

# Memory, Companion Agents and Aging Society \*

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## ABSTRACT

In the recent decades, improved quality of life and medical technology advancement have led to extension in life expectancy. However, neurological changes are commonly observed in the aging population – they are very often associated with gradual degenerative alteration in brain function, including Alzheimer’s and Parkinson’s diseases, as well as healthy aging. Recently, an increasing number of people with Alzheimer’s disease and dementia has been reported, leading to an increase in the demand for long term care facilities and staff. In order to tackle this problem, our research focuses on the creation of artificial companions with human-like memory that can generate natural interaction with the user and maintain his/her memory function in a way comparable to cognitive training approaches in conjunction to the Healthcare and Quality of Life themes of the Digital Economy.

## Categories and Subject Descriptors

I.2.11 [Distributed Artificial Intelligence]: Intelligent agents

## Keywords

Autobiographic memory, spreading activation, companion agents, aging society

## 1. INTRODUCTION

By 2026, generally in the UK, a man who turns 60 could expect to live another 24 years and a woman almost 27 years [3]. According to the Office of National Statistics, by 2031, the over 80s population is predicted to double to 5 million [6]. Although this is good news to many, it poses important challenges for health care systems not only in the UK but worldwide due to the post-war baby boom population. According to the Alzheimer Europe July-August 2009 Newsletter, age remains the single most important risk factor for dementia [1]. Thus, the number of people who require long-term

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care is rapidly increasing and the UK government intends to deal with the demand by encouraging them to stay at home and receive care from relatives – a cheaper alternative to full-time care home staff [6]. However, the relatively shrinking workforce has put the younger generation under strain. Many have a very busy lifestyle and will not be able to dedicate sufficient time at home for the care the elderly need.

With the advancement of technology aiming to enhance the life quality of the aging population in different aspects, it is important to investigate how a good standard of lifestyle can be maintained for the elderly – not only in medical sense but also in daily and social situations. The recently launched MultiMemoHome Project<sup>1</sup> is moving in this direction by attempting to explore the application of modern multimodal interaction technology to support people who require regular care at home. Another growing area of interest is in autonomous companion agents and robots. These artifacts have been used as assistive technology in patients therapy, rehabilitation and social interaction (e.g. Paro<sup>2</sup> and the Care-O-bot<sup>3</sup>). More examples can be found on the IEEE Robotics and Automation Society website<sup>4</sup>.

In order to create a long-term relationship, or so called “companionship” with these agents, technical progress is required in several areas, such as interaction styles; agent cognitive and reasoning functions; and long term responsiveness to affective states, among others. Our research focuses on the autobiographic memories component for companion agents. We argue that inclusion of “human-like” memory in companion agents will enable them to comprehend their world, make predictions about a situation, hence behave in more natural and believable ways.

## 2. ALZHEIMER’S DISEASE AND COGNITIVE TRAININGS

Alzheimer’s disease (AD) is the most common cause of dementia. To help AD patients, psychiatrists in the recent decade have developed various cognitive trainings as alternatives or supplementary treatments to pharmacological interventions focusing on two main categories of approaches: compensatory and restorative. Using an example in which

<sup>1</sup><http://www.multimemohome.org/about>

<sup>2</sup><http://www.parorobots.com/>

<sup>3</sup><http://www.care-o-bot.de/english/index.php>

<sup>4</sup><http://www.service-robots.org/applications.htm>

an AD patient has difficulties to remember what to buy in a shopping trip to a supermarket, a compensatory approach to this problem may involve writing a detailed shopping list which clearly shows every item to buy while a restorative approach may involve the patient repeatedly questioning him/herself about the items' name. Both cognitive training approaches, as reported in different studies (e.g. [5, 2]), have been proven beneficial to AD patients in both cognitive and functional aspects.

### 3. OUR VISION

We envision that a companion agent with human-like memory that is capable of interacting naturally with these patients such as sharing past experiences and telling life stories may provide a long-term technological solution for the same purpose in line with the Healthcare and Quality of Life themes of the Digital Economy. By 'human-like memory' we mean a memory that employs biologically-inspired human memory mechanisms that are at the same time technologically plausible. The agent, if provided with appropriate mechanisms for storing and retrieving information from its memory will be able to engage in social interaction with the patients. It can help them to recall their past experiences through natural conversation, thus, helping them to retain this information for longer. Additionally, it can also aid them in their daily activities by providing appropriate information when asked and remind them of tasks that need to be carried out when necessary (e.g. taking medication, appointments, etc.). Thus, instead of sole training sessions, we emphasise a more natural approach through social interaction to allow the elderly to remain independent for longer, hence reducing stress on carers and family.

This work is part of the EU FP7 project LIREC<sup>5</sup> which aims to establish a multi-faceted theory of artificial long-term companions, utilise innovative technologies to embody the theory, verify the theory and technology experimentally in real social environments, and provide guidelines for designing such companions. It differs from the Memories for Life project<sup>6</sup>, one of the UKCRC grand challenges in that we are not trying to augment human memories through digital data collection but to create companion agents that facilitate a more natural interaction and aid people in their daily tasks.

We gain inspiration for the companion's memory design from biology and cognitive psychology research taking into consideration remembering and forgetting mechanisms. We have so far implemented the *spreading activation retrieval mechanism*, a novel approach compared to existing direct retrieval mechanisms because it enables the companion to associate different events with one another as humans do based on different concepts such as location, people involved, and objects. For an example of how and when spreading activation might take place, please refer to [4]. This improves the companion's ability in answering questions and narrative generation, permitting it to respond to the user questions more appropriately and tell more believable stories. Through continuous interaction with the companion, the user may be reminded of different past events and through repetitive recall,

<sup>5</sup><http://www.lirec.eu>

<sup>6</sup><http://www.memoriesforlife.org/>

these events may become less likely to be forgotten. This approach is comparable to cognitive training approaches, however in a more social setting, thus may be beneficial to the elderly. More importantly, the autonomous nature of our approach that creates the companion agent which can plan and retrieve information dynamically for the user will significantly reduce the user's cognitive burden when attempting to retrieve a particular piece of information. The success of this approach can be measured through the establishment of long term relationships between the companion and users, i.e. users find the companion believable and useful in aiding them in their daily tasks and the companion is capable of maintaining coherent responses over a prolonged interaction period.

### 4. CONCLUSIONS

The application of the spreading activation mechanism in computational autobiographic memory allows us to develop agent-based applications that can assist users with difficulties of remembering episodic and autobiographic events in daily life. In comparison to the existing cognitive trainings, our approach provides a long-term technological solution which aims to reduce the burden and costs associated with caring staff for elderly and can allow users to easily reflect on their personal experiences reminded by the companion agent. In future we are planning to include the generalisation mechanism in the companion's memory to allow it to perform abstraction from details, hence providing the user with only the most important information, reducing their cognitive burden even more.

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