Human Memory and Behavior in relation to Personal Information Management
(Review & Research of Techniques)
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Abstract

The importance of human memory and behavior on Personal Information Management (PIM) is of utmost importance. Firstly, people often try to overcome memory problems. At times, they forget any specific detail or want to be reminded of something and this prompts the re-finding activity. Secondly the behavior of people exhibit reflects the limitations of the human memory system. It is a known fact that filing and piling behaviors are good examples of personal information management. Thirdly, it was demonstrated that the behaviors of people employ also lead to memory problems. The objects which are filed tend to be often forgotten. The design of PIM tools affects how memory is used in PIM and that many of the systems available place a burden on memory. Thus it has been emphasized that the link between PIM and memory problems is of never ending process. The empirical work builds on this point by relating PIM behavior to other kinds of memory problems. The outcome is an initial prototype PIM system, designed to support memory when re-finding personal photographs.

The recurring theme is the role that human memory plays an important role in personal information management behavior and the burden passes on the existing tools, systems and strategies place on memory. The information operates at varying levels and the level of particular pieces of information and information objects can change over time.

Introduction

Building of work, taking a practical psychological approach to the problem mainly from the fields of information science and human-computer interaction with determining the strategies people employ and their habits are managing their personal information. The underlying psychological motivations behind the strategies relate these to the principles of memory established. It has been explored to improve personal information management behavior and to ease the task of one's personal information. The features of the tools and systems available to help people manage their information, as well as contemporary research concepts and prototypes with respect to the motivations behind their design and in relation to the psychological themes are established. The recurring theme is the role that human memory plays an important role in personal information management behavior and the burden passes on the existing tools, systems and strategies place on memory.

Scope of Study

Personal Information Management can be divided into four different stages or processes as:

(A) Information Acquisition

People are prone to acquire information in two distinct ways:

-	through explicit seeking behavior, performed in response to a specific information need or 'Anomalous State of Knowledge'
-	implicitly, by interacting with information sources or channels as they go about their daily working and personal lives

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(B) Seeking Information

Several options are available to seek information to the user with respect to the method they select to solve their need. The choice of channel is likely influence the user who decides to store the information. This is because many information channels have dedicated stores associated with them.

(C) Interest of Search

The interest is not in the ways in which people search for new information i.e. information out with their personal stores.   We can provide facilities that enable them to search more efficiently for new information.   Reviewing the fields of information seeking and retrieval, focus is on as to how their seeking strategy, motivation for information acquisition and search methods affect the other aspects of personal information management behavior.

(D) Information Channels

The people who have no obvious stores associated with them. There is a crucial point that the channel used to source the information influences where the information will be stored. If the channel has a suitable place or store then the information is likely to be retained there. Otherwise, it will be stored in a place that they feel it will be less likely to be forgotten about and will offer them a path back to their state of mind at the time of storage.

Methodology (Empirical Study)

Based on the studies, a complicated array of factors is required to be combined to determine exactly how information will be found and stored. The lack of a well defined or easily predictable storage strategy places burden on the memory systems when re-retrieving objects because to facilitate re-access the user must remember contextual facts, such as the channel or tool used to retrieve the object, the task they were undertaking at the time, their location, mood etc. because all of these factors may have influenced where they decided to store the information.

Many factors affect the information seeking strategy that a user employs and the tools used to source information. These, influence how and where acquired information will be stored. It is a fact that people use multiple information sources and that there can be many stores associated with each source leads to difficulties.

The research relating to the choice of whether to keep found information and illustrates that the keeping decision itself influences what information will be remembered.   The information acquisition situations force people into a choice relating to whether acquired information should be kept or not.   This decision may be taken consciously or subconsciously, but the options are (a) To keep the information and (b) To leave the information where it is

Therefore, there is have a threshold for keeping information and adjust it to reflect the relative costs of misses and false positives and the relative benefits of hits and correct rejections. The cost of false positives to a doctor or lawyer, for example, where not having access specific information may seriously impact human life, are likely to be far greater than to someone collating information about a personal hobby. Keeping information is likely to be lower for a doctor or lawyer and the nature of the information channel and the resources available, such as storage space may alter the threshold level. The factors that people put more effort into keeping and organizing information objects that they had specific connections with, such as those that they had created themselves Technological and cultural factors also impact on the threshold level, as the cost of digital storage decreases there is less

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value placed on storage space. Thus the information that may have been ignored when storage space was more costly and precious may be kept. Sentiment has been proposed as another explanation for making the decision to keep information objects.

