Report from Dagstuhl Seminar 14362

Augmenting Human Memory – Capture and Recall in the Era of Lifelogging

Edited by

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Abstract

Recent developments in capture technology and information retrieval allow for continuous and automated recordings of many aspects of our everyday lives. By combining this with basic research in memory psychology, today's memory augmentation technologies may soon be elevated from a clinical niche application to a mainstream technology, initiating a major change in the way we use technology to remember and to externalize memory. Future capture technologies and corresponding control mechanisms will allow us to automate the acquisition of personal memories and subsequently trigger feedback of such memories through ambient large displays and personal mobile devices in order to aid personal memory acquisition, retention, and attenuation. The emergence of this new breed of memory psychology-inspired capture and recall technology will represent a radical transformation in the way we understand and manage human memory acquisition and recall. This report documents the program and the outcomes of Dagstuhl Seminar 14362 "Augmenting Human Memory – Capture and Recall in the Era of Lifelogging", which brought together 28 researchers from multiple disciplines both within computer science – mobile computing, privacy and security, social computing and ethnography, usability, and systems research – as well as from related disciplines such as psychology, sociology, and economics, in order to discuss how these trends are changing our existing research on capture technologies, privacy and society, and existing theories of memory.

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1 Executive Summary

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Nigel Davies
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Technology has always had a direct impact on how and what humans remember. This impact is both inevitable and fundamental – technology radically changes the nature and scale of the cues that we can preserve outside our own memory in order to trigger recall. Such change is not new – we have seen the transition from story-telling to written books, from paintings to photographs to digital images and from individual diaries to collective social networks. However, in recent years three separate strands of technology have developed to the extent that collectively they open up entirely new ways of augmenting human memory:

1. near-continuous collection of memory cues has become possible through the use of technologies such as Microsoft's SenseCam, social networks and interaction logs.
2. advances in data storage and processing now enables widespread mining of stored cues for proactive presentation, both in terms of cues collected by an individual and in terms of complex networks of related cues contributed by others.
3. the presence of ubiquitous displays (both in the environment and via personal devices such as Google Glasses) provides many new opportunities for displaying memory cues to trigger recall.

It is self-evident that we do not effectively encode all of the information that we encounter, nor are we able to retrieve at will, all of that content that we do encode. When trying to recall known facts, many of our day-to-day memory failures result from a temporary failure to retrieve memories rather than from their permanent erasure. Our ability to recall target information is particularly vulnerable to transient changes in accessibility that arise through changes in the contents of our short-term memories and the cues in our environment. That memory can be improved with effective cues is beyond doubt: whilst a typical participant might be able to recall only 38 out of a set of 100 words that had been continually studied and sorted over many minutes, this accuracy increases to 96% when the most effective cues are presented at test. One experiences these temporary failures to retrieve memories everyday when we might remark "I cannot recall X (e. g., his name, the company, the town, etc.), but if I saw it, I would recognise it". Tellingly, we are unlikely to experience or say the converse.

One of the most frustrating features of human memory is that we are particularly vulnerable at remembering to do something in the future (the area of memory research known as prospective memory). Prospective memory failures readily occur for remembering time-based future events (hence the value of setting computer alarms reminding us of meetings), and for remembering event-based future events (remember to post a letter on the way to work, remember to pick up a takeaway for the family tonight). Research suggests that whereas there is a general decline in memory with increasing old age, it is prospective memory and retrieval in the absence of cues that are particularly impaired, whereas cued recall and recognition are more preserved.

The Dagstuhl Seminar 14362 "Augmenting Human Memory – Capture and Recall in the Era of Lifelogging" focused on a vision of the world in which augmented memory systems make everyday use of peripheral, ambient multi-media content – delivered via large wall-mounted

displays, smartphone wallpapers, or wearable in-eye projectors – to intelligently integrate, display, and enable the review of life-relevant personal data. Such memory augmentation technologies have the potential to revolutionise the way we use memory in a wide range of application domains.

Behaviour Change: Effecting behaviour change is an important objective in many important areas such as health (e. g. lifestyle changes such as increasing exercise or stopping smoking) and sustainable transport (e. g. encouraging people to make more environmentally-friendly transport choices). Unfortunately, despite good intentions, many people experience difficulty in implementing planned behaviour: for example, it is well known that many people are reluctant to make a trip to the gym despite paying large gym membership fees. Psychological theory stresses that intentional behaviours are more likely to be implemented when individuals are reminded of their own attitude towards such behaviours (e. g., the positive gains that will result), and the attitudes of significant others to the behaviour (what loved ones, family, friends, peers, and society in general think of the behaviour and its outcomes). In addition, realistic scheduling is important: planned behaviour is more likely to be performed if it is timetabled with the transition from immediately preceding activities in mind. Finally, behaviour is more likely if it is perceived to be more achievable and more enjoyable. Memory augmentation can help with the realistic scheduling and reminding of the planned activities, and can remind people at the point at which decision making is necessary (e. g., at the planned time to visit the gym) of the positive benefits from the behaviour, the previous good experience of the behaviour and the progress that is being made.

