

## COMMENTARY

# Multi-Agent Systems: Effective Approach for Cancer Care Information Management

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### Abstract

Physicians, in order to study the causes of cancer, detect cancer earlier, prevent or determine the effectiveness of treatment, and specify the reasons for the treatment ineffectiveness, need to access accurate, comprehensive, and timely cancer data. The cancer care environment has become more complex because of the need for coordination and communication among health care professionals with different skills in a variety of roles and the existence of large amounts of data with various formats. The goals of health care systems in such a complex environment are correct health data management, providing appropriate information needs of users to enhance the integrity and quality of health care, timely access to accurate information and reducing medical errors. These roles in new systems with use of agents efficiently perform well. Because of the potential capability of agent systems to solve complex and dynamic health problems, health care system, in order to gain full advantage of E- health, steps must be taken to make use of this technology. Multi-agent systems have effective roles in health service quality improvement especially in telemedicine, emergency situations and management of chronic diseases such as cancer. In the design and implementation of agent based systems, planning items such as information confidentiality and privacy, architecture, communication standards, ethical and legal aspects, identification opportunities and barriers should be considered. It should be noted that usage of agent systems only with a technical view is associated with many problems such as lack of user acceptance. The aim of this commentary is to survey applications, opportunities and barriers of this new artificial intelligence tool for cancer care information as an approach to improve cancer care management.

**Keywords:** Cancer care - multi agent system - information management

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### Introduction

Cancer is one of the most preventable chronic disease and a major public health problem in many countries (Jemal et al., 2010; Hassanzad, 2011). National Institutes of Health (NIH) has announced that the overall cost of cancer in 2007 was \$ 226.8 billion of which 103.8 billion for direct medical costs and 123 billion dollars for indirect deaths costs (American cancer society, 2012). Physicians, in order to study the causes of cancer, detect cancer earlier, prevent or determine the effectiveness of treatment, and specify the reasons for the treatment ineffectiveness, need to access accurate, comprehensive, and timely cancer data (SEER Training Modules, 2013). Global development of information and communication technology (ICT) in various industries including the healthcare industry and the emergence of modern technology tools made it possible for user easy and low cost access to the information needed more than before (Mohammadzadeh, 2006; Annicchiarico et al., 2008). The cancer care environment has become more complex because of need for coordination and

communication among health care professionals with different skills in a variety of roles, large amounts of data with various formats of audio, image, etc. (Nealon et al., 2003). The goals of health care systems in such a complex environment are correct health data management, providing appropriate information needs of users to enhance the integrity and quality of health care, timely access to accurate information and reducing medical errors. These roles in new systems with use of agents efficiently perform well. Agent technology has emerged in past years as a new paradigm in artificial intelligence (AI) focused on the modeling, design and development of complex systems. It has become an interesting area in health care. Agents are one of the most strong artificial intelligence areas, especially in the generation of practical solutions for real problems. One of the characteristics of agent is mobility, which is suitable for telemedicine and E-health systems (Nealon et al., 2003; Annicchiarico et al., 2008). Survey indicated worthwhile effects of benefit from the agent technologies approach in cancer care improvement. Generally, the aim of this review article

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is to survey application, opportunities and barriers of this new modern artificial intelligence tool on the cancer care information as an approach to improve cancer care management.

### **Opportunities of Multi Agent System (MAS) Application in Cancer Care Management**

In health care in general and in cancer care individually, various information systems in different health care centers are used for recording and storing patient data. Thus achieving a proper decision to solve the problem as soon as possible and spending the least is so hard. It provides limits for planning and coordinating health action (Marinagi et al., 2013). Multi agent system as new achievement of software engineering is a set of independent agents that interact with each other and coordinate efforts to solve the problem (Wooldridge, 2009). These systems are very useful in health environment that is composed of different information systems with heterogeneous components. Each agent can be run in various machines which are physically located in different geographical areas and maintain part of the knowledge needed to solve the problem in the distribution method such as patient records that are kept in different parts of the hospital. Thus, agent-based systems are more powerful than centralized systems (Sánchez et al., 2009).

Technology advances have lead to increased user demand for access to huge online health information and services. Most professionals don't have enough time to explore the latest developments, find and filter relevant information. However, citizens also want to have a more active role in their care, but most people have not sufficient skills and knowledge to find relevant information (Goodall et al., 2010). In both cases, finding the right information from reliable and useful sources actively and in fastest possible time and less effort to search, analyze and filter information is particularly important. Agents can be used to provide the required information for health care professionals and patients. Information agents help users in retrieving information from different sources, analyze and process the resulting data, select the required data users, and filter out unrelated information (Isern et al., 2010). Another advantage of the intelligent agent is social ability. Agents are capable of communicating with each other through standard languages in order to exchange any information. For example medical wards in hospital can participate in planning process to continue patient treatments (Bichindaritz et al., 2010).

