TOOLS AND SUPPORT

Tools to support the workflow

Fernando Diaz, Sue Dumais, Jaap Kamps, Cathy Smith, Simone Stumpf, Elaine Toms, Arjen de Vries, and Maria Zemankova

Problem

The breakout group focused on the following two problems: First, how to embed search into the work task? Second, how can the work environment inform search? This generated lots of interesting discussion on a variety of explicit tasks, such as genealogy, term paper writing, environmental managing, wedding planning, trip planning, school selection, etc.

The discussion of tasks was rather unstructured, yet four broad observations surfaced several times. First, there seemed to be a family resemblance between the tasks discussed: each of them being a complex task requiring the combination of a variety of sources, and occurring in a session or episode that takes hours or days and weeks to finish. Second, most of these tasks have as goal a specific output that is essentially an information aggregation (family tree, written report, plan), which creates an obvious direct measure of (task) progress and success. Third, the discussion was problem driven: there was substantial criticism about how these tasks are now supported by current web search, verticals, apps, or dedicated software. Fourth, in addition to their general usefulness to support a task at hand, there is clear importance of such tools for those with poorer information, media, or search literacy.

Approach

Concerning the first problem of how to embed search into the work task. This requires a broad definition of information access methods rather than a narrowly defined search task. It also requires a holistic approach, starting from the whole task (work environment) and including all activities (such as reading, writing, thinking) beyond the narrow search interaction. Complex tasks have internal structure: each tasks has many subtasks with their own subgoals, rather than singling out the search (sub)task, there are information access activities embedded in each of the (sub)tasks.

Concerning the second problem of how can the work environment inform search. Here the task structure and constraints on the task output are a valuable source to exploit. This allows for a separation between supporting task specific aspects (supporting the product) and supporting the search or information access process (supporting the process). This will require lots of data interchange, making search aware of the tasks context and all previous activities, which raises ethical and architectural questions (locally stored, centralized cloud server, peer-to-peer exchange based on a need-to-know basis).

Challenges

Various challenges were identified: How to extract (search) tasks out of the work environment: how to define the primitives (what are 'atomic' task aspects)? Tasks are distinct from vanilla search because of 'clear' goal/success states, and task context or even templates for the `ideal' information seeking process (e.g., evidence based medicine): how to incorporate these? How to balance generic tools and task-specific tools unique to a case at hand? Task and subtasks have intricate dependencies: how to take them into account? We need more than a note-taking/scratch pad! There is a need for flexibility in the workflow through the different steps, not only a rigid

waterfall model with stages, but can we skip components/steps (look ahead) and backtrack? What are crucial features of the user profiles and contexts (in particular in collaborative task)? How can we infer or extract the needed information? Many tasks are collaborative, even those done by a single person may have different roles, how can we exploit the support tools in collaborative situations.

Impact

There have been systems that support professional tasks for many years, but often offering a specific additional search tool, rather than being embedded into the work task as ambient search support. In today's always online world, the distinction between search tasks and work tasks is increasingly blurred, with all of our work stored in the clouds (including a full transaction history) and all our context and interactions logged and shared between all on our devices. Hence this is the time to integrate search into our tasks (both in work and in daily life).

Next steps

A sensible approach is to focus on the overarching tools that piece together results from subtasks (which could be web searches, intranet, …). This would balance generic tools and task-specific tools: with support for the task process (decomposition and aggregation) being fairly generic, and specific subtasks potentially requiring dedicated task specific modules. In the evaluation, it is essential to look at a broader range of factors than only search task success (i.e., "whether an answer is found") but also on how well the tool supported finding the answers, and how this helped in achieving the overall task's goals (in particular the created information product).

Bringing search into task: Identifying task primitives

Fernando Diaz, Catherine Smith, Simone Stumpf, and Elaine Toms

Problem / Motivation / Goals

In work on interactive information retrieval, search is often studied in isolation from the task activities that prompt searching and which are dependent on the products of searching. *In situ* log studies describe search behavior that occurs in natural *task contexts* (e.g. planning a wedding), however these studies often lack information about that context, as well as data on the task activities that occur outside of the search system (e.g. recording information in a word processor). In experimental studies, research subjects are generally given a task context (e.g. pretend you are a journalist) and assigned specific task goals (e.g. find background information on the sequester). In most studies in this setting, task activities that might precede and follow search are hypothetical and little is learned about the dependencies between these activities and search. Longitudinal studies conducted in specialized domain settings (e.g. chemical engineering) have examined *in situ* task and search activities however, few studies have attempted to systematically extend this work across domains. In summary, little is known about the fundamental characteristics of dependencies between task activities and searching (hereafter called *task dependencies*). This knowledge is essential to the development of the task models required for support integrated search and task activities.

The investigation of task dependencies across domains requires a standardized framework for decomposing task structure to a sufficient level of detail. Because a suitable framework does not yet exist, part of the problem is to develop and test an initial framework. In applying the framework, the goal is to discover and describe task dependencies that occur universally across domains and task contexts; we term this type of dependency a *task-primitive*.

We propose to examine the question of whether there exists a set of task-primitives and to address the following research questions specifically.

Research questions

- Where in the flow of sub-task activities is search invoked?
- Can a set of task primitives be identified across diverse contexts and task activities?
- Can common dependencies between primitives be identified?
- How can descriptions of task primitives be standardized for research purposes?
- What might be the components of a generalized task activity model?

Approach

Our approach is to record, decompose, and analyze *in situ* task activities at a level of specificity sufficient to reveal task primitives. We will study two diverse task contexts, and will decompose task structure using the framework summarized below.