Learning: Such technologies can be used as part of a learning environment. In particular, through the use of ambient displays it might be possible to cue recall, and hence reinforce learning of a wide range of skills. For example, the acquisition of a new language could be supported by providing appropriate cues to facilitate recall of vocabulary. Similarly, a class teacher could be encouraged to remember the names of their pupils, and a study abroad student could learn culturally-significant facts as they explore a new city.

Supporting Failing Memories: Research has shown that as we age, our ability to perform uncued recall is particularly vulnerable to age-related decline. Memory augmentation technologies could be used to help remedy this memory loss by providing older users with time-relevant and context-appropriate cues. In this way, older individuals could enjoy greater self-confidence and greater independence by being reminded of moment-by-moment situated details of where they were, what they were intending to do, and how they could get home. They may also enjoy better relationships if they could be reminded of the autobiographical details of their loved ones (such as the names and ages of their loved ones' children), or if they could review and then be reminded of the details of a recent conversation or event (e. g., a recent day out or family gathering).

Selective Recall: Through appropriate selection of memory cues that are presented to the user, memory augmentation technologies might also be used to facilitate selective recall. According to the psychological theory of retrieval-induced forgetting, the act of reviewing memories not only enhances the probability of spontaneously retrieving these reviewed memories in the future, but it can also attenuate the spontaneous retrieval of related but unreviewed memories. The study of retrieval-induced forgetting has largely been confined to the laboratory using lists of categorised words. It is of both pure and applied interest (e. g., the desired attenuation of unwanted, outdated, or traumatic memories; and the undesired attenuation of wanted but unreviewed memories) to see if this phenomenon can be observed when reviewing a subset of "real world" memories, and if so, we will be

able to measure the extent to which unreviewed memories could be attenuated through selective reviewing.

Memory Based Advertising: While many of the application domains for memory augmentation technologies are for the public good, the same technologies can also be employed in the commercial context. For example, such technologies could be used to support a new form of advertising in which users have memories triggered explicitly to drive purchasing decisions. For example, when passing a shop selling luggage a cue could be presented that causes a passer-by to remember a specific experience from their past in which their own luggage didn't work satisfactorily. This may then cause the user to enter the shop and purchase some new luggage.

Collectively, the seminar participants explored the scientific foundations for a new technology eco-system that can transform the way humans remember in order to measurably and significantly improve functional capabilities while maintaining individual control. At its heart lies the creation of memory augmentation technology that provides the user with the experience of an extended and enhanced memory. Such technology is based on recent improvements in the collection, mining, and presentation of appropriate information to facilitate cued memory recall. This research is inherently multidisciplinary and combines elements of pervasive computing, information retrieval and data privacy with psychology and sociology.

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3 Overview of Talks

The research questions we pursued included the following:

1. Collection and Control. What is the best mix of technologies for capturing relevant human experiences to improve human memory? How can we create a novel class of capture systems that specifically support human memory functions while offering a fine-grained level of control over their recording and fully respecting personal privacy? This is likely to entail novel approaches to the integration of captured data across devices, domains, and owners.
2. Presentation. What are appropriate tools and methods for integrating, correlating, and visualizing captured sensor data and other information sources into a coherent "memory prosthetics" streams? Such streams will be based on theoretical principles of human memory organization, in order to positively influence the acquisition, retention and attenuation of knowledge from personal experiences.
3. Theory. On a theoretical level, we wish to explore validation of human memory theory in these new systems, targeting the feasibility of targeted attenuation of unwanted memories.

Most participants presented short talks centered around one of these questions in order to start off discussions.

3.1 Robust regularities of human memory function

C. Philip Beaman (University of Reading, GB)

A short bullet-point list is presented of "principles" of human memory relevant to lifelogging. The list is personal and not exhaustive but is indicative of the phenomena of human memory revealed from investigation within the experimental psychology lab. No attempt is made to provide theoretical justification for the principles – rather, they summarise robust and generally agreed empirical regularities that may be of use when considering what aspects of memory can or should be augmented, supplemented or enhanced.

3.2 Augmenting memory – a means to what end?

Michel Beaudouin-Lafon (University of Paris South XI, FR)

While I do not work directly on lifelogging, I have worked in several areas that can inform this field.

Twenty years ago, I worked on media spaces [1], which were designed to help people share a workspace at a distance. We learned a number of lessons related to the social aspects of human communication when it is mediated by technology, such as the law of reciprocity, the need to control accessibility or the transitions between different levels of engagement [2]. Similar principles could be applied to lifelogging as it also provides a similar window into people lives and activities.

