

Literature Review on Smart Social Contact Management System for Better Memory Recall

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Abstract-Memory of human being is usually poor and often fails. On some occasions, it generally causes uneasy situations (e.g., forget the name of a person). As the number of relations among people increases, it is difficult for people to maintain their social contacts with merely memory. To help people for better management their social contacts, a powerful social contact management tool named Social Contact Manager (SCM) is introduced. It supports a simple but efficient contact retrieval interface and auto-collection of rich contact data. With a series of questions about contact management, online survey is done. On the basis of survey results, the SCM system is developed. To estimate the usability and usefulness of SCM, a user study of contact management is performed which proved SCM is very helpful for contact re-finding. Particular phenomena about social contact management and recall are discovered. Based on the result of this user study, the human contact-memorizing pattern is also concluded. Purposely, the contact name recall is used in the academic community as the target application to showcase our proposed methodology. We further develop an intelligent social contact manager that supports 1) auto-collection of rich contact data from a combination of pervasive sensors and Web data sources. 2) When human memory fails, use associative search of contacts. 3) User study on contact memory recall is also conducted, through which several findings about contact memorizing and recall are presented.

Keywords–Social Contact Management, Human memory Aid, Pervasive Computing, Human Computer Interaction, Empirical Study

I. INTRODUCTION

Slip of Memory is a common problem among people. Many different forms of slip of memory occur in our daily life. Relationship among people plays an important role for human being such as meeting friends, dealing with business partners etc. Related issues about the social contact management are raised with the ever-increasing contact information. As human memory is overwhelmingly the most important factor in our social lives. However, due to its unreliability nature, sometimes people may find themselves in the embarrassing situation just because they fail to remember the name of the person in front of them, confused by the question like “Who is that person? I met him in the last summer in a conference.” Some research on human memory has been done in the context of social lives. Regarding names and portraits of classmates, Bahrick et al. found that even after 30 years, people are good at recognition but are poor at recall [1]. Eldridge et al. classified common memory problem in the workplace by three categories, retrospective memory, and prospective memory and action slips [2, 3]. With their in-depth studies, the retrospective memory problem turned

out to be 47% of all memory problem recorded, in which forgetting a person’s name has a high frequency. However, these methods suffer from problems, including possible loss/damage and inefficient Representative examples are note taking and address-book writing. Search support. With the development of information technology, the use of digital tools (e.g., digital contact books, e-calendars) has gained much attention nowadays. However, while enabling reliable storage and efficient query support, these digital tools still face several issues. Among these issues, the reliability of data retrieval is significant. To conduct successful searches on data retrieval tools, users must remember sufficient details about the item they want to retrieve in order to construct a query (e.g., terms in a document, the name of a contact). However, psychological research indicates that people are not good at remembering precise details. Instead, they tend to remember diverse memory cues relevant to the item [1]–[3]. For example, in conducting a document search, people may rely on some contextual memories, such as its size, time when it is created, associated links, and so on.

Using *memory cues* to address the memory lapse problem has been proved to be effective. Several types of cues are used as general ones to address distinct memory problems, such as user experience with the object, its creator, linked items, etc. However, the role that memory cues play in memory recall is rather complex and domain related, which has been of little concern in existing studies. First, in terms of the objective and user groups, many different forms of cues can be used to enhance memory recall. Just taking the contact name slipping as an example, businessmen may remember properties such as position, commercial needs, etc. On the other hand, educational background and research interests become more important information for academic researchers. This is in line with the survey result reported by Elsweler *et al.* [4], which indicates a wide range of forgetting behaviors and consequently a need for different types of tools to prevent memory failure. Therefore, depending on the context of memory aid, it may be easier for the user to utilize some types of memories over others. Second, to enhance memory recall using specific memory cues, we should collect such cues in association with the items in a data archive for future retrieval.

