

# Preface

## Special Issue on Cognitive Infocommunications

CogInfoCom is an interdisciplinary research field that has emerged as a synergy between infocommunications and the cognitive sciences. One of the key concepts behind CogInfoCom is that humans and ICT are becoming entangled at various levels, as a result of which new forms of blended cognitive capabilities are appearing. These new capabilities – not separable into purely natural (i.e., human), or purely artificial components – are targeted towards in theoretical investigations and engineering applications. This special issue presents various new results on this scientific disciplina in the following papers:

- 1) Uncertain words, uncertain texts. Perception and effects of uncertainty in biomedical communication

Literature on epistemic stance has thoroughly investigated certainty and uncertainty markers, but their effects on the reader are still unclear. This paper investigates the reader's perception of the communication of uncertainty in biomedical texts and its effects on the reader's emotions and decision making. Four versions of a scientific paper on the risks of egg consumption, with varying degrees of certainty, were submitted to participants in two pilots and two studies. The pilots reveal that although participants are sensitive to changes in degree of certainty, they are not so aware of the epistemic markers of uncertainty in the articles. Study 1 shows that with a different framing of the risks of egg consumption – increase of cholesterol vs. risk of heart attack –, (un)certainty has an effect both on participant's emotions and subsequent intentions; study 2 highlights a difference between bare "lexical" certainty (simple presence of epistemic markers) and "textual" certainty (induced by contradictory sentences).

- 2) Placing event-action based visual programming in the process of computer science education

Based on research results and experience, students who finish K-12 education lack the necessary computational thinking skills that they would need to continue their studies effectively in the field of computer sciences. The goal of the paper is to examine the currently used methods and programming languages in K-12 education and to find and present an alternative approach. The paper presents event-action based visual programming, as an alternative to today's most frequently used methods, which do not restrict the students' development ability to simplified and basic applications while retaining the advantages of visual languages. The authors of the paper organized four workshops in which they presented this programming approach to four distinct groups involved in education. The participants were guided to develop a multiplatform mobile

application using Construct 2 event-action based visual programming. At the end of the sessions the authors collected data in the form of group interviews and questionnaires on the possibilities of including event-action based visual programming in computer science education. Based on the results, the participants found the method suitable for beginner programmers to help them lay the foundations for more complex, text- based programming languages and to develop a positive attitude towards programming.

### 3) Efficient Visualization for an Ensemble-based System

Ensemble-based systems have proved to be very efficient tools in several fields to increase decision accuracy. However, it is a more challenging task to become familiar with the operation and structure of such a system that contains several fusible components and relations. This paper describes a visualization framework in connection with an ensemble-based decision support system in the domain of medical image processing. First, the paper formulates the operations that can be used for composing such systems. Then, the paper introduces general visualization techniques for the better interpretability of the components and their attributes, the possible relations of the components, and the operation of the whole system as well. The case study in the paper assigns the general framework to image processing algorithms, fusion strategies, and voting models. Finally, the paper presents how the implementation of the visualization framework is possible using the state-of-the-art 3D collaboration framework VirCA. The proposed methodology is suitable for both visualization and visual construction of ensembles.

### 4) Comparison of event-related changes in oscillatory activity during different cognitive imaginary movements within same lower-limb

The lower-limb representation area in the human sensorimotor cortex has all joints very closely located to each other. This makes the discrimination of cognitive states during different motor imagery tasks within the same limb, very challenging; particularly when using electroencephalography (EEG) signals, as they share close spatial representations. Following that more research is needed in this area, as successfully discriminating different imaginary movements within the same limb, in form of a single cognitive entity, could potentially increase the dimensionality of control signals in a brain- computer interface (BCI) system. This report presents research outcomes in the discrimination of left foot-knee vs. right foot-knee movement imagery signals extracted from EEG. Each cognitive state task outcome was evaluated by the analysis of event- related desynchronization (ERD) and event-related synchronization (ERS). Results reflecting prominent ERD/ERS, to draw the difference between each cognitive task, are presented in the form of topographical scalp plots and average time course of percentage power ERD/ERS. Possibility of any contralateral dominance during each task was also investigated. The authors of the paper compared the topographical distributions

and based on the results they were able to distinguish between the activation of different cortical areas during foot and knee movement imagery tasks. Presented results could be the basis for control signals used in a cognitive infocommunication (CogInfoCom) system to restore locomotion function in a wearable lower-limb rehabilitation system, which can assist patients with spinal cord injury (SCI).

