

Chapter 76

Combining Artificial Intelligence and NetMedicine for Ambient Assisted Living: A Distributed BDI-based Expert System

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ABSTRACT

World population is shifting towards older ages: according to recent estimates there will be 1.5 billion people over 65 years old in 2050. Local governments, international institutions, care organizations and industry are fostering the research community to find solutions to face the unprecedented challenges raised by population ageing. A combination of Artificial Intelligence and NetMedicine could be ideal to face these challenges: they provide the means to develop an intelligent system and simultaneously to distribute it over a network, allowing the communication over the internet, if needed. Hence, the authors present a Multi-Agent Architecture for Ambient Assisted Living (AAL): it is the model for a system to manage a distributed sensor network composed by ambient and biometric sensors. The system should analyse data and pro-actively decide to trigger alarms if anomalies are detected. The authors tested the architecture implementing a prototypical Multi-Agent System (MAS), based on Belief-Desire-Intention (BDI) paradigm: the Virtual Carer.

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INTRODUCTION

The lengthening of life expectancy, jointly to the decreasing of fertility, will triple the number of people aged 65 or older from 524 million in 2010 (8 percent of the world population) to 1.5 billion in 2050 (16 percent of the world population) (World Health Organization, 2011). The increasing median age of the world population has significant social and economic implications: the consequent rise of chronic diseases will result in a dramatic increase of emergency situations and missions within the coming years (Kleinberger, Becker, Ras, Holzinger, & Müller, 2007). This is becoming a substantial issue in Europe, USA and Japan owing to their high dependency ratio¹ (Christensen, Doblhammer, Rau, & Vaupel, 2009). Thus national governments, no-profit organizations as well as industry are fostering the research community to contribute to the Ambient Assisted Living (AAL) field. AAL aims at extending the time older people can live in their home environment, assisting them with the activities of daily living, promoting the use of intelligent products and Information Technology (IT) tools to provide remote care services (Sun, De Florio, Gui, & Blondia, 2009).

In this paper we propose a multi-agent architecture for an AAL system. The cornerstone of this idea is the combination of Artificial Intelligence and NetMedicine in order to develop a system able to manage a distributed sensor network, composed by ambient and biometric sensors; it should be, at the same time, an interface layer between the network, the assisted person, his relatives and the medical staff. The system, named Virtual Carer, models actions and behaviours of a human caregiver, to help a patient in his daily activities inside his home environment, simultaneously monitoring his health conditions and ensuring his security. The Virtual Carer is able to analyse data coming from the available sensors and, thanks to its knowledge base, to infer new knowledge and to decide if detected values should be notified, possibly triggering an alarm.

The need for an intelligent system controlling a distributed network clearly suggests an integration between Artificial Intelligence and NetMedicine. Artificial Intelligence provides technologies to develop a proactive expert system, while NetMedicine offers the possibility to access data and alarms triggered by the system through the web. The term NetMedicine simply denotes every medicine activity which is carried on through the Internet (Dragoni, 2009). In other words NetMedicine has to be intended as the evolution of TeleMedicine, due to the digitalization of information and the emergence of internet: the fast improvement of the ICT technologies is greatly moving the demand for knowledge by the physicians towards the cyberspace (Nakic, & Loškovska, 2012). Moreover, social networking fosters the constitution of communities sharing similar medical interests, even enhancing primary care practice (Hawn, 2009).

Multi-Agent Systems (MAS) represent one of the possible points of contact between Artificial Intelligence and NetMedicine; indeed the main advantages of a MAS approach (Palazzo, Rossi, Dragoni, Claudi, Dolcini, & Sernani, 2013), essential for the proposed system, are:

- Distribution;
- Modularity;
- Robustness.

The MAS architecture allows to distribute software agents and the platforms that manage them over one or more networks; each sensor can be associated with an agent, making the system resilient to sensor failures and disconnections. The adoption of the Foundation for Intelligent Physical Agents (FIPA) standards as the Agent Communication Language (ACL) allows to add and remove sensors and devices

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