Forgetting Through Generalisation – A Companion with Selective Memory

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ABSTRACT

This research investigates event generalisation in computational episodic memory for artificial companions. Two studies indicated a preference of a biologically-inspired selective memory over an absolute memory companion. Consequently, we present a preliminary implementation of a forgetting mechanism that enables the companion to create "generalised event representations" from its experiences allowing the companion to learn from past encounters.

Categories and Subject Descriptors

I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Intelligent agents*

General Terms

Design, Algorithms, Experimentation, Human Factors, Theory

Keywords

forgetting, generalisation, user studies, episodic memory, social companions, biologically-inspired

1. INTRODUCTION

Most humans routinely forget details of their experiences [2] although the real reason for this is unclear. One explanation lies in the reconstructive nature of memory [4, 5]. Reconstruction occurs when new incoming information is blended with existing information in memory, suggesting that memories are altered, distorted and modified over time. Information stored in memory is reduced through selection, abstraction and interpretation and except under very unusual circumstances, memory traces representing highly typical events in a particular episode will be forgotten [4]. The main goal of this paper is to present the findings from our recent studies regarding the importance of this memory mechanism in social companions. We are particularly interested in developing a companion that can establish and maintain long-term relationships with users. The results suggest that there is a trend for people to prefer a companion that has a selective memory (stores only significant information) as compared to one with absolute memory (stores everything). Based on these results, we have designed and implemented a human-like computational memory for our companion that incorporates forgetting through generalisation mechanism.

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2. USER PREFERENCES STUDIES

In the first study, 64 participants were asked to imagine living with a robot companion for a period of six months. Subjects were presented with descriptions of companions with varying specifications where the attribute *memory* encompassed the specifications "permanent, not erasable" (saves information permanently), "permanent, but erasable" (saves information permanently with a 'reset' function to clear the memory) and "biological" (saves information permanently, but an algorithm is implemented to simulate human-like forgetting). Results from a multivariate analysis showed that the "biological" version was preferred over the other two memory structures, even though implementing a permanent memory structure intuitively might appear more effective and feasible for future home companions.

In the second study, 20 subjects watched online videos of interactions between one user with two versions of a virtual conversational agent – three consecutive conversations respectively, featuring absolute (remembers everything and is able to 'recite' the original conversation) and selective (remembers only significant events through tagging of emotional responses from the user) memories. Participants then answered demographic questions and provided their opinions on the usefulness and the likability of the companions as well as their interest in and the perceived naturalness of the conversations. Open and closed questions were asked regarding the perceived differences between the two versions and the participants' preference on living with a companion. Generally, the results showed that more participants tend to like the companion with the absolute memory although these differences were not significant. However, significantly more participants indicated that the conversation between the selective memory companion and the user was more natural as compared to the absolute memory companion. These results reveal people's hesitation towards artificial companions with ‘perfect’ unlimited memory. After all, human memory is subject to flaws and is by no means perfect.

3. GENERALISATION

We are not aware of any work up to now in artificial agents research on forgetting through reconstruction [4, 5], that is, the process through which concrete episodes in episodic memory (EM) are continuously restructured and being reduced to their core meaning. We argue that generalisation will not only improve a companion’s performance through reduced information processing but may increase naturalness of the companion as reflected in the user studies. Currently, our companion is involved in simple tasks such as answering users’ questions, interacting and remembering users’ preferences and issuing reminders to users about upcoming appointments or medication time. The companion prototype is built on top of the FAtiMA-PSI architecture [3]. Its memory is divided into semantic (facts) and episodic component (events related to actions and goals processing). We will focus on the EM here. Each event in the companion’s EM consist of attributes such as *subjects, intention, action, target, objects, desirability, praiseworthiness, time, location,* etc. as shown in Figure 1.