II. RELATED WORK

Human memory is an everlasting research topic. In the late nineteenth century, Herman Ebbinghaus conducted a series of long-term memory experiments quantifying the rate at which people forget [5], which proved the unreliable nature of human memory. Due to this reason, researchers have taken much effort on human memory aids. Aiming at reducing the

impact of forgetfulness on social occasions, the bulk of computer-based memory aid tools have been developed. The most popular method is to create life logs via several different approaches. For instance, the “Forget-me-not” project used physique sensors [6]; the “Remembrance agent” leveraged text-based methods [7]; Vemuri et al. developed an audio-based personal memory aid tool [8]; the “WearCam” [9] and “SenseCam” [10] achieved via video-based approaches. These research projects could solve the general memory problem in people’s lives, e.g., forgetting what I did or what I was going to do. items in a data archive for future retrieval. One principle to be followed here is that we should lighten the burden of users on memory cue collection (i.e., manual effort should be minimized) [5]. However, auto collection of memory cues is nontrivial. It largely depends on the behaviors of the target user group and the availability of data sources. In other words, for different user groups, the information that can be collected is different. For example, for those who are active in social network sites (e.g., Twitter, Facebook), we can extract more information (e.g., friend lists, favorites) about them from the Web. In what follows, we choose the contact name memory problem, and use the academic community to illustrate the above issues. To enhance memory recall using memory cues. We explore the feature-specific nature of memory recall and propose a generic methodology to extract memory cues from heterogeneous, multi modal, physical/virtual data sources. Specifically, we intend to do the following.

- 1) Convert the memory recall enhancement problem into a feature-specific memory cue collection and management issue.
- 2) Propose a general-purpose methodology of enhancing memory recall by extracting memory cues from heterogeneous and physical/virtual data sources.
- 3) Design and implement the social contact manager (SCM) to enhance contact management and name recall.

However, these methods attempt to capture all people life, which may bring much noisy data. In the context of social contact management, this may exacerbate user’s inconvenience in contact retrieval.

To the best of our knowledge, among much research on memory aid, little research work has focused on social contact. This empirical study especially concentrates on social contact memory aid. SCM can be viewed as a topic-specific life-logging system which focuses on capture of selected scenes that are important to users, i.e., the social contact meeting records. This paper is an extension of our previous work [11], while that paper focuses more on the technical details (e.g., feature selection for CRF-based [4] biographical data extraction) for contact data gathering, in this paper we highlight the empirical study for social contact management: an online survey and a thorough user study are conducted, and a set of interesting conclusions/phenomena regarding to contact management and memory are derived and reported.

III. ONLINE SURVEY

This on line survey aims at understanding in depth how people manage and recall their social contacts and evaluating different kinds of contact information for business and work in the academic community. This survey bases on Google Doc and is totally anonymous. A total of fifty-five subjects were recruited via e-mail.

A. Question sets

The questions focus on people’s experience in social lives and are composed of three sets.

1) Participant’s profile

The participant’s personal information is asked in order to better analyze the results. It includes the participant’s age, profession, sex, their mainly used contact management tools and frequency of forgetting contact’s name (chosen from “rarely”, “sometimes” and “often”).

2) Contact info for business purpose

In order to provide insight into the importance of different contact information in working environment, participants are asked to evaluate several kinds of information including people’s education experience, working information, research interest, origin, hobby and personality as the basic information. In addition to those stated above, participants could also write down other kinds of information if they feel there are any. The participants are asked which kinds of information they care the most about a person for business purpose. For each piece of information, they are supposed to choose their attitudes from “don’t care”, “important” or “very important”.

3) Contact recall

For looking into how people recall the contact in the name forgetting case, besides the contact info, we also introduce the context information (e.g., last meeting location with the contact) which may play as important cues in contact recall. We ask participants to recall or imagine a scenario in their social lives such as a conference or a cocktail in which they have made some new friends. But for some reason or other, they haven’t contact each other for a long time so that they were not able to remember the contact’s name. Similar with the previous question set, we ask which kinds of information about the contact they are most likely to recall in this case. Besides people’s personal information mentioned above, the following information is also available: last meeting context with the contact: including the time and location, the weather condition and the topic discussed on; contact’s facial features; contact’s social relationship (e.g. his supervisor, colleague, etc.). Three options are given for these questions: “rarely used”, “maybe used” and “surely used”.

