

# Dagstuhl Seminar 19461 on Conversational Search

## Seminar Goals and Working Group Outcomes

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### Abstract

In the week of November 10–15, 2019, 44 researchers from the fields of information retrieval and Web search, natural language processing, human computer interaction, and dialogue systems met for the Dagstuhl Seminar 19461 “Conversational Search” to share the latest development in the area of conversational search and discuss its research agenda and future directions. The clear signal from the seminar is that research opportunities to advance conversational search are available to many areas and that collaboration in an interdisciplinary community is essential to achieve the goals. This report overviews the program and selected findings of the working groups.

## 1 Seminar Motivation and Goals

The conversational search paradigm promises to satisfy information needs using human-friendly dialogs, be it in spoken or in written form [Burtsev et al., 2017, Culpepper et al., 2018, Radlinski and Craswell, 2017, Spina et al., 2018]. This kind of “information-providing dialogs” and “information-seeking conversations” will increasingly happen en passant and spontaneously, in part triggered by smart objects surrounding us like intelligent assistants such as Amazon Alexa,

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Apple Siri, Google Assistant, and Microsoft Cortana, domestic appliances, environmental control devices, toys, or autonomous robots and vehicles. The outlined development marks a paradigm shift for information technology, and the key question(s) include(s):

*What does conversational search mean and how to make the most of it—given the possibilities, restrictions and challenges that come with this paradigm?*

Currently, our understanding is too limited to exploit the conversational search paradigm for effectively satisfying the existing diversity of information needs. This first Dagstuhl Seminar on conversational search brought together leading researchers from relevant communities to understand and to analyze this promising retrieval paradigm and its future from different angles. The participants discussed issues related to interactivity, result presentation, query clarification, user models, and evaluation, but also search behavior that can facilitate a human-machine debate or an argumentation related to the information need in question. Moreover, the participants defined, shaped, and formalized a set of corresponding problems to be addressed, and highlighted associated challenges that are expected to come in the form of multiple modalities and multiple users.

The complete report of the seminar can be found on the seminar web page.<sup>1</sup> Some working groups plan to make their individual reports available as arXiv preprints.

## 2 Seminar Program

The 5-day program of the seminar consisted of six introductory and background sessions, three visionary talk sessions, one industry talk session, and nine breakout discussion and reporting sessions. The seminar also involved three social events (two evening "sessions" in form of a pub quiz and of a conversational search hands-on experiment, and the traditional excursion on Wednesday afternoon). The detailed program of the seminar is available online.<sup>2</sup>

### Pre-Seminar Activities

Prior to the seminar, the participants were asked to provide inputs to the following questions:

1. What are your ideas of the "ultimate" conversational search system?
2. Please list, from the perspective of your research field, important open questions or challenges in conversational search.
3. What are three papers a new PhD student in conversational search should read and why?

From the survey, the following topics initially emerged as interests of the participants. Many of these topics were discussed at length in the seminar.

- Understanding the nature of information seeking in the context of conversational agents.
- Modelling problems in conversational search.

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<sup>1</sup><https://www.dagstuhl.de/19461>

<sup>2</sup><https://www.dagstuhl.de/schedules/19461.pdf>

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- Clarification and explanation.
  - Evaluation in conversational search systems.
  - Ethics and privacy in conversational systems.
  - Extending the problem space beyond the search interface and Q&A.

Another outcome of the above pre-seminar questions was a compilation of a list of recommended readings to gain a solid understanding of the diverse topics and technologies that are related to the research on conversational search. The reading list is provided as an [Appendix](#) and can also be found in the seminar report.<sup>3</sup>

## Invited Talks

An important goal of this seminar was to bring a broad range of researchers together to discuss establishing common terminologies among the participants. Therefore, a series of invited talks was interspersed throughout the seminar program to facilitate the understanding and discussion of conversational search and its potential enabling technologies. The list of talks included the following:

## Introductory, Background, and Industry Talks

- *What have we Learned about Information Seeking Conversations?* by Nicholas J. Belkin (Rutgers University, NJ, US)
- *Personal Knowledge Graphs* by Krisztian Balog (University of Stavanger, NOR)
- *Beyond Information Retrieval: Socially Interactive Agents* by Elisabeth André (Universität Augsburg, DE)
- *Conversational Search at Microsoft* by Jaime Teevan (Microsoft Corporation - Redmond, US)
- *Introduction to NLP* by Ido Dagan (Bar-Ilan University – Ramat Gan, IL) and Idan Szpektor (Google Israel - Tel-Aviv, IL)
- *Dynamic Composition for Domain Exploration Dialogues* by Idan Szpektor (Google Israel - Tel-Aviv, IL)
- *Introduction to Deep Learning in NLP* by Idan Szpektor (Google Israel - Tel-Aviv, IL)
- *Computational Argumentation* by Henning Wachsmuth (Universität Paderborn, DE)
- *Searching for Myself: One Naïve Individual’s Human-Centered Audio-Visual Search* by Sharon Oviatt (Monash University - Clayton, AU)
- *Overview of Dialogue* by Phil Cohen (Monash University - Clayton, AU)

