MAY: My Memories Are Yours

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Abstract. In human relations engagement and continuous communication is promoted by the process of *sharing experiences.* This type of social behaviour plays an important role in the maintenance of relationships with our peers and it is grounded by cognitive features of memory. Aiming at creating agents that sustain long-term interactions, we developed MAY, a conversational virtual companion that gathers memories *shared* by the user into a three layer knowledge base, divided in Lifetime Periods, General Events and Event-Specific-Knowledge. We believe that its cue sensitive structure increases agent adaptability and gives it capabilities to perform in a social environment, being able to infer about the user's common and uncommon events. Results show that these agent's capabilities contribute to development of intimacy and companionship.

Keywords: virtual companion, biographical memory, shared memory.

1 Introduction

In human interactions, memory is fundamental to hold up conversations and to sustain long-term relations. Without noticing we constantly choose from our memories of experiences the best fit for the current situation, either to make a decision or to communicate with other people. That valuable information is not just about one's personal experiences, but also acquaintance of others' lives too. It is this process of *sharing personal memories*, available by autobiographical remembering, that enriches our conversations, making them seem more truthful, believable and engaging [3].

Similarly, the importance of memory in agents is undeniable and many researchers have recently focused their agents' architectures on its relation to long-term believability. In artificial companions systems, episodic memory based architectures are believed to be essential [9], as they aim to reflect the agent's experience. But taking the human memory comparison a little bit further, an agent's memory that is constituted by only its own experiences might not be adequate for maintaining a long-term relationship.

This suggests that if we want to create more pleasant and acceptable agents, capable of carrying on with more engaging interactions [7] and consequently maintain the relationship for a longer period of time, we need to consider the memory aspect and its sharing and social function.

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Aiming at creating agents that sustain long-term interactions with humans, we focus on mechanisms to retain, over multiple interactions, *shared* information, that is, stories of experiences that the user has told the agent. We believe that artificial companions capable of indexing user's "experiences" in their memory and at the same time able to show acquaintance of user's life, are likely to lead to the development of attachment. To try to achieve that goal, we have explored an Autobiographical Memory architecture suggested by Conway [5].

Our purpose was to exploit whether the level companionship between the user and agent through a conversational interface correlates with the memory model or not. As such, our intention is to exploit if MAY, an agent capable of shape its memory for user's events, can influence its responsiveness and create proximity between them.

2 Related Work

The area of intelligent agents that act as companions is fastly growing. An example is the LIREC[1] and the COMPANIONS[2] projects, which focus is on creating technology that support long-term relationship between humans and computers.

Researchers have focused their efforts in creating more engaging and user adaptable agents. So far, most companion systems are focused on capturing the user attention by endowing the agent with empathetic behaviour [2] and robust dialogue capabilities[14]. However they need more social skills to surpass the limited engagement with the agent over time.

To overcome this issue, several researchers have developed methods to create Autobiographical Memory (AM). Ho et al.[8] emphasize that AM can increase believability of intelligent agents, thanks to its capacity to increase agents' adaptability to the environment or to new situations. A different approach was taken by Mei Yii Lim et al [10], where an initial prototype for a social companion generic memory was developed. The aim was to create mechanisms reflecting human memory characteristics to allow companions to identify, characterize and distinguish experiences[8]. Focusing on the adaptability to preferences and to the environment they expect the maintenance of a long-term interaction.

The mentioned autobiographical mechanisms have showed several improvements in intelligent agents, yet they have not been tested in conversational companions systems, in which AM dynamics might improve reasoning skills in real-time. Further, none of the these systems considers the creation of a "shared" memory element, but concentrates more on the agents' biographical memory.