It can, be summarized that when a person comes into contact with information, they are faced with a choice of whether to keep the information and store it somewhere within their collection, to leave the information where it is and try and remember the content or the source, or to ignore the information and not expend any cognitive effort toward it. The decision they take will depend on the prediction of future information needs and their threshold for keeping calculated to balance the amount of upfront effort with the potential benefit in the future. Both factors impact the role that memory plays in re-retrieval.

Review of Literature

(I) Storing Information Objects

Factors Influencing Categorization is one of the first attempts to understand the classificatory choices made with respect to information objects was a study of 30 office workers and their document collections. Six important document aspects were identified with respect to the filing location. These were:"type, form, volume, complexity, functions, and levels of information".

It was found that documents associated with "administrative" tasks transition between hot and cold states very often and very quickly. Whereas, documents associated with "research" tasks tend to stay warm for longer, perhaps years if associated with the writing of a thesis.

The information operates at varying levels and the level of particular pieces of information and information objects can change over time. The level of information describes the way information is being used and this will influence what a person remembers about the information and its encapsulating object.

II Categorization Strategies

To classify the filing strategies employed by different types of people for different types of information objects and in different digital and physical settings. The primary distinction identified was between neat and messy offices. There are characterized by highly structured filing systems, reflecting the structured tasks the owners performed, whereas messy offices exhibited unstructured piles of documents and overlapping papers.

It is difficult to draw parallels between the organizational strategies used by different groups of people in different situations. Both the digital and paper-based environments organizational style seems to reflect the tasks performed by individuals also noted that knowledge workers – people who interact with large quantities of information as part of their job – have particular difficulties in categorizing objects because of the kinds of tasks they need to perform.

It is found that books were largely organized by topic and then further sub-organized chronologically. Journals, on the other hand, were mainly sorted by title alone and there was certainly evidence of overlap between organizational strategies.

III Categorization and Memory

The explanations can be viewed as efforts to align with or compensate for the workings of human memory. For example, a number of reasons have been proposed for piling. Firstly, it is the result of people having multiple and conflicting uses for their document collections. People use collections both for preserving information that they may need at a later time and for reminding themselves that tasks have still to be completed.

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Piles represent a kind of short-term memory; a buffer which retains tasks that must be performed. This is useful because when documents are filed in folders you have an "out of sight, out of mind problem". It is only when the number of files / piles scales beyond a certain threshold that the disadvantages of employing a piling strategy become apparent.

It has been observed by scholars that the behavior to compensate for various types of memory lapses: "Finding behavior" i.e. filing objects in a meaningful location combats retrospective lapses because it makes it easier to locate information when it is required; "reminding behavior" i.e. strategies such as "piling" combat prospective lapses as they provide timely reminders that the information is there and available or that tasks associated with the object should be performed. The layout of objects within an office space aids recovery from action slips, which are very short-term memory failures that cause problems for the actions currently being carried out e.g. forgetting what one is doing following an interruption, forgetting why one went upstairs, or losing one's train of thought etc.

Reviewed research concerning personal information filing behavior have factors which is shown as influence how and where an information object is stored and in turn, has been related to what burden is placed on the human memory system when re-accessing an object.

IV Maintaining a Collection

Maintaining a personal information collection include re-organizing objects to better support new purposes, deleting stored objects that are no longer required, or altering records of the objects that are stored. It was found that participants often expressed frustration that they needed to maintain so many different organizational schemes in parallel. Some participants also found that they had worked hard to combine their organization schemes across channels. One person produced a printed copy of everything they felt was important and maintained an extensive paper-based filing system. Second person saved email and web references in electronic documents which could then be indexed in a computer based filing system. In another situation, an assistant and her manager worked together to establish a single categorization scheme which was then applied consistently across tools, such as email, as well as digital and paper documents.