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<sup>3</sup><https://www.dagstuhl.de/19461>

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- *Conversational User Interfaces* by Leigh Clark (Swansea University, GB)
  - *A Theoretical Framework for Conversational Search* by Filip Radlinski (Google UK - London, GB)
  - *Conversational Search and Recommendation at Spotify* by Rosie Jones (Spotify - US)
  - *Conversational Product Search* by Ronald M. Kaplan (Stanford University, US)
  - *Conversation about Preferences* by Filip Radlinski (Google UK - London, GB)
  - *Lessons We Learnt in Xiaoice* by Ruihua Song (Microsoft XiaoIce- Beijing, CN),

### Visionary Talks

- *Conceptual Model of Human-Agent Interactions in Conversational Search* by Leif Azzopardi (University of Strathclyde – Glasgow, GB)
- *Towards an Immersive Wikipedia* by Bernd Fröhlich (Bauhaus-Universität Weimar, DE)
- *Conversational Style Alignment for Conversational Search* by Ujwal Gadiraju (Leibniz Universität Hannover, DE)
- *The Dilemma of the Direct Answer* by Martin Potthast (Universität Leipzig, DE)
- *Conversational Question Answering over Knowledge Graphs* by Rishiraj Saha Roy (MPI für Informatik - Saarbrücken, DE)
- *Ranking People* by Markus Strohmaier (RWTH Aachen, DE)
- *Demystifying Spoken Conversational Search* by Johanne Trippas (RMIT University - Melbourne, AU)
- *Knowledge-based Conversational Search* by Svitlana Vakulenko (Wirtschaftsuniversität Wien, AT)
- *Clarification in Conversational Search* by Hamed Zamani (Microsoft Corporation, US)
- *Macaw: A General Framework for Conversational Information Seeking* by Hamed Zamani (Microsoft Corporation, US) and Nick Craswell (Microsoft Corporation, US)

## 3 Working Groups

In the afternoon of Day 2, initial working groups were formed based on the inputs to the pre-seminar questionnaires, introductory and background talks, and discussions among the participants. On Day 3, the grouping was revisited and updated, and, eventually, the following seven groups were formed to focus on topics such as the definition, evaluation, modelling, explanation, scenarios, applications, and prototypes of conversational search. The summaries and group members were as follows.

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**Defining Conversational Search** This group aimed to bring structure and common terminology to the different aspects of conversational search systems that characterise the field. After reviewing existing concepts such as conversational answer retrieval and conversational information seeking, the group devised a typology of conversational search systems via functional extensions of information retrieval systems, chatbots, and dialogue systems. The group further elaborated the attributes of conversational search by discussing its dimensions and desirable additional properties. Their report suggests types of systems that should not be confused as conversational search systems.

Group Members: Jaime Arguello (University of North Carolina - Chapel Hill, US), Lawrence Cavedon (RMIT University - Melbourne, AU), Jens Edlund (KTH Royal Institute of Technology - Stockholm, SE), Matthias Hagen (Martin-Luther-Universität Halle-Wittenberg, DE), David Maxwell (University of Glasgow, GB), Martin Potthast (Universität Leipzig, DE), Filip Radlinski (Google UK - London, GB), Mark Sanderson (RMIT University - Melbourne, AU), Laure Soulier (UPMC - Paris, FR), Benno Stein (Bauhaus-Universität Weimar, DE), Jaime Teevan (Microsoft Corporation - Redmond, US), Johanne Trippas (RMIT University - Melbourne, AU), and Hamed Zamani (Microsoft Corporation, US).

**Evaluating Conversational Search** This group addressed how to evaluate the quality of conversational search systems. It first described the complexity of conversation between search systems and users, followed by a discussion of the motivation and broader tasks as the context of conversational search that can inform the design of conversational search evaluation. The group also surveyed 12 recent tasks and datasets that can be exploited for the evaluation of conversational search. Their report presents several dimensions in the evaluation such as user, retrieval, and dialog, and suggests that the dimensions might overlap with those of interactive information retrieval.

As human-to-human conversations differ from human-to-machine conversations, it was argued that (at least in the near future) we should optimize conversational search systems based on human-machine conversations that are grounded in current retrieval systems and technologies. The different dimensions in which we can evaluate conversational search and conversational spoken search could be—user-focused, retrieval-focused or dialogue-focused. Lab-based and A/B testing will typically involve a complete (or simulated) system setup and thus facilitate end-to-end (e2e) evaluation. However, given the highly interactive nature of conversational search, it is unlikely that a reusable test collection will be developed to support any serious e2e evaluations—test collections, however, should be able to support component level evaluation.