Ten years later, I worked on the European InterLiving project, where we developed technology to help distributed families to live together. We created a number of technology probes [3], among which the VideoProbe [4], which automatically captured and shared photos based on activity. We discovered the importance of intimate social networks, the difficulty of designing technology that meshes with people's everyday life, and the active co-adaptation of people and technology. Similar co- adaptation is at play with lifelogging systems, and should be taken into account in their design.

More recently, I have worked on large interactive spaces that support distributed and collaborative interaction [5]. Part of this work involves creating gesture-based interfaces with larger vocabularies than the typical touch-based interfaces of today. We have created a number of techniques, based on dynamic guides and the combination of feedforward and feedback, to help users learn and remember gestures [6, 7]. This leads to the notion of co-adaptive instruments that users can learn, but that can also shape users' behaviors. Can lifelogging be used to augment not only memory, but other skills as well?

My challenge to the participants of this workshop is to go beyond the recording of events "just because we can" to a better understanding of how we can create new ways of externalizing experiences so that they can be shared with others and so that we can learn from them, both individually and collectively. Augmenting memory is a noble goal, but to what end? Memory enables us to avoid repeating mistakes and lets us learn and transmit skills. The mere recordings of our lives provided by current lifelogging systems are still insufficient to provide these functions. But shouldn't the goal also be to support new functions? The previous externalization of memory was written language: unlike an audio recording of spoken language, it enabled skimming, summarizing, commenting, etc. Similarly, we need to create appropriate instruments [8] to represent, access, share and manipulate past experiences so that we can imagine new ways to enhance our collective intelligence.

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3.3 Re-Live the moment: Using run visualizations to provide a positive feedback loop for workouts

Agon Bexheti (Università della Svizzera italiana (USI), CH)

Behaviour change is considered an important objective in many areas such as health (e. g. quit smoking, increasing exercise level, etc.) and sustainable transport. Nevertheless, for most of us it is very difficult to implement planned behaviour. We plan to exploit a finding from psychology research which states that planned behaviour is more likely to be achieved when individuals are reminded of their own attitudes towards such a behaviour (e. g. the positive benefits of running regularly). For this reason, we have developed a prototype that records among others images and background music of running sessions and assembles a multimedia slideshow which is played afterwards. The aim of this work is to encourage individuals to run more by remembering the fun they had during their last run and the post-run satisfaction they felt.

3.4 Empathic Computing

Mark Billinghurst (University of Canterbury – Christchurch, NZ)

In recent years there has been considerable research on how to build user interfaces that recognise and respond to emotion. However there has been less research on how to create shared understanding or empathy between users, using technology to allow one person to better understand the emotions of another. In this presentation we talk about Empathic Interfaces that are designed to go beyond understanding user input and to help create shared understanding and emotional experiences. We explore how Augmented Reality (AR) can be used to convey that emotional state and so allow users to capture and share emotional experiences. In this way AR not only overlays virtual imagery on the real world, but also can create deeper understanding of user's experience at particular locations and points in time. The recent emergence of truly wearable systems, such as Google Glass, provide a platform for Empathic Communication using AR. Examples will be shown from research conducted at the HIT Lab NZ and other research organizations, and key areas for future research described.

3.5 On the potential of human visual behaviour for memory augmentation and life logging

Andreas Bulling (MPI für Informatik – Saarbrücken, DE)

Joint work of Bulling, Andreas; Zander, Thorsten
Main reference A. Bulling, T. O. Zander, "Cognition-aware computing," IEEE Pervasive Computing, 13(3):80–83, July 2014.
URL http://dx.doi.org/10.1109/MPRV.2014.42

In his talk, Dr Bulling discussed the potential of eye tracking and eye movement analysis for life logging and human memory augmentation. He pointed out that what makes our eyes so interesting is the fact that they are with us wherever we go and whatever we do. Their movements are closely linked to our activities, goals, intentions, they indicate attention and what we are interested in, and they are linked to a large number of cognitive processes. This link to human cognition makes the eyes a particularly interesting sensing modality and a promising means to implement the vision of cognition-aware computing. Cognition-aware computing systems sense and adapt to the so-called cognitive context of the person that is comprised of all aspects related to mental information processing, such as reasoning, memory and learning. He then summarised recent work by his group on eye-based activity and context recognition, long-term visual behaviour analysis and automatic inference of visual memory recall. He concluded by briefly summarising the state-of-the-art in mobile eye tracking technology and challenges in using eye tracking in daily life settings.

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3.6 The Big Picture: Lessons Learned from Collecting Shared Experiences through Lifelogging

Nigel Davies (Lancaster University, UK)

The emergence of widespread pervasive sensing, personal recording technologies and systems for quantified self are creating an environment in which it is possible to capture fine-grained traces of many aspects of human activity. Such traces have uses in a wide variety of application domains including human memory augmentation, behaviour change and healthcare. However, obtaining these traces for research purposes is non-trivial, especially when they contain photographs of everyday activities. In order to source traces for our own work we created an experimental setup in which we collected de- tailed traces of a group of researchers for a period of 2.75 days. We share our experiences of this process and present a series of lessons learned that can be used by other members of the research community proposing to conduct similar experiments in order to obtain appropriately detailed traces that include photographic images.