##### 5) An Audio-based Sequential Punctuation Model for ASR and its Effect on Human Readability

Inserting punctuation marks into the word chain hypothesis produced by automatic speech recognition (ASR) has long been a neglected task. In several application domains of ASR, real-time punctuation is however vital to improve human readability. The paper proposes and evaluates a prosody inspired approach and a phrase sequence model implemented as a recurrent neural network to predict the punctuation marks from the audio. In a very basic and lightweight modeling framework, authors show that punctuation is possible by state-of-the-art performance, solely based on the audio signal for speech close to read quality. The approach tested on more spontaneous speaking styles and on ASR transcripts which may contain word errors. A subjective evaluation is also carried out to quantify the benefits of the punctuation on human readability, and the paper also shows that when a critical punctuation accuracy is reached, humans are not able to distinguish automatic and human produced punctuation, even if the former may contain punctuation errors.

##### 6) Effect of affective priming on prosocial orientation through mobile application: Differences between digital immigrants and natives

Digital revolution has drastically changed people's lives in the last three decades inspiring scholars to deepen the role of technologies in thinking and information processing. Prensky has developed the notion of digital generation, differentiating between natives and immigrants. Digital natives are characterised by their highly automatic and quick response in hyper-textual environment. Digital immigrants are characterised by their main focus on textual elements and a greater proneness to reflection. The main goal of the present research is to investigate the effect of affective priming on prosocial orientation in natives and immigrants by using a mobile application. A quasi- experimental study has been conducted to test whether and how the manipulation of the priming, through positively and negatively connoted images, influences prosocial orientation. The results attested that negative affective priming elicited by app influences negatively prosocial orientation, while positive affective priming influences it positively prosocial orientation. However this effect is true mainly for digital natives. Overall, findings underline the relevance of taking into account the effects of affective priming in technological environment, especially in the case of digital natives.

### 7) Recognition Technique of Confidential Words Using Neural Networks in Cognitive Infocommunications

A well-recognized technology that ensures privacy is encryption; however, it is not easy to hide personal information completely. One technique to protect privacy is to find confidential words in a file or a website and change them into meaningless words. This paper uses a judicial precedent dataset from Japan to discuss a recognition technique for confidential words using neural networks. The disclosure of judicial precedents is essential, but only some selected precedents are available for public viewing in Japan. One reason for this is the concern for privacy. Japanese values do not allow the disclosure of the individual's name and address present in the judicial precedents dataset. However, confidential words, such as personal names, corporate names, and place names, in the judicial precedents dataset are converted into other words. This conversion is done manually because the meanings and contexts of sentences need to be considered, which cannot be done automatically. Also, it is not easy to construct a comprehensive dictionary for detecting confidential words. Therefore, we need to realize an automatic technology that would not depend on a dictionary of proper nouns to ensure that the confidentiality requirements of the judicial precedents are not compromised. In this paper, the authors propose two models that predict confidential words by using neural networks. They use long short-term memory (LSTM) and continuous bag-of words (CBOW) as our language models. Firstly, the possibility of detecting the words surrounding an confidential word by using CBOW is discussed. Then, the authors propose two models to predict the confidential words from the neighboring words by applying LSTM. The first model imitates the anonymization work by a human being, and the second model is based on CBOW. The results show that the first model is more effective for predicting confidential words than the simple LSTM model. It is expected that the second model to have paraphrasing ability to increase the possibility of finding other paraphraseable words; however, the score was not good. These results show that it is possible to predict confidential words; however, it is still challenging to predict paraphraseable words.

