



# Challenges and trends in Ambient Intelligence

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Published online: 7 May 2020  
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## 1 Introduction

Recent technological advances have enabled us to obtain detailed information about the environment (e.g. the Internet of Things), promoting interest in Ambient Intelligence (AmI). AmI studies the context of the user and uses this information to find highly intelligent solutions in the most varied application areas (Angelo Costa et al. 2017). The techniques and hardware involved in the development of Ambient Intelligence Systems are under a state of continuous evolution.

Current research trends in AmI focus on fundamental aspects, such as data capture and fusion, as well as the processing and analysis of large amounts of information by means of AI-based methodologies for improved performance (Davide Carneiro et al. 2016). This enables in certain cases to the development of hardware adapted systems and to deal with situations that were not approachable in other contexts.

The miniaturization and reduction of manufacturing processes make it possible to develop new electronic components that are used in combination with artificial intelligence to improve the quality of life of people. In the area of information capture, current research focuses on the hardware (the development of smaller, cheaper or more efficient sensors) and the software (pre-processing of the information in the device, communication protocols, etc.) for improved information transmission.

Information fusion is associated with both information acquisition and processing, and is required in contexts with multiple sensors, data sources or processes. The applications

of new protocols, wireless sensor networks and devices have allowed incorporating important new sources of data (information). These new sources can be processed due to the advances in computing capacities and to reduction of different device's costs.

In the processing of large volumes of information, the trends are geared towards the proposal of new architectures and platforms that have faster response times thanks to distributed and real-time processing (Gangman Yi and Vincenzo Loia 2019).

It is clear that Artificial Intelligence plays a key role in AmI. The current trend is to apply well-known methodologies to solve problems in new domains, as well as to develop new methodologies, capable of offering more optimal solutions.

This special issue welcomed submissions of original papers introducing research results on all the aspects covering the roles of Knowledge and Intelligence in AmI, ranging from concepts and theoretical developments to advanced technologies and new applications.

After several rounds of review, fifteen papers have been accepted for publication. The contributions from these papers can be summarized as follows:

The paper, entitled “Value creation system in the connected home ecosystem” authored by Carlos Alberto Lopez and Luis Fernando Castillo (2020), presents a research that aims to model the behaviour of the value creation system in the connected home ecosystem. It is discovered in the analysis of results that the correct combination of technologies is a relevant point for the creation of value, as well as the measurement of the effectiveness of the strategy through the concept of digital value offer.

The paper, entitled “Integration of a Music Generator and a Song Lyrics Generator to Create Spanish Popular Songs” authored by María Navarro-Cáceres et al. (2020), develops ETHNO-MUSIC, an intelligent system that generates melodies based on popular music. ETHNO-MUSIC generates melodies with Markov Models, which learns from a corpus of Spanish popular music. Briefly, they reflect that, on the one hand, the melodies transmit a feeling of Spanish popular

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music, and on the other hand, the text of the lyrics is related to the topics analyzed, and the rhythm follows the melodic aspects of the music.

The paper, entitled “A Multi-agent Architecture for Mobile Sensing Systems” authored by Francisco Laport et al. (2020), presents an architecture for mobile sensing systems in large cities based on the intelligent agent paradigm and Multi-agent systems. The platform provides support for multi-purpose machine learning services, implementing expert learning agents in each domain where the system collects data. The main challenges in mobile sensing systems such as scalability in crowded environments, handling of a large amount of data and the increasing appearance of sensing devices are addressed by the architecture due to the agent paradigm and multi-agent systems suit these demands naturally.

The paper, entitled “Mobile Sink-Based Energy Efficient Cluster Head Selection Strategy for Wireless Sensor Networks” authored by Vinith Chauhan and Surender Soni (2020), paper introduced a mobile sink based energy-efficient clustering mechanism for Wireless Sensor Networks. The firefly optimization method is used with the objective of reducing energy dissipation and to enhance the lifetime of the network. The performance of the proposed solution is compared with several alternative approaches. Results show that the proposed methodology is able to achieve better results than other protocols in terms of network lifetime, packet delivery ratio and packet delay.

The paper, entitled “Electromyogram prediction during anaesthesia by using a hybrid intelligent model” authored by José-Luis Casteleiro-Roca et al. (2020), presents an approach to predict the Electromyogram (EMG) signal in patients undergoing surgery with general anaesthesia. The established model predicts the EMG from the BISTM signal and the quantity of the drug Propofol given to the patient. The approach is based on a hybrid intelligent system, by combining different regression techniques in local models.

