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Special issue "Deep Learning for Natural Language Processing: Emerging methods and applications"

In the last decade, the use of Deep Learning has allowed to reach considerable improvements on many important tasks in the field of Natural Language Processing (NLP), such as machine translation [1], reading comprehension [2,3], information retrieval [4] and sentiment analysis [5,6], and on building systems for question answering [7–9], conversational systems [10,11], and recommender systems [12].

Nonetheless, despite the number of successes of Deep Learning for solving different NLP tasks, researchers show increasing interest in this field of research [13–15], due to the difficulties still not optimally solved, associated with intrinsic characteristics of natural language understanding and generation, which are still performed by computer systems not as well as humans, and with the complexity of deep learning models, grown toward directions chosen empirically [16–19] and difficult to be scaled down to be implemented on the edge, the scarcity of datasets for some languages [20], and the lack of explainability of the models [21].

This special issue provides an overview of the research being carried out in the area of Natural Language Processing focusing on emerging Deep Learning methods and approaches for single and multiple language learning, understanding, generation and grounding, text processing and mining, question answering and information retrieval, as well as applications of them to different domains and also on resource-limited devices, granting explainability.

To this aim, the special issue gathered researchers with broad expertise in various fields to discuss their cutting-edge work as well as perspectives on future directions in this exciting field. Original contributions covered the range of theoretical and practical aspects, technologies and systems in this research area.

There are 4 contributions selected for this special issue, representing progress and potential applications in the following NLP areas specifically addressed:

- **Multilingual and cross-lingual neural language models.** In Ref. [22], authors face the problem that multilingual speakers tend to mix different languages in text, also switching between morphemes from various languages in the same word. Therefore, they create the first annotated Arabic–English corpus for the intra-word Language Identification task along with a web-based application for data annotation, and they implement a model using segmental recurrent neural networks, which achieved the highest performance with respect to the baseline models.
- **Natural language understanding, generation and grounding.** Authors of [23] focus on Automatic Text Complexity Evaluation to measure the grade of comprehensibility of a text, which can support the Automatic Text Simplification to meet specific reader needs. Therefore, they propose a Deep Learning based system capable of classifying both Italian and English sentences on the basis of their complexity, by exploiting the Treetagger annotation tool, two Long Short Term Memory (LSTM) neural unit layers, and a fully connected one, to obtain the probability of a sentence belonging to the easy or complex class. The experimental results show the effectiveness of the approach for both languages, compared with several baselines machine learning methods.
- **Sentiment analysis, emotion detection and opinion mining.** In Ref. [24], authors perform for the first time Sentiment Analysis in Bangla language, using an extended lexicon data dictionary and a rule-based sentiment score algorithm for extracting polarity to use along with the preprocessed text as training samples for different deep learning models including some they proposed, i.e., hierarchical attention based LSTM, dynamic routing based capsule neural network with Bi-LSTM, and BERT-LSTM. Authors test their performances, indicating that the proposed models are highly accurate in performing Sentiment Analysis tasks.
- **Applications in science, engineering, medicine, health-care, finance, business, law, education, industry, transportation, retailing, telecommunication and multimedia.** Authors of [25] focus on education, and in particular on automatic scoring of short answers, and they introduce the first deep learning-based system for Arabic short answer scoring, to provide a reliable system that can help teachers in the Arab world to elevate the quality of learning in the region. They empirically study different techniques and propose the best performing system, showing improvements of Arabic NLP tools.

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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Massimo Esposito
National Research Council of Italy - Institute for High Performance Computing and Networking (ICAR), Via Pietro Castellino 111, 80131, Naples, Italy

Hamido Fujita
Iwate Prefectural University, Japan

Aniello Minutolo
National Research Council of Italy - Institute for High Performance Computing and Networking (ICAR), Via Pietro Castellino 111, 80131, Naples, Italy

Marco Pota*
National Research Council of Italy - Institute for High Performance Computing and Networking (ICAR), Via Pietro Castellino 111, 80131, Naples, Italy

* Corresponding author.
E-mail address: marco.pota@icar.cnr.it (M. Pota).