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EDITORIAL

Guest Editorial: Special issue on "Artificial Intelligence in Health Informatics"

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Introduction

Globally, Artificial intelligence (AI) has been playing a robust and the fastest growing role in Health Informatics (HI) the last few decades. AI enables computers and machines to mimic the perception, learning, problem-solving, and decision-making capabilities of the human mind. Generally, AI refers to the simulation of human intelligence processes by machines, especially computer systems that are programmed to think like humans and mimic their actions. Modern health treatments are faced with the challenge of acquiring, analysing and applying the large amount of knowledge necessary to solve complex problems. In HI, AI can help manage and analyze data, make decisions, and identify and forecasting the upcoming health problems. The greatest application of AI technologies is delivering huge effort in the fields of health to effectively identify diseases and advance medical diagnosis and improve the efficiency of treatments, and avoid the risks of false diagnosis, the making of therapeutic decisions and the prediction of outcome in many clinical scenarios.

The aim of this special issue (S.I.) is to catch some of the advances and the recent developments in AI when applied to HI. This S.I. provides a platform for the publication of AI based articles that address broad challenges on both theoretical and application in the HI research. In this issue, the academics and researchers are invited to contribute original research articles that will stimulate the continuing effort on the application of AI approaches to solve health problems. The proposed methods in this S.I. will be connected in the development of AI programs intended to help the clinician in the formulation of a diagnosis, the making of therapeutic decisions and the prediction of outcome to overall health and wellbeing.

This special issue received twenty-five papers (25) covering broad range of AI technologies and applications in HI research filed. Among them, 16 papers were accepted for this special issue after two rounds of peer-reviews (at least). The accepted papers represent a wide spectrum of research under the theme of the special issue ranging from hay fever detection, Chinese herbal medicine in breast cancer management, health service patterns identification for injured patients, automatic diagnosis of lung diseases to big medical data handling. In Sect. 2, we present a brief summation of the selected papers for this special issue and Sect. 3 provides concluding remarks.

Summary of accepted papers

This special issue brings together 16 papers that emphasize the role of AI in advanced health informatics. A brief description of those papers is provided below.

The paper entitled, "Modeling and classification of voluntary and imagery movements for brain–computer interface from fNIR and EEG signals through convolutional neural network" by Rahman et al. reports a new approach to prepare functional neuroimages from the functional near-infrared spectroscopy (fNIR) and electroencephalography (EEG) using eight different movement-related stimuli. The neuroimages are used to train a convolutional neural network (CNN) to formulate a predictive model for classifying the combined fNIR–EEG data. The outcomes of the proposed research work will be beneficial in the implementation of the finer BCI system.

The article by Du et al. titled "Neural attention with character embeddings for hay fever detection from twitter" presents a deep architecture enhanced with character embeddings and neural attention to

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improve the performance of hay fever-related content classification from Twitter data. The study provides the proof-of-concept of state-of-the art techniques application in the context of pollen allergy towards improved public health surveillance from social media. The proposed method achieved the improved classification accuracy compared the existing methods due to the character-level semantics introduced, which effectively addresses the out of-vocabulary problem.

Lee et al. proposed the use of fuzzy cognitive map (FCM) to represent the cognition of Traditional Chinese medicine (TCM) usage in cancer treatment. This paper performed a case study analysis and summarised the effects of Chinese herbal medicine in breast cancer management. The finding of the study revels that FCMs can visually represent the cognitive knowledge, particularly the causal relationship among key factors of TCM effects and the related breast cancer status.

In the paper, entitled "Imputation techniques on missing values in breast cancer treatment and fertility data" Wu et al. investigated the impact of some notable imputation techniques using machine learning methods and suggested an efficient approach to find the relationship between breast cancer treatment and chemotherapy-related amenorrhoea. Authors assessed whether the imputation across different datasets achieves significant improvements, even if the data has a large amount of missing values.

The article by Khorshidi et al. titled "Multi-objective semi-supervised clustering to identify health service patterns for injured patients" reports a pattern recognition method for identifying injured patients based on the similarity of the patterns and their association with the outcome of interest. The real intention of developing this pattern recognition method is to group patients, who are injured in transport accidents, in the early stages post-injury. This study introduced a multi-objective optimization model to group patients. The proposed multi-objective semi-supervised clustering discovered the optimal clusters that not only are well-separated from each other but can provide informative insights regarding the outcome of interest.

