

# Contexts of Information Seeking in Self-tracking and the Design of Lifelogging Systems

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## Abstract

The development of mobile technology and wearable activity monitors, making it possible for people to retrieve data about their daily activities, is presenting aspects of information seeking behaviour not covered well by previous research. The main objective of this paper is to consider how the new information seeking contexts evident in the use of self-tracking extend current understandings of the way people need, seek, share and use information. This paper reviews current trends in information retrieval system design, interactive information retrieval, and human information behaviour research as the foundation for a discussion about the way that new trends in information seeking contexts and human information behaviour can inform research.

## 1 Introduction

The paradigm of information access as being a single-shot search request is based on the assumption that users' information needs are static, and can be well represented by query terms and supported by a single search box. In a review of the interactivity issues of information retrieval (IR) system design [59], it's suggested that different design decisions can be characterised by searcher characteristics, conceptual frameworks (e.g., IR models) and system evaluation. For instance, many IR systems developed under the framework of Boolean retrieval models were specifically

designed to support specified searches (see [7] for an overview). However, the limitation of this model has become evident when ordinary users have been engaged with various search activities. Because these users have different levels of domain knowledge, problem situations, and information searching skills, one of the main challenges is to “develop alternative interfaces that meet the needs of wide-ranging sets of users, and models and mechanisms for optimally mapping interfaces to problem situation” ([49], p. 114). Yet a single-shot approach has not been able to support different kinds of search behaviours in a pervasive computing environment.

Most recently the development of mobile technology and wearable activity monitors, making it possible for people to retrieve data about their daily activities, is presenting aspects of information seeking behaviour not covered well by previous research. Studies of the process of tracking personal data generated by daily activities, also called body-hacking, self-tracking, self-monitoring or quantified self (e.g., [3, 18, 42, 51]), suggest that the large amount of data that are captured automatically need to be summarised so that users can make sense of recorded data for various tasks, such as recall, reflection and sharing. As indicated in [40] the self-tracking paradigm can be characterised as (1) sensing (to collect raw data); (2) learning (to interpret, recognise or model behaviours using various data processing techniques); and (3) informing, sharing, persuading (to develop community awareness by leveraging social media). The sensing and learning aspects of self-tracking have posed tremendous technical challenges, while the social aspects are equally important for our understanding of this new information environment.

Conceptually the field of lifelogging has few limits and has been described as encompassing all the personal information an individual might wish to keep track of, retrieve and reuse in their own life, including emails, family photographs, audio recordings, travel itineraries and so on [62, 75]. Lifelogging then, as advocated by the

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notion of personal information curation [74], prioritises the importance of personal information in the everyday life of people and focuses on the long term management of personal information for its ongoing value to its creators. The opportunities for lifelogging are however changing substantially under a paradigm that Cisco Systems has described as the ‘Internet of Everything’ [23], where physical devices and objects connected to the Internet, to each other, and to people are providing the opportunity to collect and share real time data from people (response times, heart rates, gesture recognition and other personal biological information) in a network of people, processes, data and things.

This study distinguishes the new class of lifelogging systems that have been designed to allow people to capture various kinds of personal information about their body’s state (usually about performance and consumption) to improve their daily self-monitoring, make informed decisions and gain self knowledge (with specific goals of data gathering) [3, 18, 51, 43, 61, 67], from other classes of personal information management systems (e.g. personal desktop archiving systems). For instance, consumer products such as Nike<sup>+</sup> fuelband<sup>1</sup>, Fitbit trackers<sup>2</sup>, UP by Jawbone<sup>3</sup> and Strava<sup>4</sup> have been developed to track daily activities with the specific goal of improving personal health and performance. Most studies have focused on automatic data sourcing, data integration and storage, and data processing (e.g., [17, 70, 27, 80]), whereas some studies have explored the notion of lifelong user profiles [63] in support of long term goals [69] and modelling of user characteristics [56]. Despite the fact that some studies have recognised the importance of contextual information in the design of self-tracking systems (e.g., [16, 29, 42, 43, 61]), the relationship between information seeking contexts and use of personal health information for the design of self-tracking systems is still unclear.

