |
| Health Care Sciences & Services | 10 | ① conversational agent*, ② chatbot*, ③ dialogue/dialog system*, ④ conversational interface* |
| Medical Informatics | 10 | ① conversational agent*, ② chatbot*, ③ dialogue/dialog system*, ④ conversational interface* |
| Linguistics | 7 | ① conversational agent*, ② chatbot*, ③ conversational interface*, ④ virtual assistant*, ⑤ conversational humanoid*, ⑥ personal assistant*, ⑦ digital assistant* |
| Operations Research & Management Science | 5 | ① conversational agent*,② chatbot*,③ virtual agent*;④ relational agent*;⑤ virtual avatar* |
| Psychiatry | 5 | ① conversational agent*, ② chatbot*, ③ conversational interface*, ④ virtual assistant*, ⑤ text-based agent* |
| Acoustics | 4 | ① conversational agent*, ② virtual agent*, ③ dialogue/dialog system*, ④ talkative bot* |
| Education & Educational Research | 4 | ① conversational agent*, ② dialogue/dialog system*, ③ intelligent agent*, ④ natural language interface* |
| Information Science & Library Science | 3 | ① conversational agent*, ② dialogue/dialog system*, ③ chatbot* |
| Public, Environmental & Occupational Health | 3 | ① conversational agent*, ② dialogue/dialog system*, ③ relational agent* |
| Social Sciences - Other Topics | 3 | ① conversational agent*, ② dialogue/dialog system*, ③ relational agent* |
| Automation & Control Systems | 2 | ① dialogue/dialog system*, ② virtual human* |
| Robotics | 2 | ① dialogue/dialog system*, ② virtual human* |
| Communication | 1 | ① conversational agent* |
| Geriatrics & Gerontology | 1 | ① conversational agent* |
| Mathematics | 1 | ① conversational humanoid* |
| Medicine | 1 | ① conversational agent* |
| Telecommunications | 1 | ① virtual agent* |

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| ● | ● | ● | ● | ● | * companion |

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# THANK YOU!

Please feel free to contact us if you need further explanations.

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