3 Memory's Anatomy

Conway [5] focused his work on refining the concept of AM and drew a contrast between it and episodic memory, which limits were somehow blurred. He

[1] http://www.lirec.org/
[2] http://www.companions-project.org/

suggests, a unified model, where episodic memory is seen as a system which contains sensory-perceptual details of recent experiences, and those memories only are retained in memory when linked to a more permanent type of memory – *autobiographical memory.*

AM can be seen as “semantic knowledge” about one’s life, retaining knowledge about the progress of personal goals, a ’life story’. According to [5], this “semantic knowledge” has three levels of specificity :

Lifetime Periods can be seen has temporal and thematic knowledge. Often those periods last for years, for example “When I was at school”, and can be grouped by themes. Themes consist in outstanding situations in a higher abstraction view, such as “school” or “work”.

General events are linked to life time periods and cover single events that could last for few days or months, for example, “study for an algebra exam”.

Event-Specific Knowledge (ESK) Detailed information concerned with a single event. They are often accompanied by “images that pop into mind” and have the duration of seconds or hours.

Besides AM dynamics, this memory division provides some important functions. The *social function* is claimed by Neisser [11] as the most fundamental function of AM. Nelson [12] also suggests that autobiographical memory has high significance on *sharing memories* with other people. The *memory-sharing* [1] process is influenced by responsiveness, that is, listeners make empathetic and contextually grounded responses to what the speaker is saying. Not only does memory-sharing enhance believability of conversations, but also serves to attain engagement and intimacy in relations [3].

4 Conceptual Model for *Shared Memories*

According to Conway[5], autobiographical memories can be seen as mental constructions generated from an underlying knowledge base (or regions), which are sensitive to cues, and patterns of activation. Autobiographical memories contain knowledge at three levels of specificity: *Event-specific knowledge (ESK)*, *General Events* and *Lifetime periods.*

While *lifetime periods* identify thematic and temporal knowledge, *general events* are related to actions, happenings and situations in one’s life. *ESK*’s details are contextualized within a general event that in turn is associated with one or more lifetime periods, linking self autobiographical memory as a whole(Fig.1).

In this section we explain how we have mapped these concepts onto a virtual companion’s memory system as a way to capture factual and emotional events experienced by the user. As such, the agent’s memory is biographical as it uses a model of AM to reflect user’s experiences and better adapt to him/her.

4.1 Structure of the Knowledge Base

The knowledge base’s architecture is like a small ontology of semantic relations, which describe the main cues for triggering one’s memories. As Conway [5] and

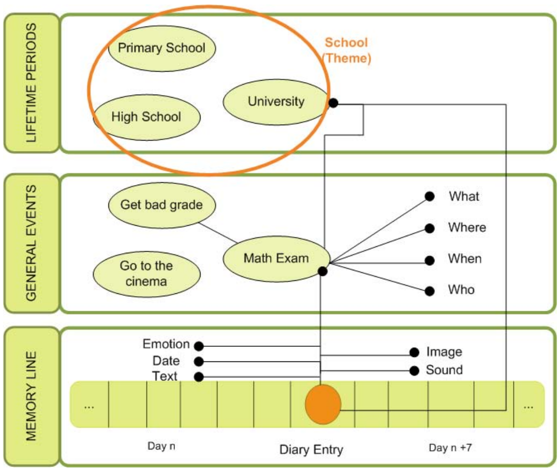

Fig. 1. Agent's Memory System

others researchers refer, anything can be a cue. In our model we only considered cues that could be represented by text and syntactically inferred from it.

Based on theoretical concepts [5], the memory is divided into three independent levels, using RDF (Resource Description Framework).

The underlying structure of this framework is a collection of triples, each consisting of $< subject, predicate, object >$. These triples are organized in graphs. Representing the information like this, we have a simple data model for inference.

The knowledge base consists of 3 subgraphs, each one representing one level of specificity (Figure 1) – lifetime periods, general events and ESKs. They act as specific views the knowledge base and all graphs(levels) are interrelated. Yet they can be evaluated separately.

Base level – memory line. This level tries to represent Event Specific Knowledge. The main idea is to capture a timeline over which the details of memories are stored. In other words, for each chronological position we have a node linked by a predicate to text objects. These objects are the associated details of the memory. The predicates are date, text (the personal description of the experience), image, and sound, and they allow the retrieval of one memory at the less abstract level.