B. Online survey result analysis

This survey was conducted online over one month. The majority of subjects are from two universities, Telecom SudParis in France and Xidian University in China. The results are presented and analyzed as follows.

1) Participant’s profile

We had totally 55 participants, of which 21 were female. As shown in the left-most pie chart in the Fig. 1, the

participants' ages were mainly between 20 and 30 years (62%). However, there were also 8 participants below 20 years (14%), 13 over 30 years (24%).

Most of the participants were students and faculty members from universities and research institutions, and their professions were diverse, including software engineer, professors, post-doc researchers, and university students. We also found that their mainly used contacts management tools were paper based contact notebook, outlook, mobile phone, email, collection of name card. We observed that most participants used the computer software as the major contact management tools.

Furthermore, as shown in the right-most pie chart in the Fig. 1, only 8 participants (14%) stated that they forgot rarely the contact's name among the 55. In other words, most of people (86%) had more or less difficulties for remembering contact's name.

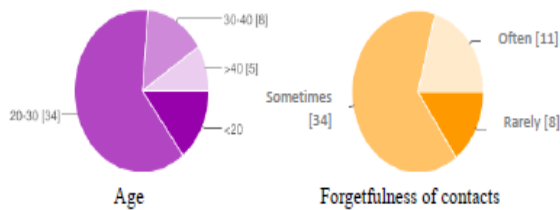


Fig 1. Participant's profile information [11]

Recall seems to be a common issue to people of different ages.

2) Contact Info for business purpose

In order to simplify the participant's choice, we give them three options such as "don't care", "important" and "very important". For the result analysis, we need to quantify these options. We valued these options as 0, 1, 2 points, respectively. In this case, the average score for each piece of information is presented in the Fig. 2. Obviously, most people care the most about contact's current working information, research interest, origin and personality. Meanwhile, contact's education experience, hobby and social relationship are more or less important information.

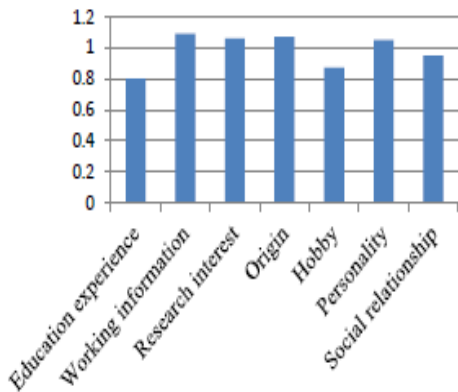


Fig 2. Importance of different information for business purpose [11]

3) Contact recall

With a hypothesis that context information also plays a significant role in contact recall, we intend to see how participants evaluate the preference of different information

for contact recall. As the same for the previous question set, we also valued the option "rarely used", "maybe used", "surely used" as 0, 1, 2 points, respectively. The average score for each piece of information is shown in Fig. 3:

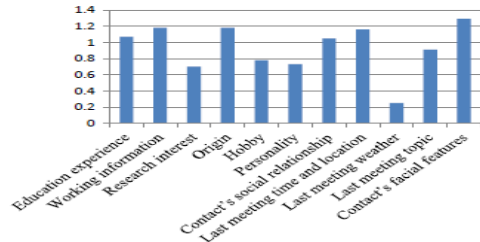


Fig 2. Survey results for contact recall [11]

Not surprisingly, we observed that context information seems to be as much important as personal information for contact recall, including the last meeting time and location as well as the last meeting topic. Obviously, the facial feature is surely an important criterion for memorizing the contact. However, not all the context information attracts the same attention as well. Few of participants used the last meeting weather to recall the contacts. Moreover, with regard to contact info, participants chose research interest, hobby and personality as less used cues to recall contact even if they were considered as important info in the previous question set.

C. What data to gather in SCM?

In order to determine what data should be gathered, we should take two factors into account: 1) the needs of users in the specific application domain; 2) the needs of the data in search task. As the first development of SCM aims at the academic use case, we identify four sets of data to be gathered.