3.7 The quantified self: Understanding and augmenting human memory

Simon Dennis (University of Newcastle, AU)

An overview of dynamical systems, behavioural, and neurscientific approaches to understanding human memory using lifelong data as well as a brief description of an initial attempt to build a Google for your life context retrieval system.

3.8 Designing Knowledge Acquisition Points: Speeding up Reading Tasks on Electronic Devices

Tilman Dingler (Universität Stuttgart, DE)

Joint work of Dingler, Tilman; Alireza Sahami

Reading is an ancient activity traditionally taken up for information gain and pleasure. With the advent of the information age and the rising popularity of electronic reading devices our reading behavior has been changing and we are facing an abundance of text on a daily basis. However, our reading strategy has mainly remained the same since our formal reading education stopped in a young age. Naturally people develop their innate reading, skimming and skipping strategies. Rapid Serial Visual Presentation (RSVP) has been proposed as a reading technique to push a reader through a text by displaying single or groups of words sequentially in one focal point. Other techniques include the use of a kinetic stimulus (such as a moving pen or finger) to guide a reader consistently across lines of text. We implemented

a number of different kinetic stimuli to guide the reader's eye across text passages on a computer screen. In a user study with 36 participants we assessed the effects of different stimuli (including RSVP) on comprehension level, perceived mental load and eye movements. We envision electronic devices to be able to detect the skill level of readers, take into account the text type and apply different reading strategy options to facilitate reading tasks.

3.9 Sensing People

Christos Efstratiou (University of Kent, GB)

Joint work of Efstratiou, Christos; Leontiadis, Ilias; Picone, Marco; Mascolo, Cecilia; Rachuri, Kiran; Crowcroft; Jon
Main reference C. Efstratiou, I. Leontiadis, M. Picone, K. Rachuri, C. Mascolo, J. Crowcroft, "Sense and Sensibility in a Pervasive World," in Proc. of the 10th Int'l Conf. on Pervasive Computing (PERVASIVE'12), LNCS, Vol. 7319, pp. 406–424, Springer, 2012.
URL http://dx.doi.org/10.1007/978-3-642-31205-2_25

The popularity of online social networking services has increasingly transformed them into lifelogging services where personal activities are manually logged and shared with others. The availability of a wide range of sensing technologies in our everyday environment presents an opportunity to further enrich social networking systems with fine-grained real-world sensing. The introduction of real-world sensing into a social networking applications can allow the unbiased logging of life activities, enabling the recording of a more accurate picture of our daily lives. At the same time, passive sensing disrupts the traditional, user-initiated input to social services, raising both privacy and acceptability concerns. In this work we present an empirical study of the introduction of a sensor-driven social sharing application within the working environment of a research institution. Our study is based on a real deployment of a system that involves location tracking based on smartphone indoor localisation, conversation monitoring using microphones in the environment, and interaction with physical objects augmented with sensors, such as desks, coffee machines, ect. The system allowed the detection of social activities, such as co-location of colleagues and participation in conversation, feeding them into a private web-based social networking platform. Following a 2 week deployment of the system involving 21 participants, we report on findings regarding privacy and user experience issues, and significant factors that can affect acceptability of such services by the users. Our results suggest that such systems deliver significant value in the form of self reflection and comparison with others, while privacy concerns are raised primarily by the limited control over the way individuals are projected to their peers.

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3.10 Augmenting Human Memory For UX Evaluation

Evangelos Niforatos (Università della Svizzera italiana (USI), CH)

We present a set of work for supporting episodic memory recall with cues for obtaining feedback on User Experience (UX). EmoSnaps is a mobile app that captures unobtrusively pictures of one's facial expressions throughout the day and uses them for later recall of her momentary emotions. We found that that people are better able to infer their past emotions from a self-face picture the longer the time has elapsed since capture. Then, a follow up study demonstrates the eMotion mobile app, which collects memory cues during commute for measuring drivers' anger and frustration levels retrospectively. Next, we presented a planned study for contrasting the traditional, limited film camera capturing with the new digital cameras and automatic life logging tools. We created a mobile app (MyGoodOldKodak) to investigate the effect of capture limitation on the user picture capturing behavior. Last, we demonstrated Atmos, a tool for crowdsourcing user estimations about current and future weather conditions.

3.11 Lifelogging at Dublin City University

Cathal Gurrin (Dublin City University, IE)

Main reference C. Gurrin, A. F. Smeaton, A. R. Doherty, "LifeLogging: personal big data," Foundations and Trends in Information Retrieval, 8(1):1–125, 2014.
URL http://dx.doi.org/10.1561/1500000033

We have recently observed a convergence of technologies to foster the emergence of lifelogging as a mainstream activity. In this talk I provided an introduction to the vision of lifelogging that we hold in DCU, which is a form of pervasive computing which utilises software and sensors to generate a permanent, private and unified multimedia record of the totality of an individual's life experience and makes it available in a secure and pervasive manner.