Middle level – general event. General events capture the main action of one memory and allow retrieval by small pieces of text syntactically inferred from text. They are "what", "where", "when" and "who". The edge "when" links to a different and more detailed object than the predicate "date" in the level below. It can also have a string related to the time of the day. Further, a general event can be within one or more lifetime periods, thus an edge should be included into this feature. For example, the event "Holiday in Rome with Sam" can be linked to the lifetime period "Year 2008" and at the same time "Relationship with Sam", because it was an event that happened during these periods of life.

Top level – lifetime period. For any given chronological period there may be a number of lifetime periods, which probably overlap in time. That is why, as Conway describes, that thematic knowledge is associated with temporal knowledge to index different parts of the memory and fix the overlap problem. The lifetime period graph is organized by context or theme, this is, a generic concept that specifies the content of a lifetime period. For example, the theme "School" may comprise lifetime periods like "primary school", "high school" and "university". Each node in the graph is a lifetime period inserted into a context, which have a bidirectional link to a general event.

5 Introducing MAY

The model just described was embedded in the design of a virtual companion agent MAY(my Memories Are Yours). MAY is an agent created to assist a teenager user on self-reflection about what happens in his/her life. The interaction between MAY and the user is through dialogue, which allows the agent to collect the user's experiences and save them in a diary form (or a timeline). The memories (or events) stored in MAY constitute a kind of "shared memory" between MAY and the user. MAY is like an *affective diary* [13].

Figure 2 shows a screenshot of a chat like interface during an interaction between a user(Amy) and MAY. At the bottom, one can see the *Memory Line*, which represents the base level of the memory hierarchy. Each cloud represents an entry in the 'diary'.

The interaction is text-based and the information extracted is syntactically inferred from it. MAY's dialogue system uses a modified version of A.L.I.C.E[3], an engine that uses AIML (Artificial Intelligence Markup Language) to create responses to questions and inputs. The dialogue is pro-active and adapted to the main goals of a teenager user – school, love and play. To preserve situations of which the agent does not have an appropriate answer, we use ConceptNet to endow the system with dynamical capabilities to adapt to unpredictable input. ConceptNet is the largest freely available, machine-useable commonsense resource and it aims to create a network of relationships, which represent the facts that each of us know about the world [6]. It is used essentially to find relations between concepts (words) in the written sentences, to relate events and to produce 'intelligent' replies to the user during the dialogue.

The events are extracted, using natural language tools, carefully adapted to the memory structure and used in the extend of the interactions to create agent's responsiveness. From those events characteristics (4W) such as 'what', 'who', 'where' and 'when', are also extracted. These are then used to index the event in the memory structure mentioned before. As anything can be a clue, if some pattern of data in memory is activated, MAY can show to the user that it has been listening, by relating the clue with some previous memories. In the following example, the user says "Tonight I'm going to the cinema" to which the agent replies "Sounds good. Are you going with Lyam?". The agent 'reminds'

[3] http://alicebot.org/

Fig. 2. Screenshot of MAY's interface

that Amy uses to go to the cinema with Lyam. This will also work for events specified as goals and to make predictions.

6 Evaluating Memories in Memory

We conducted a experiment to evaluate if is perceived some sort of relationship that the agent can establish with the user. To do that we used a friendship questionnaire to measure the quality of the relationship. The results showed that when the agent manifests acquaintance about the user's life, even little details of common events, the users classified more positively the *intimacy* and *companionship* dimensions of friendship. These outcomes corroborate Nelson argument about how the social function of the sharing process contributes to development of intimacy and consequently maintenance of a relationship. For more details please see [4].

7 Conclusions and Future Work

This companion prototype enhances some social aspects possible by having a memory structure capable of indexing user's memories of experiences. Its functionalities and its efficiency on retrieval gives the agent the ability to perform in a social environment. We explored how acquaintance about one's life can influence positively a relationship and we introduced such characteristic into a conversational companion. Yet, this memory structure may offer many others possibilities that can be explored in future work. For instance, the use of previous knowledge to make more complex analogies and more informed forecasts.

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