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Beyond traditional collaborative search: Understanding the effect of awareness on multi-level collaborative information retrieval

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ABSTRACT

Although there has been a great deal of research into Collaborative Information Retrieval (CIR) and Collaborative Information Seeking (CIS), the majority has assumed that team members have the same level of unrestricted access to underlying information. However, observations from different domains (e.g. healthcare, business, etc.) have suggested that collaboration sometimes involves people with differing levels of access to underlying information. This type of scenario has been referred to as Multi-Level Collaborative Information Retrieval (MLCIR). To the best of our knowledge, no studies have been conducted to investigate the effect of awareness, an existing CIR/CIS concept, on MLCIR. To address this gap in current knowledge, we conducted two separate user studies using a total of 5 different collaborative search interfaces and 3 information access scenarios. A number of Information Retrieval (IR), CIS and CIR evaluation metrics, as well as questionnaires were used to compare the interfaces. Design interviews were also conducted after evaluations to obtain qualitative feedback from participants. Results suggested that query properties such as *time spent on query, query popularity* and *query effectiveness* could allow users to obtain information about team's search performance and implicitly suggest better queries without disclosing sensitive data. Besides, having access to a history of intersecting viewed, relevant and bookmarked documents could provide similar positive effect as query properties. Also, it was found that being able to easily identify different team members and their actions is important for users in MLCIR. Based on our findings, we provide important design recommendations to help develop new CIR and MLCIR interfaces.

1. Introduction

A great deal of research in Collaborative Information Retrieval (CIR) and Collaborative Information Seeking (CIS), e.g. (Capra et al., 2012; Halvey et al., 2010; Morris, 2013; Shah, 2016; Soulier et al., 2016; Tamine & Soulier, 2016), assumes that team members in a collaborative search team have equal and non-restrictive access to underlying information. However, in practice, for a number of reasons such as security, privacy, etc., team members may not always have equal access to underlying information. For example, as Handel and Wang (2011) outlined, a signal intelligence specialist and a human intelligence specialist could be working together to understand a new threat. Due to their lack of equal access to underlying information such as intelligence databases, the two specialists may have differing knowledge but most importantly, they may not be able to share any or part of it between each other. Despite this, the two specialists must somehow work together to understand the threat. This type of scenario has been referred to as

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Multi-Level Collaborative Information Retrieval (MLCIR), a term first proposed by Handel and Wang (2011). Day to day activities such as searching for health information online may also introduce similar problems. De Choudhury et al. (2014) surveyed 210 people to find out how they choose between search engines and social media to search for health information. De Choudhury et al. found that people are less likely to share their health-related information with others on stigmatic conditions. This is closely related to another MLCIR example highlighted by Handel and Wang (2011) where an individual with a health issue does not want to disclose the entire range of symptoms to other people in a group. Thus, MLCIR can occur not just in certain businesses and organisations, but also in our day to day activities.

Recently, some researchers have begun to realise the complexity and difficulty of collaborative search within important domains such as healthcare (Karunakaran & Reddy, 2012), crisis management (Bjurling & Hansen, 2010) and legal search (Attfield et al., 2010); these researchers discussed how unequal distribution of knowledge and organisational hierarchies could hinder collaboration in the respective domains. Handel and Wang (2011) also discussed in detail a number of case studies from several domains including healthcare, business and government highlighting problems that emerged due to non-uniform access to underlying information.

MLCIR is complex and difficult because considerations need to be given to information flow, security and shareability between collaborators in addition to the collaboration itself (Handel & Wang, 2011). Therefore, a number of existing CIR and CIS concepts such as awareness, division of labour and persistence may be inapplicable to MLCIR. Although such concepts have previously been investigated by a number of researchers (Halvey et al., 2010; Morris & Horvitz, 2007; Shah & Marchionini, 2010), to the best of our knowledge, there has not yet been any investigation into the effect of existing CIR and CIS concepts on MLCIR. Previous work presented by Attfield et al. (2010), Bjurling and Hansen (2010), Handel and Wang (2011), and Karunakaran and Reddy (2012) has been based on observations and did not provide a systematic solution to solve the problems with MLCIR. In order to systematically evaluate the impact of non-uniform information access in CIR, we conducted a simulated user study (Htun et al., 2015). However, this work did not go as far as a user study in that actual human feedback was not provided, and not all user interaction could be easily replicated in the simulation.

To address these shortcomings, we conducted a preliminary user study which indicated three awareness types that are usable for MLCIR interfaces (Htun et al., 2017); these are query awareness, result awareness and team awareness. In this paper, we present two separate user studies where we investigated the impacts of different awareness kinds on MLCIR using the MLCIR scenarios that were highlighted by Handel and Wang (2011) and were also utilised in our previous simulated study (Htun et al., 2015). In the first user study, we investigated the impacts of query awareness. In the second user study, we investigated the impacts of result awareness and team awareness. Result awareness and team awareness were investigated as one study because at the time the study was being conducted, not many different interface components were proposed for either result awareness or team awareness that are usable in MLCIR interfaces. As for query awareness, different variety of components have been utilised in previous collaborative search systems (Amershi & Morris, 2008; Joho et al., 2008; Morris & Horvitz, 2007; Shah, 2010). The main difference between the two studies was the interfaces, and the type of awareness that they support. The combined objectives of the two studies presented in this paper are to:

1) understand the impact of supporting query awareness, result awareness and team awareness on collaborative search outcomes in MLCIR scenarios.
2) understand the impact of supporting query awareness, result awareness and team awareness on individual search outcomes in MLCIR scenarios.
3) understand the impact of supporting query awareness, result awareness and team awareness on users' search experience in MLCIR scenarios.
4) provide design recommendations to help develop new MLCIR interfaces.

Since our studies were the first attempt to investigate different awareness types in MLCIR scenarios, we developed a number of interfaces which used previous research studies as a starting point, e.g. (Amershi & Morris, 2008; Freyne et al., 2007; Htun et al., 2017; Morris & Horvitz, 2007; Shah, 2010a). Other than the interfaces, the studies shared the same experimental design. Pairs of participants were presented with three different information access scenarios and search interfaces. The participants' collaborative and individual search outcomes were measured using a number of existing evaluation metrics (Freyne et al., 2007; Joho et al., 2008; Shah & González-Ibáñez, 2011; Soulier et al., 2014), e.g. some measured performance, some measured collection coverage, etc. Participants were also asked a number of post-task evaluation questions to be able to assess their perception of search tasks, performance, etc. At the end of the study, design interviews were undertaken to obtain participants' feedback related to their search experience and to be able to provide important design recommendations for new MLCIR interfaces.

The remainder of the paper is organised as follows. In Section 2, we discuss related research regarding CIR and CIS, the awareness concept and MLCIR. In Section 3, we present the experimental setup and results of study 1. In Section 4, we present the experimental setup and results of study 2. In Section 5, we discuss the results from both studies, providing design recommendations based on findings from the design interviews. In Section 6, we highlight limitations of the studies. Finally, we conclude this paper in Section 7 and outline possible future work.

2. Background

2.1. Collaborative information retrieval/seeking

Searching for information was often considered a solo activity, but there are many situations where a group of people with shared