- *Basic info.* It involves person name, affiliation, position, country, city, contact information which including address, E-Mail address and phone number. They form common information for all types of business communications.
- *Selected bio-info.* For the academic community, biographical data, such as education experience (institute and date of graduation), research interest, and social relationship, is important information to users as well as for future contact management tasks.
- *Contextual cues.* To support associative search, we need to gather contexts that refer to the physical events that we obtain contact data. Four types of contexts are defined, which refer to when, where, in what weather the event happens and the relevant topic discussed. We still take the weather info into account even if it has been considered as a trivial cue in contact recall, because we desire to confirm the result of the online survey.
- *Impression.* User impression to a contact, such as his facial features (e.g., beard) and personality or hobby (e.g., a diving-liker), is also crucial cues for contact recall.

With these four sets of data, we present the system design of SCM in the next section.

IV. SOCIAL CONTACT MANAGER (SCM)

A critical advantage in SCM is the auto-collection of the contact information for which SCM differs from the other contact management tools. The main challenge is how to collect these data with the least intervention of user. In this section, we give a summary of the design considerations of our system along with the four sets of data we described in the previous section. More technical details can be found in our previous paper [11]. Fig. 4 illustrates the general design of SCM. The system is composed of two parts, contact data collection and search interface. The former part consists of a contact database for the storage as well as the related modules for the data collection. The contact data collection part gathers the information and stores it in the structured contact database for the future usage. The search interface as shown at the bottom of the Fig. 4 provides a simple and efficient search bar for contact data retrieval.

A. Basic info

It can be detected by pervasive sensors. Business card is traditionally a rich source for getting basic info. There are generally two possible ways to capture it from business cards: 1) using a portable mini card scanner, like IRISCard (<http://www.irislink.com>); 2) using a camera-based card scanner app for mobile devices, such as the BizSnap (<http://www.bizsnap.cc>) app for iPhone. The latter method is cheaper and more convenient, but its performance can be impacted strongly by the quality of the photo taken. In order to guarantee the precision of basic information extraction, we apply the IRISCard scanner in SCM. As shown in the Fig. 4, the homepage finder module is capable to identify the contact's homepage by leveraging the Google search API and a heuristic rules-based filter. Two factors are taken into account: 1) the namesake problem; 2) the result set always includes several types of web pages (e.g., news, digital libraries, etc.) which are noisy. We use several different combinations of keywords picked from the basic-info to generate the requests. And the filter evaluates each search result according to four types of rules: 1) *Title rules* (e.g., title contains full person name); 2) *URL rules* (e.g., url contains person name and its variant); 3) *Snippet rules* (e.g., snippet contains positive words relevant to "institution", such as "University", "Institute"); 4) *Occurrence rules* (e.g., the same search result from different requests). Based on the evaluation, the contact's homepage is selected. We tested this method based on 50 randomly selected homepages from the Arnetminer (<http://arnetminer.org/lab-datasets/profiling/>), which contains information about 898 researchers who have homepages. The results turned out to be quite positive — 47 correct homepages with a precision of 94%. Another challenge in the bio-info collection lays on extraction the bio-info from homepage. We design a CRF based extraction method. In the biographic information extraction module illustrated in the Fig. 4, the homepage in HTML is preprocessed by eliminating the tags and phrasing into the natural language; then it passes in the data-mining procedure implemented the CRF with the specifically selected features.

After the precision evaluation, most of selected bio-info can be extracted with a high precision. For example, Ph.D graduated year has a precision of 78% with recall rate of 91%; Ph.D graduated university has a precision of 100% with recall rate of 78%; research interest has a precision of 61% with recall rate of 75%. Furthermore, the overall precision attains to 85% with recall rate of 75%.

B. Contextual cues

Contextual cues including time, location and weather, can be derived from GPS-equipped smart phones with the help of certain APIs such as Google Geocoding API (<http://code.google.com/apis/maps>) and Yahoo Weather RSS feed (<http://developer.yahoo.com/weather>). The Context Extraction module transfers the raw context data (time, GPS coordinates) into the structured data (time, location and weather) and updates the contextual cues in the database. However, the topic context is highly semantic and subjective so that it should be defined by user via an input interface.

C. Impression

For impression information, it is annotated by users in our system due to its highly subjective nature. The SCM provides the input interface for this.