Another advantage of agents is the pro activeness behavior. This means that the system is able to perform the actions that are beneficial for the user, but it is not requested (Nealon et al., 2003; Isern, 2008). In other words, systems have the potential of innovation and development to meet the future needs of their users. For example, in the system it is defined that he or she suffers from chronic disease like cancer, and when this person is planning a trip to another place, agent-based systems are capable of actively seeking information about health care centers and oncologist in destination and deliver these

information to user in emergency situation.

### **Barriers of Multi Agent Systems (MAS) Application in Cancer Care Management**

Despite the strong role of multi-agent systems to improve the management of cancer, the difficulties associated with implementing this new technology remain. The most important challenges in applying multi agent system include.

Organizational challenges like organizational culture and the support of high level management; human challenges like lack of trained and skilled personnel at health care centers in this field (Khoubati et al., 2010), user attitudes, technology acceptance (Venkatesh et al., 2012; Cresswell et al., 2013) user characteristics like age, economic, social and educational status (Hardiker et al., 2011), threats to confidentiality and privacy, legal, ethical and administrative barriers, cost of system implementation and maintenance (Khoubati et al., 2010), sufficient investment (Lucas, 2008), poor design and implementation, lack of system interoperability with electronic health records and other IT tools (Lawler et al., 2011), decrease in face to face communication between doctor and patient (Lluch, 2011), failure to meet targets (Lucas, 2008), virtual information control (While, 2011), ill-functioning of system that leads to medical errors and negative effects on care outcomes, patients and personnel (Nykänen et al., 2011), defining proper strategy to select best actions (Alonso et al., 2003), technological barriers such as lack of ICT infrastructure (Cripps et al., 2011) ,developing flexible, extensible and open architecture platform, knowledge management based on MAS to ensure knowledge currency (Bhat et al., 2010); design challenges such as robustness, efficiency, and communication challenges in cooperation between agents (Kostiadis et al., 2000), applying appropriate ontology e.g. GALEN, UMLS, SNOMED in order to facilitate and accelerate retrieval and integration of health information and effective communication in systems based on agent technology (Volot et al., 1997; Safdari et al., 2009; OpenGALEN, 2013), and standards for data exchange between MAS and related tools (Nealon et al., 2003).

### **Discussion**

Health care system is faced with challenges such as weak interoperability, coordination among providers involved in patient treatment, sharing information and so on. Dynamic health environment needs high speed access to real-time health information, high interoperability among different providers with various skills. Because of potential capability of agent systems to solve complex and dynamic health solutions, health care system, in order to gain full advantage of E-health, must take steps to make use of this technology.

Multi agent systems inherently are compatible with mobile devices. Architecture of these systems allows high interoperability and quality information management and appropriate sharing data. These systems have

effective roles in health services quality improvement for the population, especially in e-health, telemedicine, emergency situation and chronic diseases management such as cancer. Multi agent system leads to improved welfare conditions and correct disease management and makes possible effective access to health services for all people in every time and every place.

In the design and implementation of agent based system, planning for items such as information confidentiality and privacy, appropriate architecture, communication standards and protocols, mode of communication between agents, ethical and legal aspects, feedbacks, user attitudes, budgeting, motivations, hierarchy, useful standards, cost afford, identification opportunities and barriers should be considered.

It should be noted that usages of agent system only with a technical view is associated with many problems such as lack of user acceptance. Hence, in all phases of design, development and implementation of technology tools, involvement of end users such as doctors and patients, and considering their needs is essential.

