

Revisiting Exploratory Search from the HCI Perspective

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ABSTRACT

In this paper, we revisit the definition of Exploratory Search tasks after 4 years of contributions from the Information Seeking and Retrieval community. We consolidate the factors that influence an exploratory search task: objective, search activities, conceptual complexity, and procedural complexity, and introduce a new factor: domain knowledge. We hypothesize that, in order to support Exploratory Search tasks efficiently, we must consider all the factors from an HCI perspective.

1. INTRODUCTION

The concept of a search task is a core component of the Information Science and Retrieval field. Many researchers have distinguished search tasks into two distinct bins: known-item and exploratory search tasks. Despite this binary classification, all search tasks can be seen as being exploratory to some degree [18], and we see that exploratory search tasks can comprise elements of known-item searching. A number of researchers have associated known-item and exploratory search tasks with distinct kinds of search behaviors and activities such as navigation, fact retrieval, learning and investigating [4, 7, 12, 13]. In instances where the searcher is able to adequately specify their information need, we can categorize this type of search as look-up or known-item because of their well-defined information need, and their search task only needing a look-up of a known piece of information. Other researchers have referred to this category as closed tasks [12], information processing tasks [4], simple tasks [5], and specific tasks [15].

The other category of search task, which will be the focus of this paper, is usually motivated by a poor understanding of the search topic, and goes beyond simple fact retrieval. The Information Science and Retrieval community has loosely defined exploratory search tasks as an open-ended, ill-defined and multi-faceted search problem that seeks to foster some knowledge product, or inform some action [13, 14, 18]. Exploratory search tasks are typically detectable from a searcher's:

- Poor familiarity with the domain of their search goal;
- Uncertainty of their search goal;
- Uncertainty in the manner to achieve their goal [19].

Exploratory search tasks are not a new phenomenon by any stretch; they have been referred to by different labels in the last 30 years. Prior to Marchionini's seminal paper on exploratory search [13], this category of search tasks has been referred to as: subject searches [9, 16], general tasks [5, 15], decision tasks [4], and open-ended tasks [12], but they all essentially refer to the same construct.

A number of works has discussed exploratory search tasks from different angles: Byström & Järvelin [4] and Bell and Ruthven [2] discussed it in relation to complexity and uncertainty; Marchionini

[13] described the activities involved distinguishing exploratory search tasks from known-item search tasks; Aula and Russell [1] described it according to the number of actions involved; and Kim and Soergel [10], and White and Roth [18] discussed the inherent sensemaking involved, and Kang et al. [8] have discussed the role of domain knowledge and expertise. In this paper, we revisit the existing definition of exploratory search tasks, and put forward a revised explanation, and finally a few ways taking a HCI perspective can address some of the difficulties experienced by exploratory searchers. In section 2, we discuss some of the attributes of exploratory search tasks; in section 3 present a revised definition; in section 4, we bring to attention an overlooked factor in exploratory search tasks; in section 5, we describe how taking a HCI perspective can support exploratory searching; and finally, in section 6 we summarize our work.

2. DEFINING EXPLORATORY SEARCH

Considerable progress has been made in identifying and studying exploratory search tasks by the Information Science and Retrieval community. The body of work describing exploratory search tasks has used factors such as complexity, uncertainty, search objective, motivation, task product, and activities as dimensions to describe them [3, 4, 12, 13, 14]. The factors we discuss below are the most objective and descriptive elements we found in our review, and on occasions we have subsumed factors that greatly overlap.

2.1 Search Objective

The objective of any exploratory search task is typically to create a knowledge product or shape an action through searching, browsing, learning and investigation. Exploratory search tasks are usually abstract, open-ended and multifaceted search problems, where the target information can be poorly-defined [13, 18]. The onus of an exploratory search task is more on the journey the searcher takes to find the required information, rather than the information per se.

2.2 Search Activities

Exploratory search tasks are associated with higher-level search activities like analysis, comparison, comprehension and evaluation as well as more undirected search behaviors like exploratory browsing¹. There is also a strong element of sensemaking and learning inherent in exploratory search tasks, and according to Marchionini's model of exploratory search tasks [13], these are **core** activities of exploratory search tasks. White and Roth [18] have discussed how more undirected exploratory search behaviors such as exploratory browsing happen in

¹ Though more high-level search activities are associated with exploratory search tasks, directed search activities like look-up are an important part of exploratory search tasks.

conjunction with focused and directed search behaviors like look-up searching.

Exploratory browsing plays an important role in exploratory search tasks: it enables searchers to resolve uncertainty during their search. White and Roth noted this to be a defining characteristic of exploratory search tasks, and ascribe this to the searcher becoming familiar with their search problem and information space [18]. This familiarity with the domain and information space enables the searcher to move further along in their search task, and move from exploratory browsing to more directed and focused searching. But, given the dynamic nature of exploratory search tasks, searchers tend to digress between browsing and searching.