D. Search interface

Augmented contact search is the other focus of SCM. The frequent slipping of contact names from human memory brings difficulties to contact search. However, a better design of the contact search tool should be able to identify a contact or at least filter most irrelevant ones leveraging several associated things (or keywords) relevant to the contact. For example, for a raw query like "I met him in a conference held in Tokyo in 2009", we can explore a keyword-based method which is commonly used in existing search engines, and use keywords like "Tokyo, 2009" to express our needs. However, given the around twenty types of contact metadata, another problem arises: how can we map a keyword to the right metadata field in the contact database, considering that a keyword may have several different interpretations. For example, the keyword "Tokyo" in the above query can represent different intentions of users, such as "the contact works in Tokyo", "I met him in Tokyo", and "he graduated from Tokyo Univ." and thus can be associated with several distinct data fields in the database. One simple way to better frame user intention is to list all data fields on the search interface and ask the user to input the keywords in right places; however, this design is rather poor, which increases the burden of users. In our design, we propose a full-scale matching method, which can figure out all possible search results in terms of different interpretations to user-delivered keywords via a Google-like search bar as shown in the Fig. 4. With this initial implementation of SCM, we conduct a user study by simulating several contact-memorizing problems and evaluating the usability and effectiveness of SCM. We detail this user study in the next section.

V. USER STUDY

The objective of this user study is to see how SCM could help remind the faded memory about contact. To achieve that, the major challenge lays on the simulation of the real memory-failure scenario. One critical factor in the tests on memory is how we should define the test data. Vemuri et al. identified that tests on memory and memory aids in laboratory settings using investigator-crafted data sets can be controlled easier than tests using daily-life data [12]. Firstly, when using data from participants' individual experiences, objectivity is not as straightforward and the results are hardly comparable. Since one person's experiences are necessarily different from another, it is unclear how to isolate variables in the face of confounds associated with the diversity of daily life.

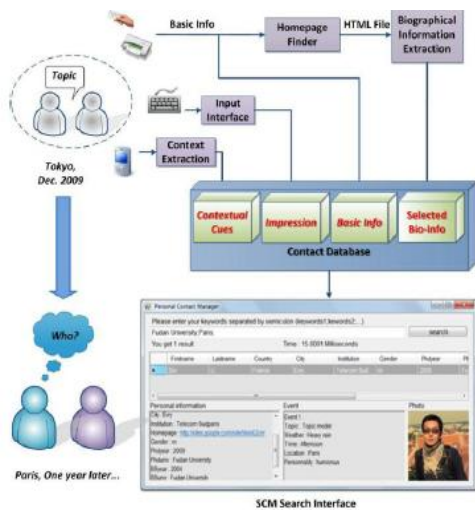


Fig 4. SCM general Design [11]

A. Selected Bio-info

How to lessen user effort on bio-info gathering is a nontrivial problem. With the prevalence of Web techniques, more and more physical objects are digitalized and can be accessed via the Internet. User profile is one such object, which is presented in various social websites (e.g., Facebook, LinkedIn) and personal homepages. As social websites may have privacy issue for accessing user data, in academic community, personal homepages are more popular and can provide open-accessed bio-info about a researcher. We propose a business card triggered bio-info gathering method: the basic info from a business card is used to find the homepage of the contact; afterwards, a hybrid of heuristic rules and CRF (Conditional Random Field) [4] based information extraction method is explored to extract needed information from the homepage. Secondly, using daily-life data needs to track and record subjects' lives which is quite difficult because of the necessity of much resources and the privacy issue. Hence, we decide to simulate the meeting with contact instead of tracking subjects' lives. This user study consists of two phases, user training and memory test. In the first phase, we introduced several contacts under different context settings to the participants; in the second phase, we tested their retained information.

B. Participants

8 participants volunteered for our experiment. They are all post-graduate students from our institute and their ages are majorly between 20 and 30 years. With regard to the origin, most of them are from Asian countries.