### 8) Eye-tracking Based Wizard-of-Oz Usability Evaluation of an Emotional Display Agent Integrated to a Virtual Environment

This paper presents the results of the usability testing of an experimental component of the Virtual Collaboration Arena (VirCA) software. This component is a semi-intelligent agent called the Emotional Display object. The authors applied Wizard-of-Oz type high-fidelity early prototype evaluation technique to test the concept. The research focused on basic usability problems, and, in general, the perceptibility of the object as uncovered by eye-tracking and interview data; authors analyzed and interpreted the results in correlation with the individual differences identified by a demographic questionnaire and psychological tests: the Myers-Briggs Type Indicator (MBTI), the Spatial-Visual Ability Paper Folding

Test, and the Reading the Mind in the Eyes Test (RMET) – however, the main goal of this paper outreaches beyond the particular issues found and the development of an agent: it shows a case study on how complex concepts in Virtual Reality (VR) can be tested in very early stage of development.

#### 9) Revolutionizing healthcare with IoT and cognitive, cloud-based telemedicine

Telemedicine instruments and e-Health mobile wearable devices are designed to enhance patients' quality of life. The adequate man-and-machine cognitive ecosystem is the missing link for that in healthcare. This research program is dedicated to deliver the suitable solution. This research's goal is the establishment of adaptive informatics framework for telemedicine. This is achieved through the deployed open telemedicine interoperability hub-system. The presented inter-cognitive sensor-sharing system solution augments the healthcare ecosystem through extended interconnection among the telemedicine, IoT e-Health and hospital information system domains. The general purpose of this experiment is building an augmented, adaptive, cognitive and also universal healthcare information technology ecosphere. This study structures the actual questions and answers regarding the missing links and gaps between the emerging Sensor Hub technology and the traditional hospital information systems. The Internet-of-Things space penetrated the personal and industrial environments. The e-Health smart devices are neither widely accepted nor deployed in the ordinary healthcare service. This paper reviews the major technological burdens and proposes necessary actions for enhancing the healthcare service level with Sensor Hub and Internet-of-Things technologies. Hereby authors report the studies on varying simplex, duplex, full-duplex, data package- and file-based information technology modalities establishing stable system interconnection among clinical instruments, healthcare systems and eHealth smart devices in trilateral cooperation comprising the University of Debrecen Department of Information Technology, Semmelweis University Second Paediatric Clinic and T-Systems Healthcare Competence Center Central and Eastern Europe.

#### 10) Morphology-based vs Unsupervised Word Clustering for Training Language Models for Serbian

When training language models (especially for highly inflective languages), some applications require word clustering in order to mitigate the problem of insufficient training data or storage space. The goal of word clustering is to group words that can be well represented by a single class in the sense of probabilities of appearances in different contexts. This paper presents comparative results obtained by using different approaches to word clustering when training class Ngram models for Serbian, as well as models based on recurrent neural networks. One approach is unsupervised word clustering based on optimized Brown's algorithm, which relies on bigram statistics. The other approach is based on morphology, and it requires expert knowledge and language resources. Four

different types of textual corpora were used in experiments, describing different functional styles. The language models were evaluated by both perplexity and word error rate. The results show notable advantage of introducing expert knowledge into word clustering process.

#### 11) LIRKIS CAVE: Architecture, Performance and Applications

LIRKIS CAVE is a contemporary Cave Automatic Virtual Environment, developed and built at the home institution of the authors. Its walls, ceiling and floor are covered by stereoscopic LCD panels, user movement is tracked by OptiTrack cameras and scene rendering is carried out by a cluster of seven computers. The most unique feature is a portable design, allowing to disassembly the whole CAVE and to transport it to another location. The paper describes the hardware and software of the CAVE and presents results of several performance evaluation experiments. It also deals with current and future applications of the CAVE, which fall into the area of cognitive infocommunications and are primarily aimed at impaired people.

#### 12) Desktop VR as a Virtual Workspace: a Cognitive Aspect

This paper explores the benefits of using a desktop VR as a virtual workspace. Forty-nine participants data included in this study. With a between-subjects design, we compared the use of extra information between a desktop VR (23 people) and a web browser (26 people). Their tasks were to solve numerical tasks and write the results in a separate spreadsheet. They could follow their performance (solved task / all tasks) on a graph. Then they filled out a questionnaire where they had to estimate their performance, and indicate the source of this estimation (the only valid source was the provided graph). In the subsample of those who used the graph, those who worked in VR estimated significantly more accurately their performance than those who solved the task in a web browser. Therefore the 3D desktop VR workspace can provide benefits to its users by displaying extra information permanently.

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Guest Editor