There are benefits to maintenance with respect to memory. The act of reorganizing or tidying involves interacting with documents in the collection and therefore refreshes fading memories of objects. The limited evidence suggests that people do not make large changes to their organizational style and they expend large efforts in maintaining their current organizations. This means a greater reliance on original recollections.

V   Re-finding Information

Use of various models for describing human information has been made. These models emphasize that when looking for information, people generally first look internally to their own personal collection before searching elsewhere. The importance of re-finding and efforts are made to improve users' ability to re-find. Nevertheless, until recently re-finding had received considerably less research attention than general information seeking behavior.   A number of groups have started to explore re-finding behavior, although much of this work relates only to the re-finding of web-pages. The task of re-finding is different from looking for new information and uses different cognitive processes. Finding new information involves recognizing that retrieved resources are useful; re-finding utilizes recollection to guide the search for specific resources that are known to be useful. Most of the evidences suggested that people have difficulties with re-finding. The results suggest that users develop personal techniques for accessing data they are familiar with and access frequently, while search engines are employed for other refinding tasks - tasks that have no associated familiar method to re-access.

Review of Behaviour and Tools of PIM Behaviour

While reviewing the Behavior and Tools of personal information management, it is observed that queries used to find personal information were shorter than typical web queries. However, re-finding queries did share some characteristics with web queries. They rarely included explicit Boolean operators, phrases, or field restrictions. Instead, participants preferred to iteratively filter through result sets by using interface widgets that refined their queries. The re-finding behavior in study, therefore, adheres closely to the orienteering approach observed and demonstrated that semantic labels are important cues during the re-finding processes, but document retrieval can also benefit to some degree from the addition of spatial location knowledge.

Thus, diversity has been discovered in the way people re-find information. Preferences have been discovered for both location based re-finding and the use of search engines. Closer inspection has revealed that the frequency with which the type of task is performed and the familiarity with the sought after information impacts the method used. The work reviewed in this section suggests that people develop specific techniques for re-accessing familiar, frequently used information and use search engines to re-find information that they are not so well acquainted with and seldom require. Distinctions have also been drawn between orienteering behavior, where the user gradually narrows in on the sought after information and teleporting, where the user attempts to directly access objects. Such behaviors reflect what the user remembers about the objects they are looking for. For instance, teleporting requires either a full recollection to recreate a previously submitted query or a precise recollection to recreate a full URL of a web page. Whereas, orienteering represents a progressive return of previously known details. It would be interesting to establish if certain kinds of tasks or objects lead to teleporting strategies and others to orienteering behavior.

Tools

Several tools have been designed to help people manage and store their information. To provide a review of such tools, the most common and pervasive tools are described and strengths and weaknesses pointed out. Then review concentrates on the systems that have been suggested to improve on commonly used tools, including contemporary research prototypes.

A feature of the work described below is the lack of tool evaluation that has been performed. The difficulties associated with performing PIM evaluations are widely acknowledged and due to the lack of performed evaluations, in this review the psychological evidence collated as a means to critique and the concepts behind the systems reviewed.

Commonly Available Tools

The tools people use to manage and re-find their information are either dedicated to searching their personal information stores, such as desktop search engines are tools which allow the management of information objects, e.g. folders in email applications. Information management tools are intended to help people find previously stored information by allowing the user to organize their information objects. However, as will be shown, both the searching and managing approaches place the load for successful recovery of information on the user's memory.

To conduct a successful search on a query-based system such as Google desktop, for example, a user must remember sufficient details about the information they want to retrieve in order to form a query.

Tools for Storing and Categorizing Objects

On review of behavior of PIM tools, it is found that manual filing and annotating information objects requires cognitive effort. The studies described and indicated that the amount of effort people are willing to expend is dependent on a number of factors, but is implicitly calculated with respect to the benefit it will offer and the cost of failing to apply effort.

The study of how people annotate paper-based and digital information objects and tool support for these tasks are both mature domains in their own right - a complete review here would be inappropriate. However, a summary of the approaches to supporting annotation is provided and the relation to memory outlined.