The four core components of our view are sensing, segmenting, indexing and interacting [1] and they were combined in a number of demonstrator descriptions covering digital visual dairies, QS visualisations and object deception and search. Finally, the issue of privacy of lifelogs was considered and one proposal presented that could help to maintain privacy of subjects and bystanders in a world of ubiquitous lifelogging.

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3.12 Lifelogging and Wellbeing for Care Home Residents

Vicki Hanson (Rochester Institute of Technology, US)

My interest in lifelogging stems from two research projects I have underway: Portrait and BESiDE, both of which deal with the wellbeing of care home residents. Portrait seeks to provide care staff (those charged with residents' day-to-day care such as bathing and dressing) with information about the personal and social life experiences of these residents. The goal is to provide care staff with a simple means of getting information to support person-centered care. BESiDE is an interdisciplinary effort that seeks to inform building design about features that facilitate physical and social activities of residents. This talk considers lifelogging methods that can inform these efforts with respect to positive interactions for care home residents.

3.13 Augmenting Food with Information

Niels Henze (Universität Stuttgart, DE)

Eating is not only one of the most fundamental human needs but also among the most regular human activities. Consequently, preparing meals is deeply rooted in all human cultures. Food, however, can not only serve to satisfy hunger but also to ubiquitously communicate information. Through food augmentation, a dinner can communicate its characteristics such as the ingredients. Food can provide instructions, for example, the recipe of a meal or communicate arbitrary information such the eater's schedule in a way that can hardly be avoided.

3.14 Activity-Enriched Computing: Retrieving and Restoring Context

James D. Hollan (University of California – San Diego, US)

The intertwining of computers with virtually every aspect of life brings many benefits, but also a growing stream of interruptions. Even though the fragmenting of activity is an increasingly accepted part of modern life, a critical research challenge remains: how to smooth and mitigate its impact and assist in resuming interrupted activities.

3.15 Photobooks for Memories

Christoph Korinke (OFFIS – Oldenburg, DE)

Many photos are taken at events to share experiences later on with others or for personal remembrance. Photobooks are used to preserve events and focus on the most pressures

moments of an event. It is common to take several shots of the same scene. Looking at thousands of them is tedious. The selection, arrangement and annotation of photos is time consuming and can be a major obstacles preventing the creation of a photobook. Algorithms can support the user by clustering and ranking images. These algorithms can even take aesthetic qualities into account by enabling (semi-) automatic creation of books with respect to e. g. golden ratio. Enrichment can be supported with scene understanding algorithms. A major challenge in case of lifelogging is to distinguish between "picture vs. moment", i. e. a photo can be an emotional moment for one person, but just be a picture for another.

3.16 Augmenting the Human Mind

Kai Kunze (Osaka Prefecture University, JP)

The talk gives an overview about the emerging field of smart glasses and how they can be used to augment our mind (e. g. how to improve our brain with technology). The talk will focus mostly on how to quantify cognitive tasks in real world environments. I also present a first application scenarios on how to use smart eyewear (e. g. Google Glass or J!NS MEME) for short term memory augmentation and cognitive activity recognition.

Considering the last centuries, major scientific breakthroughs aimed at overcoming our physical limitations (faster transportation, higher buildings, longer, more comfortable lifes). Yet, I believe the coming big scientific breakthroughs will focus on overcoming our cognitive limitations. Smart glasses can play a vital role in

1. understanding our cognitive actions and limitations by quantifying them
2. helping us design interventions to improve our mind.

The talk will focus mostly on the first point, what kind of cognitve tasks can we track already with the smart glasses that are available in the market and what will happen in the near future. I will discuss application examples for Google Glass and J!NS MEME. J!NS MEME is the first consumer level device measuring eye movements using electrodes also called Electrooculography (EOG). The MEME glasses not a general computing platform. They can only stream sensor data to a computer (e. g. smart phone, laptop, desktop) using Bluetooth LE. Sensor data includes vertical and horizontal EOG channels and accelerometer + gyroscope data. The runtime of the device is 8 hours enabling long term recording and, more important, long term real-time streaming of eye and head movement. They are unobtrusive and look mostly like normal glasses. For Google Glass I present an open sensor-logging platform (including the infrared sensor to count eye blinks) and a fast interface to do lifelogging. We will discuss which eye movements correlate with brain functions and how this fact can be used to estimate the cognitive task a user is performing, from fatigue detection, over reading segmentation to cognitive workload and the advances to track attention and concentration. Challenges discussed in the talk include how to get ground truth and how to evaluate performance in general.

