Cognitive Assistants

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1. Introduction

Society is ageing fast. A number of studies [1, 2, 3, 4] confirm this trend and highlight a negative consequence of this trend: the increased lack of care and assistance for the elderly. Elderly care (paid and unpaid) requires a high cost for the families [3], monetarily, physically, and psychologically. This cost is hard to translate to a single value, and even harder to attain help from governmental sources or external help. Furthermore, family members who provide care to their elderly relatives often report high tension levels in their relationships, degrading the quality of life for all parties [3].

From an economics perspective there are two serious issues: the lack of money for formal or informal care and the decreasing availability of formal medical care. Families are now facing serious economical stress by having elderly people under their care [3]. Elderly people tend to have health issues that require expensive treatments. Aggravating this situation, some elderly people require constant assistance, but most families are unable to hire a nurse, with the result that a family member then needs to take up this task, possibly impacting on family income. Governments are unable to cover all aspects of assistance or subsidise elderly care. For instance, in the United Kingdom there is currently a serious shortage of available hospital beds, which in particular is affecting the elderly population [5]. As a result, hospitals ask people to stay at home if possible, and discharge people sooner.

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This leaves a significant number of people at home, without proper care. The study by Ewbank et al. [5] also found that waiting times for admittance are increasing, reporting that only half of the demand is met. This issue also affects the elderly as they have to wait long periods of time before they can receive medical care.

The issue of delivering medical care has a great impact on the elderly community. The briefing of *Age UK* [3] reports that at the age of 80, six in seven elderly persons will have a long term health condition, and by age 85, 80% will have at least two long term health conditions. Additionally, 1 in 3 people aged 80 will have difficulties undertaking five or more tasks of daily living unaided, whilst when reaching 85 years old, the number increases to 2 in 3.

Cognitive problems in particular are very difficult to handle for family members and caregivers. We are now observing an increase of the number of people that suffer from these health issues [6, 3]. Cognitive diseases are usually very debilitating and can make sufferers very frail. Not being able to perform routinely activities of daily living (ADL) can have a negative impact on the moral of the elderly, leading to cases of severe depression. Constant care is typically needed in these cases and, as pointed out earlier, it is difficult for families and governments to tackle these situations adequately. Without a caregiver, the elderly are exposed to increased risks in the house and these risks are higher when they suffer from cognitive problems. Episodes of confusion are common and the typical response is panic and attempting to leave the room they are in, thus leading to falls and serious bodily injuries. There is a pressing need for help in terms of care and assistance whilst offering independence and safety [7]. Technology can be used to provide assistance through recommender systems, assistant robots, smart homes, etc. [8, 9].

Improving Quality of Life

Improving the quality of life of all citizens is critical, and is going to be a social priority in the next years. The European Union has recognized these issues and put in place funding for projects that address them [10]. This has contributed to stimulate activity in this area and as a result there are currently a number projects, both in academia and industry, developing solutions to improve the quality of life for both the elderly and the caregivers.

In particular, in the Ambient Assisted Living (AAL) domain [11, 12] we can find several solutions that aim to improve people's quality of life through the use of technology. The focus of AAL research is primarily on developing

low-cost technological solutions for the elderly and disabled people, to help them with their daily tasks.

A key sub-area of AAL focuses on Cognitive Assistants (CA). This is a relatively new area that is now growing fast, gaining traction in both the academic and corporate environments. Thanks to advances in both hardware and Artificial Intelligence solutions, the CA area has come of age, as the technology is now mature enough to enable the deployment of effective solutions.

2. Cognitive Assistants

Research in CA focuses on the development of technological devices that assist people with cognitive tasks in their daily lifes,helping them, for instance, to remember how to wash their hands, where is the soap and to turn off the water. Projects in the CA area come in many shapes and forms, some are pure software projects while others are a mixture of software and hardware.

After the age of 60 human beings start to decline in terms of memory and cognitive elasticity. This decline can often contribute to aggravate their current physical problems [13]. Furthermore, people with cognitive problems tend to be more stagnant and perform fewer activities, thus being exposed to a faster body condition decay. A way to prevent further decline of the cognitive abilities is to exercise memory through specific exercises. These usually focus on recollecting memories (past events, people, etc.), thus fortifying the neurons and creating new synapses [14]. There are also brain games that are specifically designed to prevent the decay of the cognitive capacity. While these games are effective, research has showed that is better to use one's personal information and memory [15].

