Editorial

Special issue on senti-mental health: Future generation sentiment analysis systems

0. Preface

The integration of several disciplines and their deployment into the living environment are the ingredients for the design and development of future generation solutions. In this special issue, we intended to strengthen the link between the sentiment analysis field [1–4] and the mental health research area. Within the Digital Health domain, several works demonstrated how the real-time monitoring of mood conditions led to an improvement of the overall patients and citizens quality of life. As an example, we wanted to mention the impact that emotion monitoring has on the improvement of daily healthy behavior (e.g., diet and physical activity) or how it worked as a driver for reducing the exacerbation of undesired events for patients suffering from some chronic conditions.

One-on-one interviews have always constituted a common technique to derive meaningful insights to draw comprehensive analysis. This occurs in several domains. For example, in the business scenario, customer discovery is targeted by means of one-on-one interviews to obtain insights about product features, pricing, and launching strategies. Also, within the health domain, clinical interview transcripts have been used to distinguish different patient behavior types and mental statuses in order to design effective interventions for many conditions and disorders. Or again, a client-centered counseling style for eliciting behavior change by helping clients to explore and resolve ambivalence. Therapists attempt to influence clients to consider making changes, rather than engaging in non-directive therapeutic exploration. Interviews help in providing qualitative analyses although they are subjective and are affected by the unconscious biases of the authors or the researchers. This may increase the burden of researchers especially when transcripts show a general trend derived from linear models. Approaches and techniques to identify the objectivity to the interpretation of personal interviews to derive significant insights are therefore needed. To note that an expanding collection of video clips have been released to aid in a deeper understanding of motivational interviewing, diversity and concepts of change. Starting from these, multi-modal future generation sentiment analysis systems should be devised to give the therapists all the possible information and emotional sphere of the patient and thus provide better counseling.

The special issue is sponsored by the PhilHumans and ValueCare projects. PhilHumans, https://www.philhumans.eu, is a Marie Curie European Industrial Doctorate. Its aim is to train a next generation of young researchers in innovative Artificial Intelligence (AI) and establish users' interaction with their personal health devices in an advanced and intuitive way by exploring cutting-edge research topics related to AI-supported human–machine interfaces for personal health services. ValueCare, https://cordis.europa.eu/project/id/875215, aims to deliver efficient outcome-based integrated (health and social) care to older people facing cognitive impairment, frailty and multiple chronic health conditions in order to improve their quality of life (and of their families) as well as the sustainability of the health and social care systems in Europe.

Emotions and motivational interviews

Understanding the perspective of the user is crucial for the success of many therapeutic techniques, such as motivational interviewing [5]. While a therapist usually needs to speak in a calm manner, a user (or client) can show much stronger emotions, and the acknowledgment of such emotions can be effective in making the client feel understood [6] and therefore showing empathy. The same principle is also practiced in a wide-range of peer support settings, such as certain communities in Reddit.[1]

As a result, researchers have investigated how to leverage emotion/sentiment analysis to aid a human/bot therapist or peer supporter, especially in terms of empathy. [7,8] contrasted high- and low-empathy/emotion Reddit conversations to explore cues for therapist empathy in general dialogues, [9] probed the correlation between different emotions/sentiments and empathy seeking/providing behaviors in conversations between cancer survivors. In a similar vein, the connection between emotions and empathetic condolence in online communities was analyzed by [10]. Recent research has also explored emotion acknowledgment as an explicit strategy for empathetic response generation for emotional support (including mental health support), e.g. "That is really **upsetting** and **stressful**", known as *interpretation* in the work of [11] and "reflection of feelings" in that of [12].

Mental health

Artificial intelligence needs better emotion recognition ability to achieve better human–computer interaction services [13]. Also, human beings express their emotions in various forms, including actions, language, physiological signals, and facial expressions.

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[1] https://www.reddit.com/

These emotions usually reflect their psychological state, especially physiological signals and facial expressions. People's physiological state will directly affect the psychological state, and the psychological state will react to the physiological state. Changes in physiological signals will reflect changes in physiological state, thus indirectly reflecting the psychological state [14]. Facial expression can directly reflect people's emotions, and the changes of emotions also reflect the state of mental health.

