

Special Issue on Pattern Recognition and Cognitive Assistants

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ABSTRACT

This special issue proposes a space for researchers to discuss the challenges of bridging pattern recognition and cognitive assistants. This bridge was travelled in both sides. From one side, how pattern recognition methods can help intelligent systems to become more cognitive. And from the other side, how cognitive models can improve pattern recognition methods so that the final system can better assist users. So, this special issue presents research work on these topics, aiming to observe their interrelations in order to create theoretical approaches, methodologies and computational tools to advance work on cognitive assistants and pattern recognition.

Pre-print version

1. Introduction

Ideal systems for interacting with people are those capable of interpreting their environment cognitively, that is, similarly to how people do it. In general, cognitive assistants are focused on people, providing tools that best fit them in order: (i) to extend human skills in tasks such as reasoning, learning, memorizing, acting and adapting, interpreting their biosignals, etc.; and (ii) to provide effective, cognitively-motivated support in their decisions.

Cognitive systems have been designed to boost human abilities such as memory (Chang et al., 2018), productivity (Ruiz et al., 2015), creativity (Falomir and Plaza, 2019; Oltețeanu et al., 2018; Oliveira et al., 2019; Confalonieri et al., 2018), reasoning (Pich and Falomir, 2018; Falomir and Oliver, 2016; Le and Wartschinski, 2018), learning (Coronado et al., 2018; Ruiz et al., 2018), problem-solving (Falomir and Oltețeanu, 2019) and so on. Examples of cognitive assistants were implemented in recommender systems (Casales-Garcia et al., 2020; Contreras Aguilar and Salamo, 2018; Museros et al., 2018; Ruiz et al., 2015), robotics (Marfil et al., 2019; Andriella et al., 2018; Puigbo et al., 2015), e-health applications (Yang et al., 2018; Chang et al., 2018; Sevilla-Villanueva et al., 2015), serious or educational games (Falomir and Oliver, 2016), and decision

support systems for energy consumption and waste optimisation (Gatzioura et al., 2019).

However, we realized that the link between the fields of Pattern Recognition and Cognitive Assistants has not received sufficient attention. And therefore, this was the focus of the current special issue.

2. Context of this special issue

This special issue was proposed in the 21st edition of the International Conference of the Catalan Association for Artificial Intelligence (CCIA 2018), which took place on 8th-10th October 2018. The first edition of CCIA was in 1998, so it has been a long path, and in all this time, a rich community of researchers in AI have been well-established. This conference is organized by the Catalan Association for Artificial Intelligence (ACIA), which celebrated its 25th anniversary in 2019, and it is currently an international association which brings together researchers in the Catalan Countries and other countries around the world (i.e. Germany, Ireland, Sweden, etc.) gathering more than 200 members in 2019. ACIA is also a member society of the European Association for Artificial Intelligence (EurAI). The main goal of the CCIA conference is to maintain this well-established forum of researchers that allows international and interdisciplinary communication and collaboration among the Catalan and the International AI community. CCIA Proceedings have been published continuously since 2005 by IOS Press in the *Artificial Intelligence Research and Development* series. In recent editions of the CCIA conference, extended versions

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of the best papers were invited to be published in special issues of several journals. In this 21st edition of CCIA, a special issue focused on the interactions of logics and applications of AI was organised, among others. Most of the papers presented in this issue are extended versions of papers that were presented at CCIA 2018 or research works developed by ACIA members.

3. Papers in this Special Issue on Pattern Recognition and Cognitive Assistants

Fourteen manuscripts were submitted to this special issue and the following five papers were accepted for publication.

The paper titled **Enhancing Sentient Embodied Conversational Agents with Machine Learning** by Tellols et al. (2020) presents Sentient Embodied Conversational Agents (SECAs), that is, virtual characters able to engage users in complex conversations and to incorporate sentient capabilities similar to the ones humans have. This paper introduces SECAs together with their architecture and a publicly available software library that facilitates their inclusion in applications –such as educational and elder-care– requiring proactive and sensitive agent behaviours. The authors illustrate their proposal with a virtual tutor embedded in an educational application for children. The evaluation was performed in two stages: firstly, a version with basic textual processing capabilities was tested; and secondly, a SECA with Machine Learning-enhanced user understanding capabilities was evaluated. The results show a significant improvement in users' perception of the agent's understanding capability. Indeed, the Response Error Rate decreased from 22.31% to 11.46% using ML techniques. Moreover, 99.33% of the participants consider the global experience of talking with the virtual tutor with sentient capabilities to be satisfactory.