The standard approach is for the user to manually assign suitable descriptive keywords. In terms of memory, the cognitive processing required to select and provide accurate descriptors is positive; inducing at least semantic encoding.

People often annotate paper-based information as a natural way to assist thinking and remembering. This is because annotation on paper requires very little effort. However, when material is read from a computer screen the natural interaction is lost and, consequently, the people tend to annotate digital documents less often.

Use of various systems is good because while they reduce the time and cognitive effort required in annotating, they still require some form of cognitive processing from the user and, as such, do not completely remove the natural encoding effects. However, this positive also has a negative outcome. As effort is required and because there is an added level of complexity to the tools, users may yet refrain from annotating their collections.

With the use of semi-automatic system as designed attempts to annotate found images - a process that requires verification from the user. Other systems use the surrounding textual context to annotate images. When surrounding text is available, this seems like a reasonable approach, although the results do not compare with manual indexing. The primary disadvantage of this approach however, with respect to the aims of this thesis, is that personal images often do not have any surrounding textual content with which to mine annotations.

Other semi-automatic systems, analyze the classificatory decisions made by users in the past and attempt to construct rules to model these choices. The model is then used to make suggestions to the user as to where in their organization an object should be placed.

The aim of these systems is to reduce the cognitive effort in filing and to some extent this is achieved. A long-term study found accuracy levels of 85%. Nevertheless, there are negative outcomes to such an approach. It is apprehended that such interfaces may result in a loss of control on the part of the user. In addition to the reduction in control and beneficial cognitive processing, the requirement for the user to recollect which folder the item was placed in remains.

Tools Influence the Keeping Decision

It is described that the decision of whether or not to keep acquired information, detailed three choices available to the user and uncovered the underlying psychological motivations behind each choice. Finally, it related each of the three choices to memory.

The type of tool and how the tool works impacts how this decision is made. For example, in the physical world people have to expend effort to keep information e.g. they have to file papers or shelve books. In the main, computer-based tools are the same - people must name and save files that they create, or bookmark web pages they visit in order to keep them.

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Other tools, such as email, store information automatically, and require the user to expend effort in order to delete messages.

The context associated with documents was stored and the interface exploited this to remind users of their experiences and the location of their information. As of yet, no evaluations of any of these "keep all" projects have been published.

Tools Maintaining a Collection

It was discovered that maintaining a personal information collection may include re-organizing objects to better support new purposes, deleting stored objects that are no longer required, or altering records of the objects that are stored. Several tools are available commercially to help with collection maintenance, but the evidence from studies of PIM behavior suggests that the practical use of these tools is limited. Further, very few tools have been proposed and evaluated for research purposes. The exception to this has been the work of Boardman et al. This section will detail this research work, then outline some of the tools available commercially.

Tools for Re-Finding

Several approaches have been taken to improve on the tools available for re-finding. One of the approaches is to augment the standard browsing or searching facilities. It is suggested that search facilities for personal information could be improved by using document and query expansion with the thesaurus facilities of Word net. This was an attempt to remove the need for users to remember exact terms that appear in documents when they construct re-finding queries. Although no evaluations of their system have been published, the findings of are available from http://www.moonsoftware.com

White and his colleagues discovered that users preferred and searched more effectively with interfaces that displayed top-ranking sentences rather than traditional document surrogates such as titles, sentence fragments and URLs.

Another approach to improving re-finding tools is to tailor the design to support particular strengths of human memory. For example, several groups have designed tools to support episodic memory and research endorsing temporal recollections. Here three of these systems are described.

Life streams system organizes documents based on the time that they were created, received, or modified; presenting them as a chronologically ordered stream. The beginning of a stream contains the oldest documents while the end of a stream contains those created most recently. The interface also had a reminding function. By creating a document in the future portion of the stream, users can create time-based reminders because documents are only visible at times subsequent to its position in the stream. According to the authors, this feature provides an alternative to piling without encompassing the negative outcomes that result from piling [see section but felt that Life streams was limited by the uni-dimensional presentation of the document streams. He believed that the evidence from studies of document management strategies suggested that the spatial layout of the desktop metaphor has important advantages because the organization of documents on the desktop at any point in time reflects the work context at that moment.