3.17 On the Design of Digital Mementos

Daniela Petrelli (Sheffield Hallam University, UK)

Do we have precious memories captured in digital form? How can we give those "files" a presence in our life? How would digital mementos look like and how would people interact with them to reminisce about their life? In a number of studies conducted with families I have explored these questions trying to tease out what are the principles behind the keeping of mementos and how we could reproduce the same affective level of engagement with relevant digital belongings. Findings relevant to Lifelogging technology include: as heterogeneous objects are clustered together in memory boxes, so data collected through multiple lifelog sources be fused; the physical presence of mementos in our environment makes them salient and memorable over an extended period of life; there is a strong emotional power in forgetting and rediscovery autobiographical memories. I have discussed two examples of digital mementos, bespoke devices that enable users to easily access their digital belonging in an engaging a playful way to support meaning making over time.

3.18 Digital Sign Analytics in the Context of Memory Augmentation

Mateusz Mikusz (Lancaster University, GB)

Joint work of Mikusz, Mateusz; Clinch, Sarah; Davies, Nigel

Digital signs are already present in many public places and are integrated in urban life. Researchers believe that these screens are not being used to their full potential, supporting human memory is one example of how these displays could be used in future application areas. To enable these applications we can combine displays with devices such as mobile phones and other wearables to support the aim of showing personalized and personal content. A study at Lancaster University showed that displaying personal images on pervasive displays for the individual passing by helps to trigger memory recall, and can also improve attention for digital signs. In order to allow developers and researches to analyze their display applications, we believe that digital sign analytics will be of essential relevance in future. Analytics are important to provide detailed information about movement patterns and behavior in front of the sign and across devices, for example how the walking path or destination changed after seeing an advert or other content on a screen. For memory applications, analytics are required to measure the success of new applications, the result of memory recall, and understanding whether the shown content on a screen leads to the expected behavior, measured across devices.

3.19 Reinstating the Context of Interrupted Activities

Adam C. Rule (University of California – San Diego, US)

Joint work of Rule, Adam; Tabard, Aurélien; Hollan, Jim

How can we help people re-establish the context of activities that have been interrupted? One approach is Activity-Based Computing, which groups computing resources such as documents and applications by activity so they can be closed and restored en masse. However, activities are more than just collections of documents but include fragile mental states. Tracking and visualizing computer activity could help cue these mental states. We developed a simple tool to track computer activity using key logging and screen recording. This process raised three questions: 1) What are the tradeoffs between implicit and explicit tracking? 2) How should we handle tracking and visualizing similar activities? 3) Where should tracking stop?

3.20 Emotional Memories: Cueing, Forgetting and Digital Disposal

Corina Sas (Lancaster University, GB)

Joint work of Sas, Corina; Whittaker, Steve
Main reference C. Sas, S. Whittaker, "Design for forgetting: disposing of digital possessions after a breakup," in Proc. of the 2013 ACM SIGCHI Conf. on Human Factors in Computing Systems (CHI'13), pp. 1823–1832, ACM, 2013.
URL http://dx.doi.org/10.1145/2470654.2466241

Episodic memories lie at the core of our sense of identity, and emotions play important role in organizing and cuing them. This talk introduces AffectCam, a wearable system integrating SenseCam and BodyMedia SenseWear capturing galvanic skin response as a measure of bodily arousal, with the aim to explore the value of arousal arising naturally in daily life, as a mechanism for cuing episodic recall. The system was tested with 14 participants who were asked at the end of a day of wearing the sensor to recall events cued by top high and low arousal-stamped pictures. Findings suggest the value of arousal as a filtering mechanism, with 50% richer recall cued by high arousal photos.

Most theorists argue for retaining all these possessions to enhance 'total recall' of our everyday lives, but there has been little exploration of the negative role of digital possessions. The second part of the talk focused on digital disposal and intentional forgetting following digital breakup. We interviewed 24 participants and found that digital possessions were often evocative and upsetting in this context, leading to distinct disposal strategies with different outcomes. We advance theory by finding strong evidence for the value of intentional forgetting and provide new data about complex practices associated with the disposal of digital possessions. Our findings led to a number of design implications to help people better manage this process, including automatic harvesting of digital possessions, tools for self-control, artifact crafting as sense-making, and digital spaces for shared possessions.