Data collection overview

Because we seek to understand naturally occurring task dependencies, a longitudinal design is required. Data will be collected using multiple methods and from multiple sources, including initial and periodic interviews about the task under study, collection of comprehensive log data from multiple devices, and participant diaries and annotations. Interviews will focus on expected and experienced task structure. Log data will record transitions between search systems and systems used in completing the task, as well as selected transactions within select systems. Periodically throughout data collection, participants will be asked to record annotations on specific aspects of task activities. Interviews, diaries, and annotations will be transcribed and coded. Coded data will be integrated with log data for analysis.

Selecting task contexts

We define a *task context* as a high-level multi-part goal. Task contexts differ in many dimensions. For the proposed study we focus on the specificity of the goal, level of collaboration, time urgency, duration, and geographic scale. Examples of task contexts include crisis response, travel planning, buying a house, selecting a school, developing a product, debugging code, managing a medical condition, handling a family legal matter, etc..

For the proposed study we have selected two task contexts that vary on several dimensions. The first, a small group assignment to be completed in an online course, involves collaboration with time urgency and limited duration. The second task context, personal management of an asthma condition, is primarily individual with a regular ongoing repeating time urgency. Both have specific articulated goals and limited geographic scale. The differences between the contexts provides the contrast required to address the question of whether task-primitives can be found in diverse contexts.

The framework and its application

In order to standardize the decomposition of task structure, we will use a three-phase iterative analytical framework. The framework sets aside questions of task detection or classification of tasks by type. Below, we step briefly through the application of the framework for analysis.

Phase 1: Task context decomposition

The table below outlines the two task contexts and examples of possible associated *task activities*, which we define as high-level multi-part sub-tasks of the task context. As defined in this initial

version of the framework (we expect that the framework will evolve as we learn about task dependencies), task activities express the steps or composition of the larger context. For the asthma study the activities repeat regularly, while for the group project they have a finite time limit. It is expected that task activities will emerge during iterative application of the framework.

Phase 1: *Task activity decomposition*	TASK CONTEXT	
	Group Project in Online Graduate Course	Asthma Management
TASK ACTIVITIES (hypothetical)	• Select topic from list • Plan project • Assign duties • Conduct research • Share and analyze • Prepare paper	• Measure peak flow rate • Observe symptoms • Observe triggers • Adjust medication

Phase 2: Task activity analysis
The table below provides an example analysis of integrated data from one hypothetical task activity in the group project task context. The goal of analysis is to identify activity sequences that comprise task activities, and with those activities, to identify potential task primitives. It is expected that primitives will emerge during analysis of the integrated data. Analysis will be conducted using an combination of algorithmic and human processes.

In the example below participant Joe has used his laptop to search for information on the assigned project topic, looking a library catalog and a database service. He's recorded and saved notes using his word processor. Four days later Joe uses his cellphone to search the web, and browses a Wikipedia page and a YouTube video, all related to the project topic. The next day he sends an instant message to Jill, his partner on the project and she replies. She then uses her laptop to search a database service and saves PDFs of several articles to a remote server. As can be seen in the rightmost column, each sequence has been identified as a potential task primitive.

Phase 2: TASK ACTIVITY ANALYSIS (example task activity: Select Topic)						Pot. TASK PRIMITIVE
time	*participant*	*device*	*tool used*	*information input*	*information output*	
AM 9/8	Joe	laptop	Library catalog	topic descriptions	– bibliographic records	explore
		laptop	Database service	topic descriptions	– bibliographic records – article abstracts – full text document displays	
		laptop	Word processor	notes on topics	– text file	
PM 9/12	Joe	phone	Search engine	topic terms	– results pages	
			Wikipedia	links	– text pages	
			YouTube	topic terms	– video	
9/13	Joe	phone	message	comment on	– message to Jill	contact

AM				progress		
9/13 AM	Jill	phone	message	message from Joe	– comment on plan	
			message	comment on plan	– message to Joe	
		laptop	Database service	topic descriptions	– bibliographic records – article abstracts	gather
		laptop	remote server	full text documents	– saved PDF files	store

Phase 3. Analysis across task contexts and activities
In the third phase of analysis, potential task primitives will be aligned across task contexts and task activities, with the objective of identifying and describing any global characteristics for each primitive, and any features that may be task dependent.

Phase 3	TASK ACTIVITIES					
	Group Project			Asthma Management		
Potential TASK PRIMITIVES	select topic	…etc…	prepare paper	measure peak flow rate	…etc…	adjust medication
explore						
gather						
store						
route						
filter						
evaluate						
share						
compare						
integrate						
extract						
separate						
find trends						
contact						
….						

Challenges / Resources Required / Caveats

In order to capture task activities on all types of devices, log recording methods are needed. If these methods are not available, knowledge of task activities will be limited to those that occur on personal computers. A second challenge is participant recruiting and retention for long-term ubiquitous data collection. Because participation requires the disclosure of information likely to be perceived as personal and private, adequate incentives will be necessary. Also, because the data to be collected has a large scope and will be voluminous, integration and analysis will be complex and will require resources.

Plan for future

The proposed study is limited to two task contexts in two different domains. Task contexts vary on many other dimensions. Assuming the analytical framework proves to be a useful approach,

further research in different domains and contexts will be needed to validate and extend the task primitives found in the first study.

Impact

Interactive search is ubiquitous in everyday life. It is integral to and useful for all types of life goals. At present, search is not well integrated with the tasks it supports. This makes information intensive tasks burdensome, particularly for populations that lack experience with the many applications often required to support task completion. By identifying and describing task primitives we may be able to determine those which have the broadest application and thus prioritize research and development efforts.