ID	Subject	Action	Intention	Target	Status	Meaning	Path	Object	Desirability	Praiseworthin...	Feeling	Time	Location
12	SELF	SpeechAct		Amy	succeed	greeting			1.0	0.0	Joy-0.35013676	12	LivingRoom
14	SELF		Greet	Amy	cancel				0.0	0.0	Neutral-0.0	12	LivingRoom
15	Amy	GreetBack		SELF	succeed				2.0	0.0	Joy-1.8288739	12	LivingRoom
17	SELF		Welcome	Amy	activate				0.0	0.0	Neutral-0.0	12	LivingRoom
18	SELF	SpeechAct		Amy	succeed	welcome			2.0	0.0	Joy-1.5614789	12	LivingRoom
20	SELF		OfferFruit	Amy	activate			banana	0.0	0.0	Neutral-0.0	12	LivingRoom
21	SELF	SpeechAct		Amy	succeed	banana			2.0	0.0	Joy-1.4512749	12	LivingRoom

Figure 1: Example events for the companion

These events reflect an interaction between the companion and a user, Amy (only a snapshot is shown due to space limitation) where the companion learns Amy’s fruit preferences. It can be observed that the interaction starts with a greeting followed by a welcoming remark. The companion then continues by asking Amy if she would like to have a banana and so on.

In the current implementation for abstracting the companion’s memory, we are only interested in association rule with a minimum *coverage* of 4, that is an item set (combinations of attribute-value pairs) has to appear at least 4 times in the EM to be generalised. In order to achieve this, we applied the Apriori algorithm [1] where frequent *item sets* are extended one item at a time. So, in the case of the companion’s EM, the first step would involve finding frequent one-*item sets* for all attribute values that has a minimum *coverage* of 4. The next-step generates two-*item sets* by combining pairs of one-*item sets*. Only value pairs of different attributes are combined. For example, the attribute-value pairs *subject=SELF* and *subject=Amy* will never be combined to form an *item set* since the attributes for both values are the same. This is followed by generation of three-*item sets* through combination of two-*item sets* and so on.

Since the minimum *coverage* is set at 4, any *item sets* that cover fewer than four events are discarded at the end of each step. The extension has been predefined for six-*item sets* (consisting of the attributes *subject, action, object, desirability, praiseworthiness and time*). The algorithm terminates when no further successful extensions are found. A sample result of this process is presented in Figure 2. The diagram shows that this combination of attributes appear for 5 times in the overall companion’s EM (only a snapshot is shown in Figure 1). Thus, through this abstraction, the companion can infer that talking to Amy is desirable. This GER will help the agent to predict and adapt its action in future under different circumstances.

Subject	Action	Target	Desirability	Praiseworthi...	Time	Coverage
SELF	SpeechAct	Amy	positive	positive	Afternoon	5

Figure 2: Example GER

4. CONCLUSION AND FUTURE WORK

In this paper we identified the importance of the novel event generalisation concept for artificial companion’s episodic memory. Two separate user studies reflected the better perceived nature of selective memory for companions that will be involved in social interaction with human users. We illustrated an initial implementation of the generalisation process, together with examples of concrete event structure and representations in the companion’s memory. However, as discussed in the main body, we are still in a preliminary stage of investigating *generalised event representations* and implementing an effective generalisation mechanism for a computational episodic memory. A large amount of future work is required in various directions, in particular we aim to improve the creation of *generalised event representations* through collecting more interaction history data from long-term experiments involving human users and their companion agent in the near future. Additionally, integration of an ontology will allow generalisation of attributes with different values that fall under the same hierarchical concept.

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5. REFERENCES

[1] R. Agrawal and R. Srikant. Fast algorithms for mining association rules in large databases. In J. B. Bocca, M. Jarke, and C. Zaniolo, editors, *Proceedings of the 20th International Conference on Very Large Data Bases*, pages 487–499, Santiago, Chile, 1994.

[2] H. Ebbinghaus. *Memory: A Contribution to Experimental Psychology*. New York: Teachers College, Columbia University, 1885/1913.

[3] M. Y. Lim, J. Dias, R. Aylett, and A. Paiva. Improving adaptiveness in autonomous characters. In *Intelligent Virtual Agent (IVA) 2008*, pages 348 – 355. Springer, 2008.

[4] R. C. Schank and R. Abelson. *Scripts, Plans, Goals and Understanding*. Erlbaum, Hillsdale, N.J., 1977.

[5] E. Tulving. *Elements of Episodic Memory*. Oxford University Press, Oxford, 1983.