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Guest Editorial

Thematic issue on human-centred ambient intelligence: Cognitive approaches, reasoning and learning

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Abstract. This editorial presents advances on Human-centred Ambient Intelligence applications which take into account cognitive issues when modelling users (i.e. stress, attention disorders), and learn users' activities/preferences and adapt to them (i.e. at home, driving a car). These papers also show AmI applications in health and education, which make them even more valuable for the general society.

Keywords: Ambient Intelligence, human-machine interaction, cognitive approaches, stress prediction, physical activity monitoring, education, health, activity recognition

1. Introduction to HCogRL thematic issue

Most research on Ambient Intelligent systems (AmI) have the focus on humans in order to acquire natural interaction with them [1–3,12] (and Griol *et al.* in this volume), recognize their activities at home [6] (and Torres-Sospedra *et al.* in this volume), and in general, to make environments more adaptive, intuitive and trusted [7,9].

Moreover, AmI systems can adapt to users more easily if they understand some of their cognitive issues (i.e. emotional state, health problems, etc.). With this information, they can also help to increase users' quality of life. For example, there is research dedicated to analyze users' vital constants (i.e. heart rate) to detect stress in citizens [10,11] or in drivers (V. Corcoba-Magaña *et al.* in this volume). Those stress detectors/predictors can help users to prevent it, so that they may avoid diseases deviated from it, they are alerted of risky driving behaviour, etc. Other mobile smart applications are dedicated to increase human sportive activities (i.e. V. Janko *et al.* in this volume), which also lead users to have a healthier life.

Intelligent applications in smart mobile devices or tablets with intuitive interfaces offer alternatives to traditional learning since it is attractive for students to

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learn by playing. Thus, some AmI systems were developed not only to be smarter but also to increase human intelligence. Some examples are: educative games for increasing spatial reasoning skills [4]; applications for training people with Down's Syndrome to handle money when shopping (i.e. S. Rus *et al.* in this volume); and computer-based educational systems where student models are applied to infer the presence of a specific awkwardness in their educational process, such as, attention deficit hyperactivity disorder (i.e. L. Mancera *et al.* in this volume).

Some of the papers presented in this issue are extended versions of papers that were presented during the XVIII JARCA Workshop on Qualitative Systems and Applications in Diagnosis, Robotics and Ambient Intelligence (JARCA' 16) [5] that took place in Almería, Spain, and the 12th International Conference on Intelligent Environments (IE'16) [8] that took place in London, United Kingdom. Other papers are new contributions since the Thematic Issue call was openly publicized.

2. Outline of HCogRL thematic issue

This thematic issue contains six papers. The first three papers illustrate advances in home automation, conversational mobile phone user interfaces, and driving automation, respectively. These applications present intuitive and easy-to-use systems that learn users' behaviour in order to adapt to it. The rest of the papers in this thematic issue present education-based applications for schoolchildren, for people with Down's Syndrome and for people with Attention Deficit Hyperactivity Disorder (ADHD), respectively.

In the paper titled **"In-home monitoring system based on WiFi fingerprints for Ambient Assisted Living"**, J. Torres-Sospedra *et al.* present a system where WiFi fingerprints are used to continuously locate a patient in different rooms at home. The experiments performed provide a correctly location rate of 96% in the best case of all studied scenarios. The behaviour obtained by location monitoring allows to detect anomalous behaviour (i.e. long stays in rooms out of the common schedule). The main characteristics of this system are: a) enough robustness to work without an own WiFi access point, which also involves higher affordability; b) low obtrusiveness, as it is based on the use of a mobile phone; c) highly interoperablility with other wireless connections (bluetooth, RFID); d) the ability to trigger alarms when any anomalous behaviour is detected.

In the paper titled **"Integration of context-aware conversational interfaces to develop practical applications for mobile devices"**, D. Griol *et al.* present a practical mobile application that integrates features of Android APIs on a modular architecture that emphasizes multimodal conversational interaction and context-awareness to foster user-adaptivity, robustness, and maintainability.

In the paper titled **"Prediction of motorcyclist stress using a heartrate strap, the vehicle telemetry and road information"**, V. Corcoba-Magaña *et al.* present a system that predicts upcoming values for stress levels based on current and past values for both, the driving behaviour and environmental factors. First, the relationship between stress levels and different variables that model the driving behaviour (i.e. accelerations, decelerations, positive kinetic energy, standard deviation of speed, and road shape) is analyzed. Stress levels are obtained using a Polar H7 heart rate strap. Vehicle telemetry is captured using a smartphone. Second, the accuracy of several machine learning algorithms (i.e. Support Vector Machine, Multilayer Perceptron, Naïve Bayes, J48, and Deep Belief Network) is studied when applied to estimate the stress based on the input data. Finally, an experiment is conducted in a real environment by considering three different scenarios: home-workplace route, workplace-home route, and driving under heavy traffic. The results obtained show that the proposed mechanism can estimate the upcoming stress with high accuracy and that this algorithm can be used to develop automatic driving assistant applications that recommend actions to drivers in order to prevent stress.

The rest of papers of this thematic issue present education based applications.

In the paper titled **"e-Gibalec: Mobile application to monitor and encourage physical activity in schoolchildren"**, V. Janko *et al.* present e-Gibalec, a system designed to encourage schoolchildren towards a more active lifestyle. This system consists of a mobile application that, through sensors built into the smartphone, detects children's physical activity and rewards them in a game-like manner. It also consists of a web application that allows the parents and physical education teachers to look at the children's physical activity history, so they can further motivate them if needed. The authors also discuss the motivational mechanisms employed in the system, provide an evaluation of the accuracy of the activity-recognition com-

ponent, and present a pilot study that measures the effect of e-Gibalec system on a sample schoolchildren population.

In the paper titled **"Assistive apps for activities of daily living supporting people with Down's Syndrome"**, S. Rus *et al.* present an application for money-handling training and assistance for shopping whose main aim is to advance in the independence and integration into society of people with Down's Syndrome. The results gathered after evaluating this application in different pilot studies and workshops with a large group of people with Down's Syndrome are explained. Moreover, results obtained from interactions with different devices (i.e. tablet, personal computer and interactive table) are also compared. Evaluation results for the shopping application are also provided.

In the paper titled **"A Domain-Independent Data ADHD Student Model for Computer-Based Educational Systems. Data Analysis in Higher Education"**, L. Mancera *et al.* present a student model to infer the presence of Attention Deficit Hyperactivity Disorder (ADHD) symptoms in a Computer-Based Educational System, also known as Learning Management Systems (LMS). This student model takes into account two types of students' characteristics: generic and psychological. Each one is measured through a set of variables, which are correlated to obtain a final profile that can be useful to assist the teaching-learning process. In order to reach this purpose, three Web application tools that collect information about these characteristics have been developed, integrated into an LMS and validated in a case study composed of 30 students (5 suffering from ADHD, 5 that present similar characteristics to ADHD and 20 that supposed do not suffer from ADHD). This case study was carried out through a quantitative research approach and a descriptive scope. Results show that the implemented tools are useful to identify attention problems symptoms in students enrolled in e-learning courses.

3. Epilog

Users are the main focus of the presented papers showing that Ambient Intelligent systems are becoming smarter, more intuitive and more easy-to-use. These papers also show AmI applications in health and education, which make them even more valuable for the general society.

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