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3.21 Déjà Vu – Technologies that make new Situations look Familiar

Albrecht Schmidt (University of Stuttgart, DE)

Joint work of Davies, Nigel; Langheinrich, Marc; Ward, Geoffrey
Main reference A. Schmidt, N. Davies, M. Langheinrich, G. Ward, "Déjà Vu – Technologies That Make New Situations Look Familiar: Position Paper," in Adjunct Proc. of the 2014 Int'l Joint Conf. on Pervasive and Ubiquitous Computing (UbiComp'14) – Workshop on Ubiquitous Technologies for Augmenting the Human Mind (WAHM'14), pp. 1389–1396, ACM, 2014.
URL http://dx.doi.org/10.1145/2638728.2641720

We envision a technology concept for making new situations and encounters more familiar and less threatening. Going to new places, interacting with new people and carrying out new tasks is part of everyday life. New situations create a sense of excitement but in many cases also anxiety based on a fear of the unknown. Our concept uses the metaphor of a pin board as peripheral display to automatically provide advance information about potential future experiences. By providing references to and information about future events and situations we aim at creating a "feeling of having already experienced the present situation" (term Déjà Vu as defined in the Oxford Dictionary) once people are in a new situation. This draws on the positive definition of the concept of déjà vu. We outline the idea and use scenarios to illustrate its potential. We assess different ways the concept can be realized and chart potential technology for content creation and for presentation. We also present a discussion of the impact on human memory and how this changes experiences.

References

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3.22 Visualisation for activity based computing

Aurelien Tabard (University Claude Bernard – Lyon, FR)

We present our ongoing efforts to visualize computer based activity. We aim at leveraging visual perception and visual memory to explore past activities. This approach avoids the problems of activity recognition (trying to infer automatically activities) and activity specification (letting users specify what their ongoing activity is).

One premise of our work is that such visualizations need only be intelligible to the person whose activity was capture as s/he will be able to make sense of it in a much richer way based on the past experiences. Another important point is our strategies to compress time in order to enable more efficient browsing of highly visual temporal data (i. e. screenshots of desktops). To this end, we explore animations, key point within screenshots, and activity breakpoints as important memory cues.

3.23 Long-term activity recognition to provide a memory to others

Kristof Van Laerhoven (TU Darmstadt, DE)

Main reference E. Berlin, K. Van Laerhoven, "Detecting Leisure Activities with Dense Motif Discovery," in Proc. of the 2012 ACM Conference on Ubiquitous Computing (UbiComp'12), pp. 250–259, ACM, 2012.
URL http://dx.doi.org/10.1145/2370216.2370257

The concept of activity recognition, in which machines are able to capture what a person is doing, is usually described in terms of where the system is situated (worn by the user, in the user's environment) or what system's purpose is (to improve ones' health, to serve as a memory aid for later, etc.). In my presentation, I presented the numerous challenges that lie in focusing on long-term activity recognition in which the system is recording the day-to-day activities of someone else.

Many studies that involve tracking behaviour related to lifestyle, mental state, or mood are currently based on questionnaires that rely on study participants remembering what they were doing in the past days or past weeks. This reliance on human memory poses several dangers: recall can be notoriously bad and is often biased. Having a machine detect activities automatically, with a minimum of intervention required by the study participant, would be an attractive alternative. Sleep researchers could monitor the activities that their patients would perform during the day and the effect they have on subsequent nights, or psychiatrists could analyse the interplay between certain episodes such as depressions or mania, and regularly- performed activities.

As a case study of such research, I presented work from a wrist-worn activity recognition system [1], in which long-term 24/7 inertial data is logged and analysed for specific leisure activities such as practicing yoga, or playing the guitar. For creating such a memory system, I stressed on the current challenge of making such a system powerful enough so that it can parse the huge amount of data that long-term studies of weeks to months of inertial data (taken at 100Hz) produce. A second challenge that remains to be solved, I argued, is the proper visualisation of said data so that it can be used by others.

References

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3.24 The act of recall will affect future recall: Early insights into intelligent reviews

Geoff Ward (University of Essex, GB)

We entertain the possibility that one might wish to review a daily digest of one's day, and we consider what effect such a review might that have on one's spontaneous ability to later access one's memory for past events. We present three experiments that examine whether the phenomenon of retrieval-induced forgetting (RIF) could be observed in the real world, as well as in the psychology laboratory. According to this literature, actively retrieving a subset of memories will lead to enhanced later accessibility to these practiced items, but decreased accessibility to related but unreviewed memories. We replicate and extend RIF in the laboratory using words and pictures as stimuli, but our initial experiments using more real-world stimuli (i. e., fictitious holiday events) suggest that the accessibility to real life events increases by being reviewed but reviewing does not decrease the later accessibility of related but unpracticed memory events.

3.25 Lifelogging image presentation and navigation

Katrin Wolf (Universität Stuttgart, DE)

In this talk, characteristics of lifelogging images are discussed and initial design ideas for lifelogging image navigation are presented.

Image characteristics changed a lot over the history of image production. Capture devices for photography and movie production were in the beginning expensive and required expert knowledge. As also the image production cost money, the images and movies produced in the old times were often showing important events, such as weddings. Moreover, portraits were professionally captured in special and rare moments in rather wealthy peoples' life. During the last hundred year image capture technology became affordable for many people, the procedure of picture taking does not require special skills anymore, the pictures do not need to be developed but are immediately accessible, and the process of recording pictures do not cost money anymore. Thus, image capturing is done by everybody and massive amounts of images are produced, need to be stored, achieved, and novel methods of image organization are needed to be able to browse through archives and find specific pictures or movies. Lifelogging cameras allow for passively take pictures. Thus, large data is produced that is difficult to be archived and even harder to search in for certain information and memory recall.