2.3 Conceptual Complexity

The concept of complexity has been described at length by Byström and Järvelin [4] and Bell & Ruthven [2]. Byström and Järvelin have categorized tasks based on *a priori determinability*, or how much of the task's requirements, process and outcomes can be determined beforehand. This is similar to Kuhlthau's concept of uncertainty, where in her work on longitudinal searching [11] she showed that uncertainty decreases with understanding. The uncertainty surrounding exploratory search tasks can be a result of the problem context being under-defined, or the difficulty and complexity of the search task. Byström and Järvelin correlated an increase in uncertainty with the search task becoming more complex and difficult. It is widely accepted that well-defined search tasks like known-item searches have a high level of *a priori determinability* because the searcher is able to determine what information is needed and how they should go about finding it. Whereas for more complex tasks like exploratory search tasks, these factors cannot be *a priori determined* because of the dynamic and transient nature of the searcher's perceived information need and understanding of the problem context. Their uncertainty of the domain and search goal makes the process of searching, browsing and learning undirected to a degree. This has not only been shown to affect the complexity of the search task, and the searcher's information seeking behavior [4], but also increases the uncertainty of the task.

2.4 Procedural Complexity

Complexity has also been used by Aula & Russell [1] to describe search tasks. However, there is a semantic difference in their definition, Aula and Russell [1] denote the number of subtasks and steps involved in a search task, whereas Byström and Järvelin's and Bell and Ruthven's definition refers to the conceptual complexity related to the search task, such as how complex is it to determine the task requirements. Both these definitions of complexity are valid and important in understanding exploratory search tasks, but for clarification we need to delineate these different constructs, and understand the differences between these two perspectives on complexity. To illustrate this point, a search task requiring a searcher to identify CHI best papers for the last 10 years is clear and conceptually very straightforward, but as this search task has a number of steps, it is procedurally complex.

2.5 Other Attributes

Li and Belkin [14] have collated a comprehensive list of attributes and facets to describe everyday tasks from various studies in Information Science and Retrieval. Their classification provides ample description, but for the purposes of this work some of the

facets are redundant, and the search tasks can be better conceptualized by only using a core subset to describe them. For example, attributes relating to the duration, importance and urgency of a task are not considered as core attributes to describe a search task, as we believe these factors do not change the nature of the search task, and whether it is exploratory or not. Our focus has primarily been objective factors such as search motivation and search activities. In the literature, subjective factors such as domain knowledge and search expertise have been overlooked, and excluded in the discussion of exploratory search tasks. These factors play an important role, and affect how information is discovered [8] and how complex a search task is perceived [6, 14, 18].

2.6 Examples of Search Tasks

So far, we have discussed the characteristics that distinguish exploratory tasks; we next provide an example and contrast it with a known-item search task to illustrate these differences.

For the known-item task, searchers would need to identify information to complete the task. In this search task, there is very little uncertainty concerning the information the searcher is looking for, and as it is well-defined they would be able to formulate a definitive judgment on whether they have completed their task or not. In comparison, the exploratory search task

Known-item task

Identify three Voice over Internet Protocol (VoIP) telephone services.

Exploratory task

You are considering purchasing a Voice over Internet Protocol (VoIP) telephone. You want to learn more about VoIP technology and providers that offer the service, and select the provider and telephone that best suits you.

Figure 1: An example of known-item and exploratory search tasks.

requires the user to initially learn about the search topic, and then formulate a decision based on self-defined relevance criteria. This task is not only more difficult and open, but also more engaging, less well-defined, and requires more *a priori* information to be known. The onus therefore is on the searcher to formulate an understanding, and analyze and investigate the information.

3. A REVISED DEFINITION

Based on our survey of the literature, we can define exploratory search tasks involving:

- ✓ **Objective:** The purpose of which is to inform a decision or produce some new knowledge;
- ✓ **Search Activities:** Which must involve an element of learning, investigation and discovery;
- ✓ **Conceptual Complexity:** The search steps and target information can be vague;
- ✓ **Procedural Complexity:** The search task must involve a number of search actions;

If we revisit the exploratory search task described above, in light of our criteria for exploratory search tasks, we see that the above example does satisfy these criteria:

- ✓ **Objective:** The intention of the search task is to select a VoIP telephone;
- ✓ **Search Activities:** Learning and investigating is integral to this search task in order to select an appropriate service;
- ✓ **Conceptual Complexity:** How to go about looking for the information, or specific services are unknown;
- ✓ **Procedural Complexity:** The search task requires comparison of several services;

However, if any of these criteria are unmet, this can change the nature of the search task, and can potentially affect which category of search tasks it belongs to. For example, if the search task fails to comprise search activities like learning and investigating, this would mean the search activities for this search task are no longer high-level, and only involve look-up type search behaviours. Because of the absence of higher-level search behaviours, the search task can fall into the known-item search task category.