Group Members: Jaime Arguello (University of North Carolina at Chapel Hill, US), Avishek Anand (Leibniz Universität Hannover, DE), Leif Azzopardi (University of Strathclyde, GB), Robert Capra (University of North Carolina at Chapel Hill, US), Leigh Clark (Swansea University, GB), Jens Edlund (KTH Royal Institute of Technology - Stockholm, SE), Norbert Fuhr (Universität Duisburg-Essen, DE), Ujwal Gadiraju (Leibniz Universität Hannover, DE), Claudia Hauff (Delft University of Technology, NL), and Rishiraj Saha Roy (MPI für Informatik - Saarbrücken, DE)

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**Modeling Conversational Search** This group addressed what should be modeled from the real world to achieve a successful conversational search and how. They discussed why a range of concepts and variables such as capabilities and resources of systems, beliefs, and goals of users, history and current status of process, and search topics and tasks should be considered to advance understanding between systems and users in the context of conversational search. Their report points out that the options the current search engines present to users can be too broad in conversational interaction. It suggests that a deeper modeling of users' beliefs and wants, development of reflective mechanisms, and finding a good balance between macroscopic and microscopic modeling are promising directions for future research.

Group Members: Elisabeth André (Universität Augsburg, DE), Nicholas J. Belkin (Rutgers University - New Brunswick, US), Phil Cohen (Monash University - Clayton, AU), Ronald M. Kaplan (Stanford University, US), Martin Potthast (Universität Leipzig, DE), Johanne Trippas (RMIT University - Melbourne, AU), and Arjen P. de Vries (Radboud University Nijmegen, NL).

**Argumentation and Explanation** Motivated by inevitable influences made to users due to the course of actions and choices of search engines, this group explored how the research on argumentation and explanation can mitigate some of the potential biases generated during conversational search processes, and facilitate users' decision-making by acknowledging different viewpoints of a topic. The group proposed a research scheme that consists of three layers: a conversational layer, a demographics layer, and a topic layer. Their report also explains that argumentation and explanation should be carefully considered when search systems (1) select, (2) arrange, and (3) phrase the information presented to the users. Creating an annotated corpus with these elements is the next step in this direction.

Group Members: Khalid Al-Khatib (Bauhaus-Universität Weimar, DE), Ondrej Dusek (Charles University - Prague, CZ), Benno Stein (Bauhaus-Universität Weimar, DE), Markus Strohmaier (RWTH Aachen, DE), Idan Szpektor (Google Israel - Tel-Aviv, IL), and Henning Wachsmuth (Universität Paderborn, DE).

**Scenarios for Conversational Search** This group aimed to identify scenarios that invite conversational search, given that natural language conversation might not always be the best way to search in some contexts. Their report summarises modalities and tasks of search as two dimensions to define where conversational search might make sense. Modality can be determined by a situation such as driving or cooking, or devices at hand such as a smartwatch or AR/VR systems. As for the task, the group report explains that the usefulness of conversational search increases as the level of exploration and complexity increases in tasks. On the other hand, simple information needs, highly ambiguous situations, or very social situations might not provide appropriate scenarios for conversational search. Proposed scenarios include a mechanic fixing a machine, two people searching for a place for dinner, learning about a recent medical diagnosis, and following up on a news article to learn more.

Group Members: Lawrence Cavedon (RMIT University - Melbourne, AU), Bernd Fröhlich (Bauhaus-Universität Weimar, DE), Hideo Joho (University of Tsukuba - Ibaraki, JP), Ruihua Song (Microsoft XiaoIce- Beijing, CN), Jaime Teevan (Microsoft Corporation - Redmond, US),

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Johanne Trippas (RMIT University - Melbourne, AU), and Emine Yilmaz (University College London, GB).

**Conversational Search for Learning Technologies** This group discussed the implication of conversational search from learning perspectives. The report highlights the importance of search technologies in lifelong learning and education, and the challenges due to the complexity of learning processes. The group points out that multimodal interaction is particularly useful for educational and learning goals since it can support students with diverse backgrounds. Based on these discussions, the report suggests several research directions including the extension of the modalities to speech, writing, touch, gaze, and gesturing, the integration of multimodal inputs/outputs with existing IR techniques, and the application of multimodal signals to user modelling.

Group Members: Sharon Oviatt (Monash University - Clayton, AU) and Laure Soulier (UPMC - Paris, FR).

**Common Conversational Community Prototype: A Scholarly Conversational Assistant** This group explored potential domain applications that could facilitate research; it proposed developing and operating a prototype conversational search system for scholarly activities as academic resources that support research into conversational search. Example activities include finding articles for a new area of interest, planning sessions to attend in a conference, or determining conference PC members. The proposed prototype is expected to serve as a useful search tool, a means to create datasets, and a platform for community-based evaluation campaigns. The group also outlined a road map of the development of such a scholarly conversational assistant. The report describes a set of software platforms, scientific IR tools, open source conversational agents, and data collections that could be exploited in conversational search work.

Group Members: Krisztian Balog (University of Stavanger, NOR), Lucie Flekova (Technische Universität Darmstadt, DE), Matthias Hagen (Martin-Luther-Universität Halle-Wittenberg, DE), Rosie Jones (Spotify, US), Martin Potthast (Leipzig University, DE), Filip Radlinski (Google, UK), Mark Sanderson (RMIT University, AUS), Svitlana Vakulenko (University of Amsterdam, NL), and Hamed Zamani (Microsoft, US).

## Acknowledgements

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## Appendix: Recommended Reading List

The publications below were recommended by the seminar participants via a pre-seminar survey. There are also specialized reading lists available in the respective reports of the working groups.

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