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ABSTRACT

This special issue editorial begins with a brief discussion on the current trends of innovations in healthcare and medicine driven by the evolution of sensing devices as well as the information processing techniques, and the social media revolution. This discussion aims to set the stage for the actual papers accepted for the special issue which are extensions of the papers presented at the InMed 2014 conference held in San Sebastian, Spain, in July 2014.

1. Introduction

Computer science, information communication, and information processing are major driving forces for innovation in Healthcare and Medicine. A data processing pipeline starts with the data capture methods, ranging from auto-mated/autonomous biochemical and physiological sensing devices up to manual filling of medical records. Across all the healthcare systems, data storage and data communication infrastructure are critical for the appropriate exploitation of the data, which besides its use by the healthcare provider can be even shared through social systems[1]. Moreover, intelligent data processing helps to improve diagnosis, prognosis, and alarm detection.

1.1. Data collection

There is a continuous improvement in sensing devices that produce information of medical value. New sensors are efficient, highly accurate, and with low power consumption, weight, that can be integrated into wearable systems for applications such as continuous activity monitoring [15]. The limits of sensing devices are reaching science fiction boundaries, for instance, graphene applications include the high resolution monitoring of neuronal activity by in-trusive implants over the brain cortex Park et al. [17]. Additionally, Electronic Health Records (EHR) in their diverse standards and implementations have become a huge source of information with promises of improved care quality, research and prevention facilitation [10] and very challenging problems regarding confidentiality, interoperability, search, and big data exploitation from many sides of the healthcare industry.

1.2. Data processing infrastructure

The explosive growth of the amount of information in conjunction to the desire of anytime/anywhere access to the data for personalized medicine poses a broad spectrum of issues in the data processing infrastructure. The integration of several systems made possible the electronic medical prescription that allows fine accounting of resources, but which is not free of errors [7]. Innovative NonSQL database management systems posses several properties that make them suitable for the large data generated by realtime monitoring sensors [13]: flexibility, easy scalability, and intrinsic distributed nature. Besides, data processing has growing security requirements. For instance, the digital nature of medical images allows tampering that can be prevented by stenographic watermarking techniques [2], however this image manipulation risks its diagnostic value if it is not done appropriately [9]. Also, confidentiality requires secure storage and transmission to avoid leaking information, and its anonymization for research purposes [18], which are a definitive necessity when the health care provider relies on cloud services [20]. Big data processing infrastructure [5] is becoming a common tool for many statistical and summarization studies, such as the visualization of cancer comorbidities [11].

1.3. Intelligent data processing

The growing trend towards the automatization of the medical data analysis relies in the increasing availability of data and the maturity of the fields of machine learning and computational intelligence. They are already being used for extracting evidences from electronic health records (EHR) such as in learning the time changing efficiency of cancer treatments [8], but intelligent algorithms can be also used for assisting diagnosis, such as the

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

http://dx.doi.org/10.1016/j.compbiomed.2016.03.003
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automatic infection detection from urinoculture Petri dish image analysis [4]. The increasing role of computational intelligence has been, for instance, recognized in the need of a sandbox for Genomics clinical decision support [6]. Intelligent search in EHR databases uses natural language processing techniques, such as document similarity [3] in order to exploit information towards preventive and personalized medicine.

1.4. Discussion

The above introduction is a collection of glimpses over a fast grow- ing research literature that spans over several disciplines having impact on health care and medicine innovations, where computer science, data processing, com- putational intelligence have a growing role. This advancing field frontier is the framework where the contributed papers are set.

2. The papers in the special issue

The special issue starting paper by Olivares et al. [16] deals with innovative cheap and accurate inertial sensing devices that are used for body motion and posture analysis, with applications to behavior corrective therapies and rehabilitation. A critical issue is the appropriate noise removal and trajectory pre- diction for accurate motion estimation and analysis, which is often carried out by Kalman filter approaches. However, body motion frequencies cover a broad spectrum, which challenges Kalman filter parameter tuning approaches. The paper deals with innovative gating procedures adapting the filter parameters to the motion intensity and speed. Adaptation is based on the analysis of the frequency content of motion trajectory using specific filters, which may allow in the future for real time processing for the on line computation of rehabilitation strategies.

In the context of the ever growing collections of medical image datasets, the need for automated tools that ease the search and the inspection of the datasets are increasingly needed. The paper by Lumini et al. [14] proposes enhanced features for medical image classification by augmenting the original image into stacks of processed images, carrying spatial scale smoothing, gradient image computation, 2D discrete wavelet transformation for grey-scale images, or color image space transformations, and color image enhancement for color images, to obtain the desired multilayer representation. The stack images are input to 3D texture feature extraction processes to produce the image features which are classified by conventional support vector machines (SVM) with very good results on tests over a broad collection of datasets. For some descriptors, the resulting coefficients are very high dimensional so that some dimension reduction is applied, such as Principal Component Analysis (PCA). The broad variety of image datasets tested, as well as the comparison with other methods reported in the literature, assess the power of this representation for practical applications.

The paper by Jurado et al. [12] deals with pharmacy stock management in the framework of classical control, applying the model predictive control (MPC) strategy. Pharmacy stock management is a very heavily constrained and stochastic problem, which is further complicated when trying to carry simultaneously the management of more than one hospital. Maintaining the stock is costly and has space limitations because of the need to keep medicines refrigerated. Besides, cost of understock is very high, and the demand is strongly random. Therefore, stock management has to reach a balance between the risk of understock and the cost of maintenance under a randomly fluctuating demand. Joint policy by several hospitals may help to alleviate understock costs at the extra-cost of stock coordination and trust between hospitals. The paper follows a chance constrained approach to MPC (CC-MPC) posing the constraint satisfaction as a probabilistic process, which reduces computational cost and improves convergence to a solution. The hard constraints are trans-formed into probabilistic constraints and the expected value of the cost function is considered for minimization.

There is an increasing ability to produce big picture healthcare analysis using global information from the healthcare services. The paper by Yabuuchi et al. [19] deals with the analysis by fuzzy regression relating the eating habits and the health status of the Japanese population. Changing habits are leading to a health degeneration mostly influenced by the introduction western eating products and lifestyle habits. However, quantitative assessment of the situation is far from easy, due to the lack of well designed studies and the difficulties of available data analysis. The authors use data published by the ministry of health of Japan to assess the effect of different kinds of food consumption and lifestyle parameters on medical care expenditure. Authors have proposed a robust fuzzy regression approach that improves over conventional fuzzy regression and statistical regression, in the sense of decreasing uncertainty in the effects extracted from the data.

Electronic Health Records (EHR) have a considerable wealth of information for exploitation, much of it stored in natural language fields filled by the medical practitioners while attending the patients. There are a lot of research going on the exploitation of this information in english language by natural language processing algorithms, however little is being done in other languages. The paper by Alicante et al. [1] carries an unsupervised study of EHR natural language fields in Italian language. The unsupervised approach is forced by the lack of annotated corpus in Italian. They follow a two step approach, first carrying an entity discovery process, secondly performing clustering in the space of entity pair relations. The authors use as much a priori information as possible, like the Unified Medical Language System (UMLS), and the Pharmaceutical Reference Book (PRB) of the italian governmental agency. Also barrier features are used to guide the feature selection process for relevant entity pairs. Results on a big dataset of EHR achieve semantically meaningful results.

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