Artificial intelligence has a fast computing speed, and it can extract relevant feature rules from face images more effectively and then judge whether people's emotions are in a healthy state. In [15] the authors proposed a feature-based emotion recognition model based on an electroencephalogram, which combined the mutual information-based feature selection method with kernel classifier to improve the accuracy of emotion classification tasks. The experimental results verified the effectiveness of the proposed method. Instead, in [16] the authors proposed to replace the Deep Neural Network (DNN) and Support Vector Machine (SVM) with the Extreme Learning Machine (ELM) in audio and visual emotion recognition. The results showed that the method could achieve better accuracy in emotion classification in audios and videos. Then, in [17] it has been proposed a new pose invariant dynamic descriptor to encode the relative motion information of facial landmarks. The results showed that the method could deal with speed changes and continuous head pose changes to realize fast emotion recognition.

Social media mining

Health 2.0 is a term coined in mid-2000s and represents the use of social media, user-generated content, and cloud-based services in healthcare [18]. It is meant to stress the implications of Web 2.0, a term popularized by Tim O'Reilly to denote the participatory role that users have nowadays on the Web [19], in the specific domain of healthcare. Health 2.0 influences both patient and healthcare provider services so it is important to study its effects in detail. For example, patients can select hospital, clinic, doctor, and, sometimes even medication based on the opinion of other patients, and, care givers can adapt treatments and their associated processes by accounting also for patients opinion in order to deliver better services [20,21].

One application of Health 2.0 is the use of sentiment mining [22] for making sense of the patients opinions spread over the social Web. Sentiment mining can be approached as a polarity classification task, where the sentiment (positive, neutral, or negative) with respect to a healthcare entity (e.g., hospital, doctor, treatment) is determined. Recently a lot of attention was given to a more refined task, i.e., aspect-based sentiment analysis [23], where in the context of the health domain would mean computing the sentiment with respect to the various aspects of the health-related entity of interest (e.g., waiting time, quality of treatment, and communication for a doctor) [24]. Hybrid solutions that combine healthcare sentiment ontologies with deep learning solutions (e.g., where ontology concepts provide extra features, next to word embeddings produced by XLNet, for a Bi-LSTM classifier) have shown superior results to previous state-of-the-art deep learning solutions [25].

Natural language understanding and emotions

In the last decade, the NLP community has shown a great interest into Sentiment Analysis, as being a key element for various applications, from recommender systems to dialogue systems. However, moving from sentiment as polarity towards the more complex field of emotions has been not as easy as one could imagine at the beginning of that journey. Some resources such as SenticNet [26], corpora for emotion analysis [27] and lexicons of word affect intensities [28] have been produced, but the application of sentic and affect computing in Natural Language Understanding has been until now quite limited compared to "sentiment analysis as polarity prediction". Apart from the obvious reason that detecting polarity is a simpler task than classifying into different emotions, there is also the fact that not many applications can take advantage from this fine-grained analysis. But mental health issues represent a domain in which emotions are very important and "classic" emotion analysis may show some limits.

1. Aims

In this special issue we promoted the submission of contributions integrating the Sentiment Analysis and Mental Health domains for empowering patients and domain experts in performing effective and efficient real-time monitoring of patients' conditions.

The proposed special issue fosters interdisciplinary research for communities working on Artificial Intelligence, Semantic Web, Natural Language Processing, Image and Signal Processing, Big Data, Sensor Networks, Psychiatry and more joining their forces in order to develop Future Generation Sentiment Analysis Systems. We are sure that new interdisciplinary research will lead to breakthrough discoveries within several domains bringing improvements for a wide range of actors.

We expected this special issue to give us some insights about the current limits of existing technologies, resources and methods, especially with regard to sentiment and emotion analysis, in the specific domain of Mental Health. In this way, we could try to understand if they are sufficient, in their current state, to address the challenges posed by this domain, and how they can be improved.

2. Contents

The special issue on Senti-Mental Health attracted 12 submissions covering Machine Learning, Sentiment Analysis and Emotion Detection, Cognitive Computing, and Conversational Agents technologies. Each paper was reviewed by at least three reviewers. The papers that have been accepted in this special issue cover several different domains and tasks.