A method of navigating through large image data is to use meta information, which allows to apply computational search algorithms for information navigation and recall. In autobiographical memory, time, place, persons, events, and emotions are used as memory cues, and we propose to use the same cues as meta information to navigate through autobiographical image data. Finally initial mockups were presented that build on the idea of allowing for navigating through by using the autobiographical memories mentioned before.

4 Working Groups

The seminar included a series of break-out sessions to foster more in-depth discussion around 3 central topics: Visualization, Applications of Lifelogging, and Social Impact.

4.1 Visualization

This group discussed the topic of *visualizations* and basically took on 3 key questions:

- How do we support in-the-moment annotating?
- How do we visualize multi-dimensional information?
- How do we search for, select, and filter the recordings

Their output included a number of key thoughts, outlined as follows: the way a visualization is designed depends on the **intended application**. Systems designed for personal reflection will differ significantly from those designed for social communication. We can use **abstractions** or parts of an image to convey information about what was happening. For example, tracking a single pixel of a doorway can show occupancy. **Space** can be used to show time. For example, using the periphery of a screen to show what happened in the past, or what will happen next. Another example is using small multiples. **Multiple interactive views** can be used for search, selection, and filtering Visualizations should support **multi-scale viewing and navigation**. For example, viewing locations at the country, state, and city level Techniques from **cinematography** can inspire life-log visualizations. For example, storyboards and panoramas. Certain applications will want to preserve a storytelling element.

4.2 Applications of Lifelogging

This group engaged with the topic of identifying and sketching out the application space for lifelogging. Key questions included:

- Why do people engage in lifelogging?
- What lifelogging activities are there, what goals and benefits people envisage from them?
- How can lifelogging practice be motivated?
- Which are the challenges of adopting lifelogging and how can we address them?

The group discussed main activities of lifelogging, such as information retrieval, event reminiscing and the reflection on successive events. Thereby the granularity of the activity's details may differ: in some cases retrieval of specific aspects or factual data about an event may be required, such as the name of a speaker or person met. In other cases reminiscing over an entire event may be the goal, such as remembering the last holiday or Christmas celebration. One abstraction higher there is the reflection on patterns of data extracted from successive events, i. e. behavior change: a person may have run longer and quicker over the last 6 months. Hence, the main benefits of lifelogging activities seem to be 1) Retrieval (supporting daily functioning for both work and leisure), 2) reminiscing (supporting mood regulation and group cohesion) and 3) reflection (supporting self-awareness for self-regulation and behaviour change). The group defined a **3x3 taxonomy** of lifelloging technologies, which combines these 3 main lifelogging activities with 3 societal contexts, namely: individuals, small group of individuals knowing each others and large group of individuals with loose ties (Table 1).

Table 1 A 3x3 taxonomy for lifelogging activities in their societal context.

	Retrieval	**Reminiscing**	**Reflection**
Individual	todo lists, photos, videos, business cards	photos, text messages	quantified self technologies
Small Group	private wikis	photos, artifacts	group forums
Large Group	Wikipedia, dictionaries	war memorabilia	smart cities reflecting on environmental changes and impact

4.3 Social Impact

This group discussed the social impact of lifelogging and memory augmentation on 3 levels: for 1) individuals, 2) groups or closed communities and 3) societies or countries. Key focus of the discussion were negative and positive aspects of massive data collection. In the following some considerations shall be outlined:

4.3.1 Risks

What has been described in several literary pieces is the question of mass surveillance and the resulting lack of privacy. Scenarios include authoritarian governments demanding all people's data. Hence, society would not be able to deny its actions. High instance control would be given the power to change history by modifying or forging the data and hence influence people (digital propaganda). On an individual's level, people could get psychotic if they are taken the right and possibility to forget. Others may develop tendencies to live in the past and get drawn into a behavior of neurotically checking their own history/memories. On a different notion, if lifelogging produces simply too much data and if we as society and individuals don't know what to do with it, it just collects dust.

4.3.2 Opportunities

If lifelogs and recordings were ubiquitous and designed to be preserved long-term, one obvious advantage is the facilitation of historical research. Researchers could go back in history and for example experience wars or economic highs in order to learn about conflict resolution or better understand (their own or foreign) cultures. Further, a comprehensive long-term dataset may create greater awareness of sustainability issues, CO_2 levels, environmental impact, social science or lifestyle and wellbeing. These datasets would create a level or transparency that could help us understand how other communities live, democracy improve and thus teach us important lessons about citizen science. Mining such dataset could reveal patterns which could be used to in many ways (e. g. increase societal security by predicting negative behavior and preventing it).

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