The paper, entitled “Performance Evaluation of Unsupervised Techniques in Cyber-Attack Anomaly Detection” authored by Jorge Meira et al. (2020), is focused on predicting and detecting anomalous patterns in computer systems that may be indicative of malicious intents. In particular, it performs a comparative evaluation of unsupervised learning algorithms in the detection of attacks and compared the performance of different types of anomaly detection techniques in two available public datasets: the NSL-KDD and the ISCX.

The paper, entitled “Machine Learning for Quality Control System” authored by Gonçalo San-Payo et al. (2020), presents a system, that makes use of an image classification model capable of learning new classes incrementally and increase its knowledge, to help the quality control officers of a clothing factory in their quality control processes. In this

work, a defect can be a missing component or a wrong component in a production object. The main goal of the system is to classify the components that compose a production object through the use of a classification model.

The paper, entitled “A Robustness Approach to the Distributed Management of Traffic Intersections” authored by Cesar L. González et al. (2020), proposes a distributed coordination management system for intersections of autonomous vehicles through the employment of some well-defined rules to be followed by vehicles. The performance of the model is quite similar to other centralized adaptive approaches but since it is a distributed approach, it can be more robust against failures. At the same time, the system outperforms other conventional traffic control systems such as Green Wave in terms of velocity, waiting time and traffic flow.

The paper, entitled “Acceptance and Use of a Multi-Modal Avatar-Based Tool for Remediation of Social Cognition Deficits” authored by Arturo S. García et al. (2020), presents the evaluation process of a system designed to improve affect recognition in patients with social cognition deficits. The presented system facilitates the generation of multi-modal avatar-based therapies by mental health professionals in this important clinical domain. It describes how the system was assessed by therapists after viewing a video explaining its most relevant aspects.

The paper, entitled “Hybrid System for Video game Recommendation based on Implicit Ratings and Social Networks” authored by Javier Pérez-Marcos et al. (2020), presents a hybrid system of video game recommendation, through the use of collaborative filtering and content-based filtering, and the construction of relationship graphs. In order to improve the recommendations, a new method for estimating implicit ratings is proposed that takes into account the hours of play. The recommender system improves the results of other techniques presented in the state of the art.

The paper, entitled “Prediction and failure analysis of composite resin restorations in the posterior sector applied in teaching dental students” authored by Ignacio J. Aliaga et al. (2020), presents a study on the causes and types of failure of posterior composite resin restorations performed by dental students at the Complutense University of Madrid. The study aimed to improve both the cognitive knowledge and skills of dental students which may cause failures of the restoration placed in posterior teeth. The work was useful for the performance of a predictive model to estimate the probability of failure of resin restorations placed by students.

The paper, entitled “What is of Interest for Tourists in an Alpine Destination: Personalized Recommendations for Daily Activities Based on View Data” authored by Tahir Majeed et al. (2020), proposes a recommender system that is capable of providing personalized recommendations to tourists thereby facilitating and enriching tourist’s experience

and stay. A hybrid recommender system is presented that uses implicit user feedback in the form of view duration. The proposed system was tested using real data derived from tourists using the mobile app in a Swiss alpine destination.

The paper, entitled “Using LOT methodology to develop a noise pollution ontology: a Spanish use case” authored by Paola Espinoza-Arias et al. (2020), describes the development process of an ontology to represent the acoustic pollution data collected by measurement stations located in cities, providing a common model for data publication. The developed ontology reuses several well-known ontologies and includes classes, properties, and instances specifically created to cover this domain. This work also includes real examples of how to instantiate the ontology.

The paper, entitled “A Gamification Framework for Getting Residents Closer to Public Institutions” authored by Manuel Rodrigues et al. (2020), presents a framework for gamification in smart cities, with a digital implemented solution presented in the form of a mobile application, which aims to improve city hall public services and people’s communication, bringing them closer together. Several experiments proved that the system is user-friendly and behaving as expected. From a gamification perspective, it is evident that a reward system can significantly increase civic participation, whether due to competitive reasons or just due to the possibility of acquiring products from the store at a lower price.

Finally, the paper entitled “Profile Generation System using Artificial Intelligence for Information Recovery and Analysis” authored by Pablo Chamoso et al. (2020), presents a system for retrieving personal information from the Internet on the basis of several input criteria. The system is capable of differentiating the information of different people with the same name. In the case study, the information has been gathered from sources containing information about people living in Spain. This study has identified the most useful and reliable tools when it comes to web crawling and web scraping. Also, different AI methodologies have been tested for both face recognition and topic modelling in order to determine, which are the ones with the best accuracy and overall performance.

**Acknowledgements** As the special issue editors, we would like to take this opportunity to thank the various authors for their papers and the reviewers for their work. We are also grateful to Vincenzo Loia, Editor-in-Chief of the Journal of Ambient Intelligence and Humanized Computing.

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