The main objective of this paper is to consider how the new information seeking contexts evident in the use of self-tracking and new lifelogging systems extend current understandings of the way people need, seek, share and use information. This paper reviews current trends in IR system design, interactive information retrieval (IIR), and human information behaviour (HIB) research as the foundation for a discussion about the way that new trends in information seeking contexts and human information behaviour can inform research.

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<sup>1</sup>[http://www.nike.com/us/en\\_us/c/nikeplus-fuelband](http://www.nike.com/us/en_us/c/nikeplus-fuelband)

<sup>2</sup><https://www.fitbit.com/au/comparison/trackers>

<sup>3</sup><https://jawbone.com/up>

<sup>4</sup><http://www.strava.com>

## 2 IR System Design

The capturing of search contexts is important for IR system design because users have difficulty articulating their information needs (e.g., [7, 11, 48]). Research on user query formulation has focused on the capturing, analysis and modelling of search contexts through search and transaction logs from various systems, such as OPACs, search engines and social media. One of the major research issues is to design IR systems that can effectively support users’ query formulation tasks by inferring the user’s familiarity with search topics and search intents (e.g., [4, 72]). The techniques of relevance feedback [38], real-time interactive query expansion [73] and query suggestion [1, 33] have been proposed and evaluated primarily in laboratory settings.

However, one of the main issues in IR system design is when and how to provide assistance through direct system intervention, as we learn more about the searcher characteristics, search goals and contexts from various sources of evidence (e.g., [10, 33, 50, 72]). With the availability of large amounts of user search data, these user models have been able to customise search results by making inferences of user characteristics and search contexts (e.g., [19, 78]). Since search terms are quite sparse descriptions of complex information needs and it’s difficult to interpret contextual information from search data, these user models have not been able to consider the higher level of information-seeking goals and information-seeking behaviours. Nonetheless, the highly contextualised personal information environment of self-tracking and the quantified self, together with users’ long-term information-seeking goals and tasks, as discussed in lifelong user profiles and information filtering systems, see e.g., [9, 63]) provide a rich setting for the design of self-tracking in lifelogging systems.

## 3 Interactive Information Retrieval

Research on user interaction issues is the bridge between system-oriented and user-oriented approaches of IR. This thread of research has been known as interactive information retrieval (IIR). Recent research has been concerned with user interaction at both the levels of system and interface (see e.g., [15, 31, 55]).

From the perspective of interactive IR, research on user information problems has concentrated on theoretical understanding of user search behaviours in interacting with IR systems by considering the user’s search goals, tasks, cognitive state, search strategies and performance (e.g., [8, 30, 57]).

In a series of studies designed to make the user interactions with the text as central processes of IR, it’s proposed that user search behaviours can be char-

acterised by information-seeking strategies, and IR systems should be designed by incorporating different kinds of user search behaviours [5, 8, 79]. In order to characterise users' information seeking strategies and model intermediaries' search behaviours, a mixed-method approach has been adopted to study user-intermediary interactions in professional settings. This thread of research has identified purposes of utterances and focus of a dialog using discourse analysis [6], and later developed into user models of shift of focus in interactive IR [54], shift of user intentions [77], successive search in information seeking episodes [45, 44] and task-based model for Web searches [37]. User models developed from IIR studies, however, have not been widely applied to IR system design (see e.g., [50, 58] for further discussions).

## 4 Human Information Behaviour

Studies of HIB are concerned with how people need, seek, share, and use information in various contexts. Research has focused on how information seeking contexts at various levels influence people's information behaviour [13, 34, 76]. More specifically, in recent discussion of the development of conceptual modelling in HIB research [21, 65], one of the major forces underlying theory development was a focus on the modelling of information behaviours and the contributing information-seeking situations or contexts that trigger information-seeking actions, as exemplified by several models (see e.g., models in information behaviour research, reviewed in [76]).

This line of research arises from the cognitive viewpoint of user studies with an aim to understanding user interactions with IR systems and informing the design of new information services and systems. The cognitive approaches of information behaviour emphasise the individual characteristics, whereas the social approaches focus on the meanings and values associated with the social aspects of information behaviour [53]. More recently, drawing from the systems approach, the ecological approach of human information interaction focuses on how the environmental constraints shape the use of information tools, with the ultimate goal of facilitating the conditions where humans interact with systems [25].

