An Augmented Memory System – Mnemonet

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The Vision

We are our memories. Studies of patients with chronic amnesia demonstrate that memory is at the basis of our sense of self. Amnesia is not just a condition of the old, infirmed and damaged. People forget or poorly recollect throughout their lives. In particular, people have an inability to remember events from the early years of their lives. Psychological studies indicate that there are very few memories from before the age of 3. The episodes recalled from before 8 compared to any other part of the life span are scarce. It is not the age of the memories that is important but when in the life period they occur. Explanations of this *infantile amnesia* range from neurological immaturity, through to repression, an inability to tell stories or else maintain a theory of mind of others.

This challenge is to build a fabric that would allow this early void to be filled and could also be used through life to retrieve and represent very large parts of ones own autobiographical history. This augmented memory support would be recorded and replayed using many devices – *super toys* for the young child, wearables and embedded devices as the child goes to school and grows into adulthood. The memories built up and represented might be held in distributed or centralised infrastructures in a variety of modalities and forms. However, the associativity between content and experience, the rich linkage between knowledge and context, the selective attention given to emotionally salient events would render the result a *mnemonet* - a personal memory system.

The Trends

That such a challenge is now conceivable is due to a number of continuing trends. Twenty years ago (between Intel’s 286 and 386 technologies) we could integrate between 120,000 and 275,000 transistors on a circuit. Moore’s Law has pretty much held, so now we live in an age where the Pentium 4 processor contains 42 million components. Whatever your favorite measure, computational resource has more or less doubled every 12 to 18 months. At the end of the ’70s, computer science researchers had on average 1,000 times more computational power than their early ’60s counterparts. Today’s students have 1,000 times more than their late ’70s forebears. We can envisage hardware and processing capable of dealing with the substantial amounts of autobiographical experience this challenge demands. The fidelity and cost of sensor technology is also dramatically increasing. The scenarios discussed in wearable and pervasive computing all contemplate the type of wireless computing infrastructure that would render this Grand Challenge feasible. Where local resources are not available grid based computing could provide sufficient processing and storage on demand.

Large industrial organisations are investing significant effort in providing the hardware and software capability to build the sorts of robust autonomous system that might provide the means of delivering aspects of this Grand Challenge. In this context the games and entertainment industry is a particularly potent driver. Games companies are building increasing amounts of adaptive behaviour into their software avatars (early examples such as Tamagotchi demonstrate the public appetite for these interactions) – behaviours that would enable rich interactions with children. Sony with its Aibo robot dog and plans for other super toys aim to provide persistent companions for young children. These companions will experience much of the same environment and context as the child. These developments along with robust speech recognition and visual processing methods means that we can begin to imagine detailing and recording, modelling and annotating the interactions a child has with its environment.

Developments towards a Semantic Web and a Global Computing Infrastructure also provide some of the components we will need. The AKT IRC is looking to integrate and develop methods and techniques to harvest and annotate, personalise and re-present large amounts of semantically heterogeneous content across a range of modalities. The EQUATOR IRC is investigating forms of novel interaction between physical and digital systems. It is exploring new kinds of interactions with computational devices including their integration into play and story telling contexts.

This challenge will need to draw on work from Cognitive Science and Psychology. This will range from research on state dependent memory (recalling information better if the context of encoding is recreated) to the importance of modulatory systems (emotional and other affective states) in directing attention. We will need to be informed by ideas of selective attention – the ability to pay attention to particular parts of the sensory experience. Such selection is not only determined by the goals of the system but also by the particular modality in question. We will need to be informed by what is known of the conceptual reorganisations that occur in development. We will need to understand how play and story telling underpins much of the early development in young children.

The challenges

The challenges that arise in trying to build a mnemonet are fundamental for computer science, cognitive science and engineering. We need to be able to lay down multimodal memories for sustained amounts of an individual's early experiences. These modalities will include sight and sound but as any reader of Proust will recall they will need to embrace smell, taste and touch. It would require the development of methods of synesthesia to encode memories across multple representations.

The ambition is not for constant surveillance but as noted to have substantial amounts of selective attention. We need ways to determine what episodes and events, objects and items are likely to be of interest. And this has to work across modalities. We don't want grainy idiosyncratic tedium, and huge amounts of memory where nothing is happening. Our representations need to reconstruct how the individual experienced the event.

The knowledge and experiential life cycle has to be supported - from capture through to modelling, indexing and cross association, retrieval and elaboration, maintenance and curration. There is the problem of incorporating elements of active inference into our memorial system, we thread experience, link contents on the basis of inferred relationships between them. What is the role of forgetting even for an autobiographical system?

These interests will need to take into account what might be of interest in later life, as well as what is of immediate interest to an individual. These interests will have high emotional and attitudinal components. We will need to relate knowledge and understanding to emotion and drive. The storage, modelling, interlinking and indexing of such memories will draw on current ideas in semantic representation and annotation but would need to go much further. How do we generate the appropriate narrative – to elaborate and replay the memory in an appropriate form.

How do we ensure the persistence and survival of content captured across different devices over extended periods of time? How do we account for the developmental change we will see in the individuals whose experiences are being recorded? There are substantial issues about ensuring the privacy, security and integrity of such *memories* held in any kind of shared fabric. This is a Grand Challenge for Computer Science and for those researching the interface between human and machine.

Why now and why this

As a challenge it has the particular merit of demanding progress in areas that other grand challenge problems also recognise. For example, on the hardware side it has much in common with *Disappearing Computer* proposal. Aspects of the challenge relate to issues identified in a similar US exercise in particular *Augmented Cognition*, and *Tutors for All*. There are at least two UK funded IRCs that are working in technologies that will contribute to the software aspects – the integration of knowledge and content in the AKT IRC and the interface between digital and physical devices in the EQUATOR IRC. The OST Cognitive Systems Foresight programme is also looking at potential synergies between neuroscience and computational systems.