C. Experiment design

1) User training

In the user training phase, the participants were assigned to "meet" six contacts in different places at different time. One of the primary challenges in this phase is how to simulate the "real meeting" scenario in the laboratory setting.

a) Real-meeting simulation

There are three major difficulties we have identified for real meeting simulation: 1) it is possible that the participants might have already known more or less about the contacts; 2) during a real meeting, the interlocutors may not mention all their personal information that we have defined previously; 3) the behavior of the interlocutor (e.g., body language, tone) may have a strong impact on participants' memory which may lessen the effect of the personal information that we want to measure. To avoid these difficulties, we chose to use the "fictitious contact" and simulated the meeting scenario by introducing them to the participants periodically in the form of presentation in different locations. Fig. 5 shows a photo for one introduction in computer lab. The usage of the fictitious contacts assures that the participants have no earlier knowledge about the contacts. The form of presentation permits us to introduce the participants the desired information, avoiding other impact such as the behavior of the interlocutor as mentioned previously. To prepare the fictitious contact, we created a 100-contact database in the SCM, and we chose and introduced 6 of them to the 8 participants. Shown in Table I, we completed their personal profiles according to the SCM database structure, by filling up with some fictitious information (due to the privacy issue contact name doesn't show up). The C1 represents contact 1 in the table I.

Furthermore, due to the subjective nature of the description for contact's facial feature and personality, we avoided them in our experiment. Meanwhile, the influence of information like contact's social relationship highly depends on the participant's personal experience (e.g., the participants and the contact may have the same friends.) which is difficult to evaluate and not comparable between each other. So we didn't consider this information either.

Table I. Selected Contact and Part Of Their Information [11]

Contact	Education experience	Working information	Origin	Hobby	Research interest
C1	Master diploma in Hong Kong University of Science and Technology, 2009	Ph.D student in Hong Kong University of Science and Technology	Hong Kong, China	Ping Pong	Artificial Intelligence
C2	Ph.D degree, Cambridge university, 2008	Professor in University of Greenwich	London, England	Diving	Management
C3	Ph.D degree, University of California, 2000	Associate Professor in University of Hong Kong	Hong Kong, China	Basketball	Social science
C4	Ph.D degree, Washington State University, 1998	Dean in University of Illinois	Illinois, US	Dog	Smart home
C5	Ph.D, Peking University, 1990	Vice President of National University of Singapore	Singapore	Music	History
C6	Ph.D degree, Massachusetts Institute of Technology (MIT), 2010	Post-doctor in Tokyo University	Tokyo, Japan	Piano	Robot

2) *Memory test*

This phase was performed one week after the last introduction in order to guarantee that the participants' long term memory of the last introduction enters the stable stage. For each participant, we showed him the contact's photos, and asked if he could remember the contacts' name. In case of the negative response, we gave them SCM's search interface to help them find out the right contact. To avoid prematurely exposing the other participants the contacts information, the participants were asked to do the test individually. Moreover, we defined a maximum time limit of 3 minutes for each search. One search is considered as failed if the participant couldn't find out the correct contact in the time limit. During the test, we recorded for each search the used keywords and their order, as well as the time used to find out the contact if it didn't pass the time limit.

D. *Experiment result analysis*

Not surprisingly, none of the participants could remember contact's name in the memory test. For 6 contacts introduced to each participant, the 8 participants processed totally 48 searches. With the help of SCM, only 5 searches (10%) failed to find out the correct contacts within the time limit. The keywords can be analyzed from three points of view: 1) *how often are they used by participants?*; 2) *with what sequence the participants recall the keywords?*; 3) *what is the distribution of the erroneous keywords?* From these three perspectives we are going to discuss the roles of different information in contact-memorizing problem.

1) *Usage of keywords*

a) As demonstrated in the Fig. 5, we are able to identify the importance of different keywords used in the experiment. 5 kinds of information such as working information, origin and last meeting location and time as well as sex turned out to be the most used keywords which represented 82.7% usage of all the keywords.