Researchers have intensively studied information behaviours of scholars and professionals since these groups have rich information activities within their work environments. As such, the research literature has accumulated a relatively large number of HIB studies of scholars and professionals (see [41] for a comprehensive review). More recent research, however, has paid attention to ordinary people and their everyday life partly due to the everyday life information seeking

(ELIS) research program [60]. Originating from the field of sociology, the notion of *way of life* has been effectively used to characterise ordinary people's everyday life information seeking contexts (e.g., [2, 71]). As a result, research in this area has been extended to take into account information seeking in the contexts of hobbies and leisure activities as part of everyday life (e.g., [12, 14]). However, the transfer of concepts between different subfields of Library and Information Science, such as HIB and IR, has been difficult for some time [39] (see also [24] for further discussions).

## 5 Discussion

### 5.1 Capturing search contexts

From IR perspectives, since the search terms (or termed query terms or queries) are indicators of user information needs, researchers have investigated the sources and search effectiveness of search terms in naturalistic mediated search settings [66], or evaluated a technique of eliciting more robust terms from user information need descriptions [36]. More recently some research has been devoted to the evaluation of multi-query search sessions [32, 35, 47, 64] and consideration of cross-session search behaviours [46]. Overall, these studies have moved beyond the paradigm of information access as being a single-shot search request because they consider the changes in user search behaviours and the relationship between search strategies and search effectiveness within and across search sessions.

The user models developed by IIR researchers have the potential for informing the design of self-tracking in lifelogging systems since they specifically consider successive information searches. For example, the micro level analysis of user goals [77] has indicated that users are engaged with different information seeking strategies which can be characterised by types of interactive intentions (i.e., the micro level of user goals), methods of interacting with information and resources encountered. Similarly, studies of transmuting successive searches [45, 44] have suggested that behavioural characteristics of searches (e.g., the number of unique pages visited) can differentiate stages of successive search.

As mentioned earlier self-tracking takes place in highly contextualised personal information environments that are directly related to the activities (e.g., sport, exercise and driving) or health (e.g., heart rate monitoring and calorie counts) of people seeking to know more about themselves. Similar to the design of information filtering systems [9] and the notion of lifelong user profiles [63], this contextualised information environment involves users or groups of users, with long-term information-seeking goals and tasks. One of the challenges in the design of lifelogging systems for

self-tracking is how to represent regular user interests as user profiles, and how to summarise logged data so that users can make sense for various tasks and long-term use.

## 5.2 Information seeking contexts and information access tool use

HIB research is concerned with the contexts of work and how information access tools can be designed to better support work practices. A recent context-rich study of the use of PubMed database in support of problem-solving activity suggests the importance of connecting the user's patterns of information seeking and their associated needs for information access tools support in specified contexts [52]. Drawing from senior people's health information seeking strategies [26], an image-based retrieval interface for drug information has been designed to meet seniors' needs in a health information context. These are the examples of qualitative fieldwork that are designed to characterise the contexts of information seeking (i.e., environmental constraints in [25] and how they affect the use of information access tools.

Within the context of health information seeking, researchers have used physiological data to tailor health information for people with diabetes [22], investigated the relationship between health information behaviour and stages of change in physical activity and exercise [28], identified physical activity information needs [68] for people with multiple sclerosis, and explored the relationship between health information seeking and health status [20]. Overall, these studies demonstrate the importance of considering information seeking contexts to support the design of self-tracking tools for long-term goals and potentially behavioural change.

With respect to self-tracking system design, researchers have developed empirically motivated design principles for lifelogging primarily to support memory [75]. Some open research questions regarding self-tracking and new lifelogging system design include:

1. What are the characteristics of personal health information behaviour based on understandings of information behaviour in everyday life?
2. How do we consider the reflective personal information practice of individuals?
3. How do we incorporate social approaches to information use and sharing in self-tracking and new lifelogging system design?

A significant gap in research to date is an understanding of the information needs of individuals who are seeking to track their own personal data. While this paper has explored the possibilities for enhancing

IR/IIR/HIB research processes to account for the information seeking contexts of individuals, addressing the questions we have raised will be an important driver in future research.

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