The paper titled **Measuring user relevance in online debates through an argumentative model** by Alsinet et al. (2020) states that online debating forums are important social media for people to voice their opinions and engage in debates with each other. Measuring user relevance on these forums can be useful to identify different user profiles or behaviors in online debates, for example, users that tend to participate at the beginning of a debate and whose comments trigger participation, or users that post relevant comments but are not replied too often. To help users to distinguish such different user profiles, the authors propose graded measures based on users, influence, the controversy that they generate throughout the debates, their contribution to the polarization of the debates, and their social acceptance, that is obtained by analyzing the debates in which the users participate. The approach presented here is based on an argumentation-based analysis that represents a debate as a valued argumentation framework, in which comments of a debate are arguments, the attack relation between arguments models disagreement between comments, and values for arguments represent the overall support of users for comments. Finally, the measures presented are tested with a sample of users from Reddit debates, identifying four main groups of users, from users with almost no impact on the debate to very active ones with decisive comments for the outcome of the debate.

The paper titled **A bio-inspired quaternion local phase CNN layer with contrast invariance and linear sensitivity**

to rotation angles by Moya-Sánchez et al. (2020) explains that deep learning models have been particularly successful with image recognition using Convolutional Neural Networks (CNN). However, the learning of a contrast invariance and rotation equivariance response may fail even with very deep CNNs or by large data augmentations in training. This paper was inspired by the V1 visual features of the mammalian visual system to emulate as much as possible the early visual system and add more invariant capacities to the CNN. The authors proposed a new quaternion local phase convolutional neural network layer encoding three local phases. Two experimental setups were presented in this paper: an image classification task with four contrast levels, and a linear regression task that predicts the rotation angle of an image. In sum, new patterns and feature representations for deep learning were obtained, which capture illumination invariance and a linear response to rotation angles.

The paper titled **Swapping trajectories with a sufficient sanitizer** by Salas et al. (2020) states that real-time mobility data is useful for several applications such as planning transports in metropolitan areas or localizing services in towns. However, if such data is collected without any privacy protection it may reveal sensible locations and pose privacy risks to an individual associated to it. Thus, mobility data must be anonymized preferably at the time of collection. This paper considers the SwapMob algorithm that mitigates privacy risks by swapping partial trajectories. The authors formalize the concept of sufficient sanitizer and show that the SwapMob algorithm is a sufficient sanitizer for various statistical decision problems. That is, it preserves the aggregate information of the spatial database in the form of sufficient statistics and also provides privacy to the individuals. This may be used for personalized assistants taking advantage of users' locations, so they can ensure user privacy while providing accurate response to the user requirements. The authors measure the privacy provided by SwapMob as the Adversary Information Gain, which measures the capability of an adversary to leverage his knowledge of exact data points to infer a larger segment of the sanitized trajectory. The authors also test the utility of the data obtained after applying SwapMob sanitization in terms of Origin-Destination matrices, a fundamental tool in transportation modelling.

The paper titled **Visual Question Answering with Attention Transfer and a Cross-modal Gating Mechanism** by Li et al. (2020) deals with Visual Question Answering (VQA) which requires to understand both language information and corresponding visual contents. A lot of efforts have been made to capture single-step language and visual interactions. However, answering complex questions requires multiple steps of reasoning which gradually adjusts the region of interest to the most relevant part of the given image, which has not been well investigated. To integrate question related object relations into the attention mechanism, the authors of this paper propose a multi-step attention architecture to facilitate the modeling of multi-modal correlations. Firstly, an attention transfer mechanism is integrated to gradually adjust the region of interest considering reasoning representation of questions. Secondly, the

authors propose a cross-modal gating strategy to filter out irrelevant information based on multi-modal correlations. Finally, they achieve the state-of-the-art performance on the VQA 1.0 dataset and favorable results on the VQA 2.0 dataset, which verifies the effectiveness of our proposed method.

4. Epilog

The papers presented in this special issue bridge pattern recognition and cognitive assistants: how pattern recognition methods can help intelligent systems to become more cognitive (e.g. Machine Learning enhanced Sentient Embodied Conversational Agents in Tellols et al. (2020)) and how cognitive models can improve pattern recognition methods (e.g. the V1 visual features of the mammalian visual system inspired quaternion local phase CNN layers in Moya-Sánchez et al. (2020)).

The guest editors of this Special Issue on Pattern Recognition and Cognitive Assistants would like to thank all the authors who submitted articles to this issue. We are also grateful to the reviewers for their effort in evaluating the papers considered, and for giving highly constructive feedback to the authors. Finally, we also thank the general editor Gabriella Sanniti di Baja for her support.

Acknowledgments

Z. Falomir thanks the Cognitive Qualitative Descriptions and Applications (CogQDA) project funded by the University of Bremen and the YERUN Research Mobility Award (Young European Research UNiversities, second edition, 2018/2019). E. Plaza thanks the support by DIVERSIS (CSIC Intramural 201750E064). K. Gibert thanks the support of the Intelligent Data Science and Artificial Intelligence Research Center at UPC and the grant CO-2018-23-T-00454 funded by UPC to organize the 21st CCIA in Roses (Catalonia, Spain) in October 2019.

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