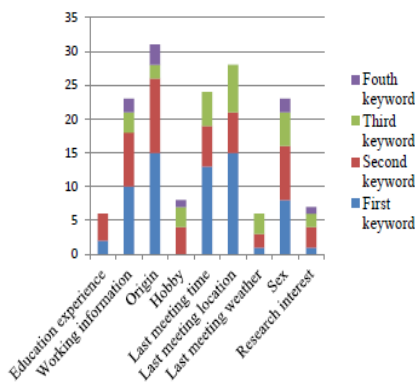


Fig 5. Frequency of correct keywords used in the contact searching procedure. [11]

As the same result from the online survey, hobby, research interest and last meeting weather didn't give much impression. Surprisingly, education information was less evaluated in the experiment. The most likely explanation is that the participants who are graduate students are not really engaged in the academic realm as a professor. They are not

sensitive to this related information which is supposed to be considerable in the academic use case.

2) *Order of keywords*

From the point of view of keywords order, the proportion of the first usage for each keywords set can be seen from Fig. 6. In the case that participants had kept several pieces of information in mind, we could identify which one came firstly when they recalled contacts. The context information including time and location turns out to be the most likely to recall during the contact retrieval, of which more than 50% are used as the first keywords. Besides, contact's personal information, including origin and working information is also easy to recall.

3) *Erroneous keywords*

Memory failure often causes the erroneous information in different manners. An immediate question raised here is *how did the information become wrong?* Forgetting is not the only type of memory problem, though perhaps the most studied. Schacter outlines the larger space of common long-term memory problems with his "Seven Deadly Sins of Memory" [13]. Of seven memory problems indicated, three among them could be identified as the cause of erroneous keywords:

- Misattribution (right memory, wrong source, e.g. attributing contact A's origin to contact B)
- Suggestibility (implanting memories, leading questions, e.g., attributing a not mentioned institute to a contact.)
- Bias (distortions and unconscious influences, e.g. no long considering contact A as a funny guy after knowing him for 6 months.)

During the experiment design, we have avoided the information such as contact's facial features and personality due to their highly subjective nature. Consequently, the bias wouldn't be a reason of erroneous keywords in our case. By analyzing and categorizing the erroneous keywords, we find that more than 90% of them are caused by misattribution problem, which means people often confuse one contact with the other rather than "invent" the contact information.

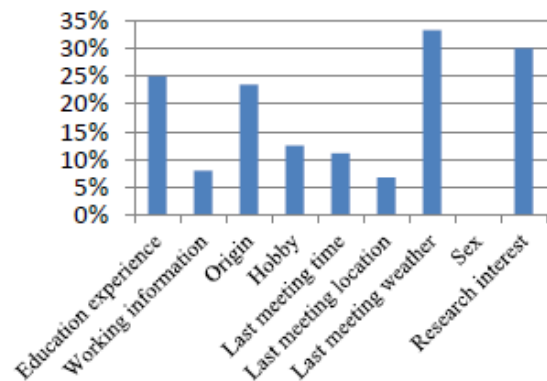


Fig 6. Erroneous keywords frequency. [11]

Distribution of the erroneous keywords is demonstrated in the Fig. 7. Not surprisingly, shown a photo of contact, there is hardly confusion about sex. Furthermore, working

information, last meeting time and location as well as hobby also have a low error rate. The ideal cues for recalling contact should be the ones with the high usage frequency and the low error rate. Compared with the analysis of usage of keywords from Fig. 5, although origin is the most used information, it has an important error rate. On the contrary, hobby has a trivial error rate but also a low usage frequency. Hence, we identify that 4 highly regarded contact retrieval cues, including working information, sex, last meeting time and location, are the ideal cues for contact retrieval.

E. Discussion

1) Comparison between user study and online survey

In general, the results from the user study correspond well with that from the online survey. Among the common keyword sets, working information, origin, last meeting context from two results coincides pretty well. However, there exist still differences. With respect to education experience, the online survey shows that people care about it and they considered it as a common cue to recall contacts. In contrast, the results of the user study turn out to be that it is less used. The worse is that it has a high error rate of memory. This is probably caused by the profession of the participants. Graduate students are not really involved in academic realm.

2) Recall time

As shown in the table II, we recorded the recall time for each search. C1 represents the contact 1 and P1 represents participant 1. The “X” means the failed search.