The MEMOIRS system was also designed to allow retrieval based on temporal contexts. It organizes information objects in terms of events. The system combines diary facilities with a filing system and treats files in the same way as appointments are handled in date book or calendar applications.

There are some other systems have like the Piles which teaches the strategies observed in physical office environments. The Data Mountain system attempted to support three

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dimensional spatial capabilities in the management of Web bookmarks. Information retrieval systems designed to support spatial memory to assist in re-finding information like a Book House project is an example. The main feature of the Book House system was that it used the metaphor of rooms to help people find and re-find books. The idea behind attribute-based systems is to overcome the limitations of the traditional hierarchical or spatial systems.

In studies of spatial memory, the objects and object locations that people remembered were influenced by what people knew about the objects and the type of scene they were asked to remember. In studies of temporal memories, recollected dates were influenced by the number of facts people knew about the cue and what people remembered about other events that could be used as anchors. If you examine the designs of the systems that aim to exploit particular memories they do not necessarily enable the user to apply these augmenting strategies that featured in the psychological experiments. Consequently, the benefits of exploiting particular memory systems could be lost, although evaluations are required to confirm this.

Findings

The importance of memory in PIM behavior is detailed. It can be detailed in three categories as under:-

1. Firstly, people often re-find to overcome memory problems. They may have forgotten a specific detail or want to be reminded of something and this prompts the re-finding activity.
2. Secondly, the PIM behavior people exhibit reflects the limitations of the human memory system. It was explained that filing and piling behaviors are good examples of this.
3. Thirdly, it was demonstrated that the behaviors people employ also lead to memory problems. For example, objects that are filed are often forgotten about. The second part of the chapter illustrated that the design of PIM tools affects how memory is used in PIM and that many of the systems available place a burden on memory.

It is emphasized that there is link between PIM and memory problems and the empirical work builds on relating PIM behavior to other kinds of memory problems. The outcome is an initial prototype PIM system, designed to support memory when re-finding personal photographs. The information operates at varying levels and the and information objects can change over time. The level of information describes the way information is being used and this will influence what a person remembers about the information and its encapsulating object.

Recommendations

Based on the study of the behavior of human memory and its review with detailed strategies employed by people when they store information within their personal stores, maintain or reorganize their stores thereby attempt to re-find information from within their stores, the findings and recommendations can be summed in the following manners:-

1. The main outcome of the behavior is that the information people keep is scattered around in a number of storage locations which is referred to as the problem of information fragmentation and ensures that to re-access information, people are required to remember a number of details about the contexts in which documents were previously created, accessed or used.
2. It is illustrated that information fragmentation is worsened by the fact that people do not always decide to keep information that they think may be useful, which means re-finding can sometimes involve searching for information not actually stored in a location local to the user.

3. It is also worth mentioning that people are aware of their memory limitations and alter their behavior accordingly.   Filing behavior is an attempt to lessen the burden on memory when re-finding. Piling is an attempt to leave reminders about the availability of objects or that some task associated with an object needs to be completed. However, there is a tension between filing and piling strategies and both suffer from performance degradation when large quantities of objects are involved.

4. The processes involved in maintaining a collection can be beneficial to the recollection of objects within the collection. Nevertheless, the evidence suggests that few people regularly update or reorganize their personal information objects, preferring instead to place their efforts into re-finding when there is an information need.

5. The last stage of personal information management behavior to be discussed was information re-finding. Studies have shown re-finding behavior to be prevalent for many kinds of information, indicating that more effort should be placed into learning more about the processes involved in re-finding and understanding the needs that users have.

6. Systems have been developed to exploit spatial, temporal and semantic memories in information re-finding, but the evaluation of these systems have been very limited. There is psychological evidence endorsing each of these modes of recollection. Nevertheless, the effectiveness of individual recollection modes was partly explained by evidence demonstrating that people augment their recollection with special techniques that utilize previous knowledge and inference.

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