## References

- Annicchiarico R, Cortés U, Urdiales C (2008). Agent Technology and e-Health. Birkhäuser Verlag, Switzerland, 141-8.
- Alonso E, Kudenko D, Kazakov D (2003). Adaptive Agents and Multi-Agent Systems: Adaptation and Multi-Agent Learning. Germany: Springer-Verlag Berlin Heidelberg. P:21.
- Bichindaritz I, Vaidya S, Jain A, Jain LC (2010). Computational Intelligence in Healthcare 4. Springer-Verlag Berlin Heidelberg, 25-48.
- Bhat S, Wahid A (2010). Multi agent based knowledge management: issues and challenges. *Int J Computer Sci and Commu*, **1**, 293-7.
- Cripps H, Standing C (2011). The implementation of electronic health records: a case study of bush computing the Ngaanyatjarra Lands. *Int J Med Inform*. **80**, 841-8.
- Cresswell K, Sheikh A (2013). Organizational issues in the implementation and adoption of health information technology innovations: an interpretative review. *Int J Med Inform*, **82**, 73-86.
- Goodall K, Ward P, Newman L (2010). Use of information and communication technology to provide health information: what do older migrants know, and what do they need to know? *Quality Primary Care*, **18**, 27-32.
- Hassanzade J, Molavi e vardanjani H, Farahmand M, Rajaiifard AR (2011). Gastrointestinal Cancers in South of Iran, a population Based Study. *Iran J Cancer Prev*, **4**, 163-9.
- Hardiker NR, Grant MJ (2011). Factors that influence public engagement with eHealth: a literature review. *Int J Med Inform*, **80**, 1-12.
- Isern D, Sánchez D, Moreno A (2010). Agents applied in health care: a review. *Int J Med Inform*. **79**, 145-66.
- Isern D (2008). Agent-Based Management of Clinical Guidelines. PHD THESIS. Barcelona.
- Jemal A, Siegel R, Xu J, Ward E (2010). Cancer statistics. *CA: A Cancer J Clin*, **60**, 277-300.
- Khoubati K, Dwivedi Y, Srivastava A, Lal B (2010). Handbook of Research on Advances in Health Informatics and Electronic Healthcare Applications: Global Adoption and Impact of Information Communication Technologies. Hershey. New York: Medical information science reference. 91, 10, 156
- Kostiadis K, Hunter M, Hu H (2000). The Use of Design Patterns for the Development of Multi-Agent Systems. Proceedings IEEE International Conference on Systems, Man, and Cybernetics (SMC2000).
- Lucas H (2008). Information and communications technology for future health systems in developing countries. *Social Sci Med*, **66**, 2122-32.
- Lawler EK, Hedge A, Pavlovic-Veselinovic S (2011). Cognitive ergonomics, socio-technical systems, and the impact of healthcare information technologies. *Int J Industrial Ergonomics*. **41**, 336-44.
- Lluch M (2011). Healthcare professionals' organizational barriers to health information technologies- a literature review. *Int J Med Inform*, **80**, 849-62.
- Mohammadzadeh N (2006). Study of Attitudes of Iranian Medical Record Faculty Members about Effectiveness of IT in Health Information System: 2005-2006. MS of Medical Record Education Thesis. Tehran University of Medical Sciences.
- Marinagi C, Panayiotopoulos T, Spyropoulos C (2013). PTPS: a model for timeline-based planning and scheduling of patient tests in hospitals. *AWERProcedia Information Technology and Computer Science*. Vol 03: 1766-71. 3<sup>rd</sup> World Conference on Information Technology (WCIT-2012). ISSN: 2147-5369.
- Nealon JL, Moreno A (2003). Agent-Based Health Care Systems. Nealon JL, Moreno A (2003). Applications of Software Agent Technology in the Health Care Domain, Whitestein Series in Software Agent Technologies and Autonomic Computing, Switzerland: Birkhauser Verlag.
- Nykänen P, Brender J, Talmon J, et al (2011). Guideline for good evaluation practice in health informatics (GEP-HI). *Int J Med Inform*, **80**, 815-27.
- SEER Training Modules, Importance of Cancer Registry. U. S. National Institutes of Health, National Cancer Institute. 2013-01-06 (of access).
- Sánchez D, Isern D, Rodríguez Á, Moreno A (2009). General purpose agent-based parallel computing. In: Omatu S, Rocha MP., Bravo J, Fernández F, Corchado E, Bustillo A, Corchado J.M. (eds.) IWANN 2009. LNCS, vol. 5518, pp. 231-8: Springer, Heidelberg.
- Safdari R, Partovipour E, Maidani Z (2009). Unified medical language the infrastructure of EHR. Tehran: jaffari.p66.
- Venkatesh V, Thong JYL, Xu X (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *Forthcoming MIS Quarterly*, **36**, 157-78.
- Volot F, Joubert M, Fieschi M, Fieschi D (1997). A UMLS-based method for integrating information databases into an Intranet. Proc AMIA Annu Fall Symp, 495-9. PMID: PMC2233547.
- Wooldridge M (2009). An introduction to multi agent system. UK: John Wiley and Sons.p 9. ISBN: 9780470519462.
- While A, Dewsbury G (2011). Nursing and information and communication technology (ICT): A discussion of trends and future directions. *Int J Nursing Studies*, **48**, 1302-10.