It should be noted that some factors are more critical to helping us classify a search task than others, for example the procedural and conceptual complexities involved: these criteria only really affect how complex and difficult a search task is perceived, and regardless of whether a search task is more or less procedurally or conceptually complex, it is not critical to defining whether a search task is exploratory or not.

The above criteria are adequate to help us exploratory search tasks based on their description. But, our criteria overlook two very important factors: the searcher's domain knowledge and expertise. As discussed by [8, 6, 17], a searcher's domain knowledge of a search task, and their search expertise can affect how they search and look for information.

4. THE ROLE OF DOMAIN KNOWLEDGE

The role domain knowledge plays in affecting the extent to which a search task is exploratory has received less attention than the factors already mentioned. If we revisit our definition, if a search task involves exploratory search behaviours such as exploration, analysis and synthesis of information, these essentially can be transformed into lower level search behaviours such as look-up and navigation in circumstances when the searcher is familiar with the search topic and has a certain amount of *a priori determinable* knowledge of the information they need for the task. Using the above example of an exploratory search task, what makes this search task exploratory is the search activities involved i.e.:

- Learn
- Explore
- Investigate

This search task is considered exploratory in its current form, but if the searcher has knowledge of VoIP technologies and services, the conceptual and procedural complexity of the search task is reduced. What is also interesting is the search activities that need to be undertaken by the searcher are downgraded from exploration and investigation to look-up. So for a searcher with knowledge in this domain, the search task might look like this:



Figure 2: What an exploratory search task might look like to a domain expert.

As a result of the searcher's familiarity and knowledge of the domain, the need to learn about VoIP technologies and services is no longer there; instead, they undertake more focused searching. Conversely, for a searcher with little or no domain knowledge in this area, we can expect their search behaviors to include learning, investigating and analysis.

5. HOW HCI CAN HELP

To be able to properly support exploratory searchers, we hypothesize that we need to identify and address each of these four factors from an HCI perspective. It should be the aim to improve the knowledge or search skills of the user, where prior research has shown that both reduces the exploratory nature of the task [19].

5.1 Objectives

Many systems try to help the user identify their needs, by suggesting popular query refinements, for example, or providing auto-completion at query time. Much of the time, systems make assumptions about whether the user is searching broadly or narrowly, and varies the way it presents results. It may perhaps be useful to make these assumptions more transparent in the user interface, and applying the principles of interactive feedback to the objectives the system thinks the user has. If the user is looking to learn about VoIP technology, then the system may present itself differently than when the user is actively deciding on the right service to purchase.

5.2 Search Activities

Many systems try to support users in discovery, especially online retailers that recommend what other customers have also bought. The nature of exploratory search, however, is often improved by understanding. As understanding goes beyond knowledge to knowing the limitations or the counter arguments to knowledge, we believe it may be possible to help users build understanding from the facts presented in a system, where comparison tools, for example, go some way to showing the advantages and disadvantages of different options.

5.3 Conceptual Complexity

Conceptual complexity is perhaps most affected by domain knowledge, where systems should try to introduce users to the factors that are relevant in a domain. Faceted interfaces go some way towards doing this by presenting the types of metadata that are relevant to a current search. eBay, for example, displays different facets depending on the type of product being browsed. Some of our recent work proposed that the interconnectivity displayed in facets may help users in sensemaking [20]. While the search activities above should be oriented towards helping users work within the domain, supporting conceptual complexity involves bringing users up to speed on what they should work on.

5.4 Procedural Complexity

Procedural complexity is the factor that is perhaps most suitably approached by HCI. Procedural complexity can be dramatically reduced by the search functionality provided by the user interface.

A service that provides an easy comparison service for VoIP technology dramatically reduces the task of comparing options. Performing this service directly with a search engine, however, involves many iterative and repeated result viewing, perhaps within multiple tabs.

6. SUMMARY

In this paper, we have put forward a definition of exploratory search tasks that takes into consideration objective and subjective factors. Objective factors like the objective and search activities of a search task determine the category a search task is assigned to. We have discussed how the conceptual and procedural complexity makes a search task more or less difficult, and challenging to undertake. We have also brought to attention subjective factors such as domain knowledge and search expertise which can affect the search activities undertaken by a searcher, and thus how “exploratory” the search task is perceived.

We believe that all four factors identified in our review of exploratory search tasks have to be addressed independently within an exploratory search user interface in order to support searchers effectively. Reduced knowledge of any one of these attributes can turn a normal search task into an exploratory one. We have presented initial ideas for addressing these factors from an HCI perspective and plan to explore these further in the future.

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