Helping people to remember is therefore the main focus of CA research, which aims to help people with their daily activities by providing information about past events or people. For instance, CA projects may focus on intelligent calendars, activity recognition systems or memory banks. The domain of action of CA projects is broad and touches several aspects of human activities. CA solutions can be deployed in the homes of the elderly, in schools, and even in hospital environments; they may use screens, mobile devices, televisions and robots as methods of interaction. The diversity and potential of CA solutions are illustrated below with a few examples.

[16, 17] propose an intelligent calendar that helps people remember their tasks, as well as suggesting social events in an effort to promote active ageing. [18] proposes a system that presents information about the current health condition of its users, exploiting sensor systems that monitor their vital signs. [19, 20] discuss the interaction between robots and elderly people, and suggest strategies to increase their acceptance. [21] proposes using daily tasks as games and gamification to engage the elderly, allowing them to have a healthy contest. Finally, [22] proposes a system that shows information based on the current location of the users, thus helping them to exercise their memory and geospatial abilities.

3. Conclusions

This special issue presents the most recent advances in the area of cognitive assistants. Thus, it is intended to provide an overview of the research being carried out in this interdisciplinary field.

These days CA technology is being extended to what is sometimes called "smart advisors", which provide a universal human-centric computer information solution. Smart advisors combine generic decision support techniques with context-awareness and personalized recommendation using machine learning. They aim to help people in their daily activities in a general sense. Today, a number of prototypes of such systems exist. Some of them are well integrated into online services, as well as mobile devices. Others are embedded into dedicated robot prototypes, often oriented on care taking. Recently a more general concept of companion technologies has been introduced.

The articles contained in this special issue are very heterogeneous in terms of scope, region and are by people that are a reference in this field. Five articles compose this Special Issue, and they are distributed globally, with contributions from the following countries: Germany, New Zealand, Spain, Taiwan, and United States of America. This shows the interest of academia in the CA area and the level of development that is currently underway, and provide different perspectives related to their own culture. Next we present the accepted articles with a brief explanation of their themes and aims.

MyMemory: A Mobile Memory Assistant for People with Traumatic Brain Injury. This article presents MyMemory, a cognitive assistant that aims to assist Traumatic Brain Injury patients in coping with their memory impairments. It consists of a mobile application that displays reminders

to its users, providing extensive context about the activity to be performed. Furthermore, the article presents a study that reports a high level of acceptance by the MyMemory users, including improvements in memory function and autobiographical memory.

Deciding the Different Robot Roles for Patient Cognitive Training. This article presents a system that interacts with caregivers and care-receivers via a robot. The aim is to learn the parameters of tests (Syndrom Kurztest) from the caregivers and perform those tests on the care-receivers. The goal is to have a complete interaction loop, improving the levels of engagement and increasing the tests' confidence levels. Thus, attaining reliable results about the cognitive impairments of the care-receivers.

Attention Allocation for Human Multi-Robot Control: Cognitive Analysis based on Behavior Data and Hidden States. This article presents a strategy to improve the cognitive awareness of robot operators in difficult tasks, e.g., navigating a robot in a challenging environment. They have found that Hidden Markov Models demonstrate fundamental differences among the queuing mechanisms and reliability conditions. Thus, they can be helpful in investigating the use of human cognitive resources under multitasking environments.

A Cognitive Assistant for Improving Human Reasoning Skills. This article presents LIZA, a pedagogical agent that aims at improving the reasoning and decision-making dialogue ties of its users using natural language. It is used on an e-Learning environment, thus it is a conversational tool (using chat) that displays information according to the type of conversation. The goal is to engage the users and to present data saving the users from reading irrelevant information, thus achieving higher learning gains in comparison to classical e-Learning platforms.

A Cognitive Assistant for Learning Java featuring Social Dialogue. This article presents an architecture that aims to improve the students' learning rate through a social dialog. The aim is to identify the students doubts and provide exact information that will help them advance in their studies. The goal is to keep the students engaged and improve their satisfaction levels and learning curve. This article also presents an evaluation that validates the hypothesis.

These five articles show distinct scopes and aims within the CA domain. We believe that it shows maturity and reveals that the society is in great need of technological solutions that improve their lives through what could be considered little gestures (helping in ADL) that have a great impact on wellbeing.

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