Towards Socially and Emotionally Believable ICT Interfaces

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Abstract In order to realize an artificial intelligence focused on human needs, it is necessary to identify the interactional characteristics that describe human mood, social behavior, beliefs, and experiences. The cross-modal analysis of communicative macro-signals represents the first step in this direction. The second step requires the definition of adequate mathematical representations of these signals to validate them perceptively (on the human side) and computationally.

1 Introduction

The human beings have always aimed to conceive tools that would allow exceeding their limits and improving their skills. In the past, the exploitation of these tools required long training acquired skills favoring the establishment of dedicated expertise. This trend changed radically few decades ago in computer science when automatic systems have been proposed which are more and more capable of operating autonomously and intelligently. Behind this radical change there is the need to exploit automatic systems in everyday living environments to simplify communications,

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exchanges, and services, facilitate social inclusion and improve the quality of life and wellbeing of all citizens, and particularly vulnerable people.

There is a huge demand to develop complex autonomous systems capable of assisting people with different needs, ranging from different physical illnesses (such as limited motor skills) to psychological and communicative disorders. Key services required to these systems include: (a) the automatic monitoring of daily functional activities; (b) the abilities to detect subtle changes in individuals' functional, phys-ical, social and psychological activities; (c) the identification of appropriate actions enabling individuals, particularly vulnerable ones such as seniors, to appropriately operate in society, and (d) the offering of therapeutic interventions and rehabilitation tools.

Currently one category of the world population particularly in needs is seniors. The world population is aging rapidly (https://www.un.org/en/sections/issues-depth/ ageing/) and the World Health Organization consider the consequences of this process very difficult to handle, since there is a great inhomogeneity among individuals with regard to their physical and cognitive functionality while aging. The consequences of this process are far-reaching, since aging leads to physical and cognitive declines, mental disorders with varying degrees of severity, such as such as Parkinson's disease and dementia, and anxiety and depression. The increasing number of seniors who need support to carry out their daily activities will lead to a future lack of professional and/or informal caregivers to meet their needs and a limited access to therapeutic interventions.

As a result of this situation, national health institutions will be exposed to consider-able burdens in terms of health care costs, and care associated with the medical cures. One solution is to develop complex autonomous systems, in the form of socially and emotionally believable ICT interfaces capable of detecting the onset of such disorders, providing, where possible, initial on-demand support to patients, offering doctors' sustenance for diagnoses and treatments, suggesting strategies for favoring social inclusion and wellbeing.

In addition, such socially and emotionally believable ICT interfaces can be embedded in several promising applications such as:

- Platforms for measuring creative learning, mobile learning, experiential learning, social learning and collaborative learning (multi-dimensional learning)
- Integrated technological platforms for early interventions and managements of cognitive and physical diseases
- Responsive and symbiotic personal assistants
- Real-time cognitive brain-like computing systems simulating perception, atten-tion, inner speech, imagination and emotions.

The efforts made so far have not been satisfactory due to a lack of atten-tion to users' needs and expectations and the difficulty of understanding how to model interactions taking into account contextual and environmental (including people and objects) effects on individuals' actions/reactions, social perception, and practices of attributing meanings/sensations in long-term relationships. To under-stood human needs in context more investigations are needed, aimed at analyzing

human-machine interaction in the domestic and social spheres in order to develop complex autonomous systems capable of establishing with their users trustworthy relationships, and taking appropriate actions to arouse empathic feelings and esteem.

In addition, there are no standard procedures for the structured development of complex autonomous systems "meeting" users' expectations and demands. Although cognitive psychology and neuroscience have offered suggestions to model these behaviors [1–6] and potential solutions have been proposed [7] to avoid triggering repulsive reactions by users towards such systems (the "uncanny valley" effect, Moore [8] the research is still at a seminal state.

To implement friendly and socially believable human-machine interactions would require accounting of research aspects such as:

- How communication practices are transformed in different contexts;
- Which are the user's cognitive and emotional consequences when interacting with machines;
- How endorse machines of an effective ability to process behavioral and contextual information.

As a consequence it would be necessary to:

- Explore new data to gather models of behaviours in a multimodal communication environment;
- Elaborate new mathematical models accounting of contextual, social, cognitive and emotional effects.

2 Content

The themes of this book tackled aspects of dynamics of signal exchanges either processed by natural or artificial systems attempting to contribute to the above research in four fields organized in sections. Each section contains contributes aiming to progresses AI and neural nets toward socially and emotionally believable human-machine interactions. These contributes were initially discussed at the 29th edition of the International Workshop on Neural Networks (WIRN 2019) held in Vietri sul Mare, Italy, from the 12th to the 14th of June 2019. Particularly:

Section I contain this introductory paper [9], this volume.
Section II contains contributes devoted to applications of neural networks in seismic signal classification, sentiment analysis, image classification, behavioral traits, stress, and emotions from music, images and handwriting. It includes 20 original contributes.
Section III includes 5 papers dedicated to exploit neural networks and pattern recognition techniques in medicine.

Section IV contains 6 papers reporting on computational and methodological intelligent approaches in economics and finance, such as bio-inspired optimizers to solve complex financial optimization problems and machine learning techniques to model the behavior of economic agents.
Section V contains 6 original papers on recent research advances in multimodal signal processing that process and combine information from a variety of modalities (e.g., speech, language, text) in order to enhance the performance of human-computer interaction devices.
Section VI discusses themes on dynamics of signal exchanges and empathic systems and related applications of ICT interfaces able to detect health and affec-tive states of their users, and interpret their psychological and behavioral patterns. The section includes 13 chapters.

3 Conclusions

A change is needed to approach the implementation of socially and emotionally believable cognitive systems (no matter if they are or not physical embodied) that must reflect on:

A deep investigations on the relevant consequences that occur at the cognitive and emotional level of the final user;
An efficient *modeling of users' communicative signals, competencies, beliefs and environmental information* in order to provide relevant feedbacks and services.

In these contexts artificial intelligence is the theoretical structure from which to derive algorithms for information processing able to produce new representations of such problems and generalized solutions for nonstationary and non-linear input-output relations. Limitations due to the fact that algorithms of this type may not converge towards adequate solutions and produce meaningless results are surpassed by biologically inspired machine learning models. These new AI ICT Interfaces will deliver innovative sets of cognitive/physical care services, personalized and cooperative interactions to boost social inclusion and engage user intimate companionship, preserving privacy and offering safety and security by-design.

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