The first paper, "An Emotion and Cognitive Based Analysis of Mental Health Disorders from Social Media Data", by Ana Sabina Uban, Berta Chulvi, Paolo Rosso, presented a study of mental disorders in social media, from different perspectives. The goal was to understand whether monitoring language in social media could help with early detection of mental disorders, using computational methods. Authors have developed deep learning models to learn linguistic markers of disorders, at different levels of the language (content, style, emotions), and further try to interpret the behavior of the developed models for a deeper understanding of mental disorder signs. The prediction models have been completed with computational analyses grounded in theories from psychology related to cognitive styles and emotions, in order to understand to what extent it is possible to connect cognitive styles with the communication of emotions over time. The final goal was to distinguish between users diagnosed with a mental disorder and healthy users, in order to assist clinicians in diagnosing patients.

The second paper, "Assessing Vulnerability to Psychological Distress during the COVID-19 Pandemic through the Analysis of Microblogging Content", by Marco Viviani, Cristina Crocamo, Matteo Mazzola, Francesco Bartoli, Giuseppe Carra, Gabriella Pasi aimed at evaluating the possible effects of some critical factors

related to the pandemic on the mental well-being of the population. In particular, the authors first considered a collection of social textual contents related to COVID-19 gathered on the Twitter microblogging platform in the period between August and December 2020. They aimed at investigating potential lexicon identifiers of vulnerability to psychological distress in digital social interactions with respect to distinct COVID-related scenarios, which could be "at risk" from a psychological discomfort point of view. Such scenarios have been associated with peculiar topics discussed on Twitter.

The third paper, "Predicting User Emotional Tone in Mental Disorder Online Communities", by Barbara Silveira, Henrique Soares Silva, Fabricio Murai, Ana Paula Couto da Silva, analyzes how discussions in Reddit communities related to mental disorders can help improve the health conditions of their users. Using emotional tone of users' publications (posts and comments) as a proxy for emotional state, the authors uncover relationships between state changes and user interactions. First, they observe that authors of negative posts often write rosier comments after engaging in discussions, indicating that users' emotional state can improve due to social support. Second, they build models based on SOTA text embedding techniques and RNNs to predict shifts in emotional tone. The authors show that it is possible to accurately predict the users' reactions to the interactions experienced in these platforms, and present some examples which illustrate that the models are correctly capturing the effects of comments on the thread author's emotional tone.

The fourth paper, "Empathic Conversational Agents for Real-time Monitoring and Co-Facilitation of Patient-Centered Healthcare", by Achini Adikari, Daswin De Silva, Damminda Alahakoon, Jiahui Wong, Mathew Gancarz, Suja Chackochan, Bomi Park, Rachel Heo, Yvonne Leung, proposes an empathic conversational agent framework based on an ensemble of natural language processing techniques and artificial intelligence algorithms for real-time monitoring and co-facilitation of patient-centered healthcare for improved mental health and wellbeing outcomes. The technical contributions of this framework are: detection of patient emotions, prediction of patient emotion transitions, detection of group emotions, formulation of patient behavioral metrics, and resource recommendations based on patient concerns. The architectural contributions of the framework are intelligent communication channels that stream empathic conversational elements and resource recommendations for the multi-user conversations and co-facilitation updates for the human healthcare provider interface.

The fifth paper, "Real-time Epileptic Seizure Recognition using Bayesian Genetic Whale Optimizer and Adaptive Machine Learning", by Ahmed Anter, Mohamed Abd Elaziz, and Zhiguo Zhang, presents a new model to recognize seizure states (e.g., ictal, pre-ictal, interictal) from electroencephalogram in the IoT framework to monitor patients remotely. It uses an efficient hybrid genetic whale optimization algorithm based on naive Bayes for feature selection, and an adaptive extreme learning machine based on a differential evolutionary algorithm for classification. The former has the goal of enhancing the exploitation of the whale optimization algorithm in the search of the optimal solutions. The latter is used to determine a fitness function to assess every agent in the search space. The results showed that the proposed approach avoids over and under fitting and provides competitive performance in classifying seizure states from electroencephalogram.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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