Artificial Immune Systems for Anomaly Detection in Ambient Assisted Living Applications

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ABSTRACT

This paper makes a case for the use of Artificial Immune Systems (AIS) in the area of Ambient Assisted Living (AAL) for anomaly detection and long term monitoring. A brief literature review of some of the solutions developed for AAL and the use of AIS in other fields of research is presented. The authors advocate the use of AIS in AAL based on their unique features and their ability to address problems specific to the long term monitoring of people. An improved method for the optimisation of detector generation for AIS, which uses a novel intelligent seeding technique, is presented. The new seeding technique is compared with two other detector seeding methods. The simulation results are presented showing an improvement in the classification accuracy and warranting current and future work.

Keywords: Ambient Assisted Living (AAL), Anomaly Detection, Artificial Immune System (AIS), Detector Seeding, Long Term Monitoring

INTRODUCTION

Advances over the last decades in medicine research are helping humans to live longer than ever before, simultaneously; younger people are increasingly reluctant to start a family early, which has resulted in a reduced birth rate. This scenario can be observed in most western countries. Both trends lead to a shift in the current age pyramid (illustrated in Figure 1), which indicate that soon there may be more people over the age of 65 than under(Commission, Economic, & Affairs, 2009).

One consequence of this is that fewer carers have to look after the growing number of elderly and therefore need to be efficiently organized and supported. The research of Ambient Assisted Living (AAL) is centred on finding novel, efficient and cost effective ways to support carers and elderly to stay longer healthy at home.

The work in the area ranges from sensor development for better vital sign monitoring (Boylan, 2011) and position information to recognition of Activities of the Daily Living (ADL) (Sim, et al., 2010) over to health monitor-
Research has tended to concentrate on finding solutions for health and lifestyle problems using short term monitoring. New research on the other hand, is focussed more on the use of long term monitoring of a person (Elbert, Storf, & Eisenbarth, 2011). The authors believe that the ultimate solution will be an adaptive approach that will harness the strength of both short and long term monitoring without the need for user involvement. Therefore understanding what normal behaviour means is a crucial part of the long term monitoring process. Thus the simplest starting point for a long term monitoring is a person without any abnormal behaviour pattern (healthy person) to train the system over a long period of time. The user should only become aware of such a system in a case of an emergency situation later on in their life. The authors propose the use of an artificial intelligence (AI) technique already used in electronic hardware fault and network intrusion detection based on Artificial Immune Systems (AIS) for the purpose of anomaly detection in health monitoring (Bersch, Azzi, & Khusainov, Fall Detection using Biologically Inspired Monitoring, 2011).

RELATED WORK

AIS is an AI method designed to mimic typical functions of the human immune system (HIS) while being oriented at the better known genetic algorithms (GA). The main task of the immune system is to classify body cells in a self set (normal) and a non-self set (abnormal). The framework for this unsupervised classification technique is that normal cells have to be a frequent pattern in the body while abnormal cells have to be the exception in the body. The human immune system uses the chemical surface of a body cell to determine if the cell has been discovered before or not, therefore acting as an anomaly detection system. Different researchers have shown that the characteristics of the human immune system can be modelled using AI terminologies to work outside the human body.

The use of AIS outside the area of AAL is quite varied; some examples are intrusion detection for computer networks, fault detection of electronic machines and unsupervised classification of different data sets. The main connection of these fields are that the AIS is used to “find” the normal self set of the computer network, machine or dataset and trigger an alarm in the case of a deviation from the norm.

In Hofmeyr and Forrest (2000) the authors designed a general purpose architecture for AIS and proofed their concept using a network intrusion detection system (LISYS). This architecture was used as the basic framework for the research described.

Another research team (Zhi-tang, Yao, & Li, 2005) designed a fuzzy anomaly detection algorithm based on AIS to use it for network anomaly detection. Their results showed that the negative selection algorithm can be used to detect anomalies on real network traffic data and the efficiency of the developed algorithm.
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