TABLE II. CONTACTS RECALL TIME [11]

Recall time (min)	Introduced 3 weeks ago		Introduced 2 weeks ago		Introduced 1 weeks ago	
	C1	C2	C3	C4	C5	C6
P1	3	2.5	1	2	3	2
P2	1	2	3	3	2	1
P3	3	3	1.5	3	0.5	0.5
P4	3	X	1	2	X	0.5
P5	1.5	1	0.5	3	2	1
P6	X	1	1	X	2	1
P7	2.5	2	2	X	1	1
P8	3	2	1	1	1	1
Average recall time	2.42	1.93	1.37	2.33	1.64	1.00

Record precision=30 seconds (0.5 min).

Depending on contact profile and introduction environment as well as participants’ personal influence, the contact recall time varied a lot. For example, the average recall time of contact C6 is only 1 minute compared with 2.42 minutes for contact C1. The main reason is that C6 was introduced one week ago but it has been 3 weeks since the introduction of C1. Besides, the recall time for contact C3 is also short. We identify that the origin of contact C3 is Hong Kong, China. The majority of the participants are also from Asian country. They memorized the contact from the similar origin more easily than others. However, the overall tendency of contact recall time with the introduction time is still obvious. As shown in the Fig. 7, the average recall time is proved to increase with the elapsed time since the

introduction, i.e. participants need more time to recall information as time passed by, which corresponds with Ebbinghaus’ Forgetting Curve.

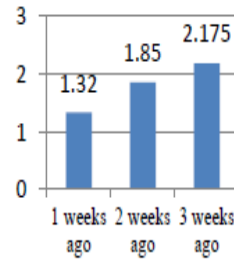


Fig 7. Average used time for recalling one contact (min) [11]

3) Memory bias

Memory biases may either enhance or impair the recall of memory, or they may alter the content of what we report remembering. During this user study, memory bias is also confirmed in social contact memorizing. For instance, even if hobby is not a favorable cue, one participant who is also a ping pong liker recalled easily the contact C1 due to the same hobby. Moreover, as stated in the previous subsection, the recall time of the contact C3 is generally short due to the participants having the similar origin as this contact. The similar cases are also recorded for research interest. Intuitively, people are more likely to remember information that is more or less related to them. This is caused by the self-reference effect. The self-reference effect is the tendency for individuals to have better memory for information that relates to oneself in comparison to material that has less personal relevance. It was first proposed by Rogers et al. [14] in 1977. Symons et al. also confirmed the self-reference effect in memory through a meta-analysis [15] in 1997.

4) Future improvement for SCM

Based on the analysis of the result from this user study, we can enhance SCM’s contact retrieval method in term of contact retrieval cues. As identified previously, working information, sex, last meeting time and location, are the ideal cues for contact retrieval. The improved method uses the priority ordering mechanism to put the contacts found by ideal cues at the top of the result list. For example, a user searches “Cambridge University”. Contact A whose working information is related to “Cambridge University” has high priorities than contact B who graduated from this university (because working information has higher priority than education experience). Consequently, contact A appears on top of contact B in the result list. Another possible improvement was proposed by a participant, which is the usage of the audio-based contact search interface implemented on smart phones.

VI. CONCLUSION

This paper presents an empirical study of an intelligent social contact management system — SCM. From the point of view of human memory, we attempt to design SCM to match the specific contact memorizing problem. Through an online survey, we identify four sets of contact-related

information. By leveraging a combination of pervasive sensing and Web intelligence techniques, we automate the contact data gathering procedure which used to be a burden to user. An enhanced contact search method is also designed for people to use when they are not able to remember contact but just some fragments of information. To evaluate SCM's usability and effectiveness, we performed a user study with a memory experiment. The results showed firstly the preference of different contact information, and then discovered several memory patterns specifically applied in contact memorizing problem. First we identified four ideal cues, working information, sex, last meeting time and location. Second, the decline of memory retention with time proves that people need more time to recall their earlier memory. Third, the memory bias in contact memorizing confirmed the self-reference effect in memory. As we continue to develop SCM, we hope to improve the contact retrieval method by using the priority ordering mechanism and developing an audio-based contact retrieval interface on smart phones.

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