Dialogue-Based Information Retrieval

Abhishek Kaushik(✉)

ADAPT Centre, School of Computing, Dublin City University, Dublin 9, Ireland
abhishek.kaushik2@mail.dcu.ie

Abstract. Conversational search presents opportunities to support users in their search activities to improve the effectiveness and efficiency of search while reducing cognitive load. Since conversation is a natural means of human information inquiry, framing the information retrieval process within a dialogue is expected to make the search process more natural for the user, in terms of query entry, interaction to locate relevant content, and engaging with the system output. My PhD Research project seeks to make progress toward realizing the vision of conversational search systems.

Keywords: Conversational search · User search behaviour · Dialogue-based search

1 Introduction

In the operation of a current information retrieval (IR) system, a user enters a text query describing their information need. In response to this, the system returns a list of potentially relevant items ranked in order of their estimated likelihood of relevance [2]. The user then selects one or more relevant items with which to satisfy their information need. However, often the user is not able to fully describe what they want to know, their query may be ambiguous or fail to match well with the content of relevant items. If any of these situations arose while seeking information from a human intermediary, the natural response would be to enter into a dialogue to resolve the problem [2]. The objective of this research is to advance IR systems by developing and implementing a framework to support the use of dialogue-based approaches in IR.

2 Motivation

Current Search Systems: In order to satisfy their information need using a current search system, a user may need to perform multiple passes using queries modified based on information gained in previous searches. This strategy has various limitations:

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1. The user must seek to completely describe their information need in their query. Insufficient knowledge of the subject of their information need or the available search targets can make this process frustrating and inefficient.
2. There is a high cognitive load in forming such queries.
3. The IR system is designed to satisfy the information need in a single pass based on the query entered.
4. The user generally inspect multiple returned items to find relevant information.

The Potential for Conversational Search: Conversational search seeks to support more natural interaction between users and content information archives via dialogue-based engagement. Existing studies have been conducted to explore the potential for conversational search using humans as an intermediate agent between user and the search engine. For example, the work by Trippas *et al.* at RMIT [5,6] which focuses on speech only based search for users seeking information on general topics such as those that a user might pose to a web search engine [5,6].

By contrast, my research starts from the analysis of current standard IR systems, and seeks to understand the scope for conversational interventions in the search process and how these might be facilitated. Since the incorporation of conversational methods into IR processes is currently poorly explored, my research assumes the use of text-based engagement with IR systems leaving alternative engagement using speech interfaces for future studies.

Conversational and Dialogue Systems: Outside the area of IR, there is currently much interest in dialogue and conversational systems for engagement with information systems. These applications generally focus on fixed tasks in very narrow domains. In search, while the scope of the user tasks can generally be well defined, the topics and material over which the system must operate are diverse and unstructured. This poses unique challenges not faced by standard conversational systems which perform clearly defined tasks of limited scope.

In conversational search, we can think in terms of an agent taking the role of a human intermediary supporting the user's search activities. Such a conversational search agent should exhibit autonomic behaviour with the ability of self-adaptation according to the searcher's information seeking activities and potentially relevant content identified. It is not clear what the most appropriate technology to drive such an agent will be, but given the potential to define the activities and responsibilities, and the absence of large training data sets, I propose to explore rule-based approaches, at least as a mechanism to bootstrap the abilities of the agent. The study conducted by Stein *et al.* [4] explained dialogue strategies during information seeking activities in a collaborative environment.

Cognitive Models of the Search Process: In order to develop sound conversational search methods, it is important to examine the relevant cognitive issues in the search process. Early contributions in understanding and modeling information needs and activities of searchers were made in Belkin's work on the development

of the Anomalous States of Knowledge (ASK) model [1]. This highlights the difficulties of users in specifying the details of their information needs for engagement with IR systems. Various extensions to the ASK models taking alternative or complementary approaches to model information seeking have been developed since then, e.g. Kuhlthau's Information Search Process (ISP) [3] and Vakkari's [7] learning model of search. I propose to explore the integration of these models in the rule base of an agent, in order to model and direct support of the user's search activities [2].

3 Research Questions

In order to undertake my PhD research, I have identified the following research questions which I am seeking to address.

RQ1: How can conversational interventions be used to support user search activities? What opportunities are there for conversational support in current search engines? I carried out and reported a study examining the behaviour of users when using a standard web search engine, designed to enable me to identify opportunities to support their search activities using a conversational agent [2].

RQ2: What are the requirements of a conversational search interface? User cognitive load: The whole search process places cognitive load onto the user. We observed users can take a lot of time to read a single long document to satisfy their information need [2]. A search agent could potentially reduce this cognitive load by making suggestions to the user, e.g. of extracted significant information which assist in either understanding or resolving their information need.

Challenges and limitations: We need to study engagement with potential conversational interfaces in user-based studies and consider how our system can maintain a record of previous conversations.

RQ3: How should my work on conversational search be implemented and evaluated? Consideration of the requirements of my conversational search system will form the basis of the design and implementation of technologies and prototypes to enable them. In addition, methods for evaluation will need to be explored.

4 Methodology

The overarching approach to my PhD project is propose and evaluate conversational search methods into established search processes. To achieve this I am working on the following elements:

1. Examining the actions undertaken by searchers using current systems, relating these to cognitive models of the search process, and proposing how the functionality of a conversation search agent might be used to enable more effective and satisfying search experiences.

2. Proposing strategies to enable conversational strategies within the search process.
3. Building prototypes of the proposed conversational search components, and their incorporation within a standard search engine framework using an open source toolkit.

4.1 Current Status

Completed Work

1. Initial review of existing relevant literature.
2. Study of user search behaviours using current search tool [2].

Current Work

1. Development of methods for automatic content analysis for use in conversational engagement, e.g. highlighting significant and diverse elements of retrieved content.
2. Proposal of dialogue strategies and agent models for use in conversational search.

These are currently under active investigation with some parts already implemented.

Future Work

1. Development of evaluation strategy and test data.
2. Implementation of models of prototype conversational search components and system.
3. Evaluation of proposed models.

5 Research Issues for Discussion at the Doctoral Consortium

Conversational search is a rapidly emerging research area which is currently attracting considerable interest from the information retrieval research community.

The scope of potential research in conversational search is very broad. As this time, I need to work towards determining the exact form of the main focus in my PhD research. As part of deciding the topics that I will concentrate on, I am interested in identifying potential risks in my plans, and in developing potential response plans for these.

Regardless of the exact topics investigated, evaluation is an important component of experimental IR research. The emerging nature of research in conversational search means that there are no standard evaluation methods or datasets available for work in this area. I am thus very interested to get input on this aspect of my work.

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