Esmaeili et al. proposed a concept of a Clinical Decision Support System (CDSS) in the paper, titled: "A decision support system for mammography reports interpretation" using data mining methods to help clinicians to interpret mammography reports. The input of this system is free-text mammography reports. In the proposed plan, Random Forest, Naïve Bayes, K-nearest neighbor (K-NN) and Deep Learning classifiers were used to build a model capable of predicting the need for referral to biopsy. Then, the models were evaluated using cross-validation with measuring Area Under Curve (AUC), accuracy, sensitivity, specificity indices. The proposed system could be helpful for radiologists as an aid system.

In the article titled, "Prediction of intrapartum fetal hypoxia considering feature selection algorithms and machine learning models", Cömert et al. carried out advanced signal processing techniques to achieve reliable segments and to extract features for describing the signals. In that paper, three filters and two wrappers feature selection methods and few machine learning models such as artificial neural network (ANN), k-nearest neighbor (kNN), decision tree (DT), and support vector machine (SVM), were employed to build a model for prediction of intrapartum fetal hypoxia that was evaluated on cardiotocography (CTG) data.

The paper, titled "Towards the classification of heart sounds based on convolutional deep neural network" by Demir et al. proposed a methodology for heart disease detection based on heart sounds. The proposed method consisted of three successive stages, such as spectrogram generation, deep feature extraction, and classification. In the spectrogram generation stage, the heart sounds were converted to spectrogram images by using time–frequency transformation. The deep features were extracted from three different pre-trained convolutional neural network models such as AlexNet, VGG16, and VGG19. Support vector machine classifier was used in the third stage of the proposed design for identifying heart disease. The proposed method significantly outperformed the baseline methods.

Rahman and Joadder reported a new approach for spatial filtering called 'Space-Frequency Localized Spatial Filtering (SFLSF)' to improve the performances of Motor Imagery (MI) Classification in the Brain–Computer Interface (BCI) applications. The SFLSF method initially divided the scalp-EEG channels into local overlapping spatial windows. Then a filter bank was used to divide the signals into local frequency bands. The group of channels, localized in space and frequency, were then processed with spatial filter, and features were subsequently extracted for classification task. The proposed space-frequency localized approach helps to deliver better classification result compared traditional methods.

The article by Joadder et al. titled: "A performance based feature selection technique for subject independent MI based BCI" proposed a new performance based additive feature fusion algorithm combining with machine learning techniques in order to classify the motor imagery (MI) signals into particular states. This study presented a novel computer aided feature selection method to determine the best set of features for distinguishing between motor imagery tasks. The selected features were then fed into a Linear

Discriminant Analysis, K-nearest neighbor, decision tree, or support vector machine classifier for efficiently classification of MI states. The proposed methodology improved the overall classification performance of MI identification for BCI application.

In the paper, titled: "Nutrient analysis of school lunches and anthropometric measures in a private and public school in Chennai, India", Bergman et al. investigated the impact of the School Lunch Program in India and observe measures related to nutrition adequacy and stunting in school aged children in Chennai, India. BMI for Age Z-scores for the private school and public school were significantly different. Analysis of nutritional parameters of meals suggest that students in the Private School received a less nutrient dense lunch meal compared to public school.

In the paper, titled "Constructing a knowledge-based heterogeneous information graph for medical health status classification", Pham et al. introduced a framework based on a knowledge-base heterogeneous information graph (HIG) to discover new medical knowledge for the prediction of a patient's health status. The proposed method used integrated knowledge of the medical domain and taking advantage of Pearson correlation and semantic relations in building a classification model for diagnosis. This study contributed a model to medical practice to help practitioners become more confident in making final decisions in diagnosing illness.

The paper, titled: "A study of factors related to patients' length of stay using data mining techniques in a general hospital in southern Iran" presents a data mining based method for investigating effective factors and also for predicting the length of stay (LOS) in Shahid-Mohammadi Hospital, Bandar Abbas, Iran. Authors used 526 patient records of that hospital from March 2016 to March 2017. The proposed prediction model was designed based on nine data mining classifiers applied with and without feature selection technique. Finally, the models were compared. The results demonstrated that the most important factors affecting LOS are the number of para-clinical services, counseling frequency, clinical ward, the specialty and the degree of the doctor, and the cause of hospitalization.

Demir et al. in the paper, titled: "Convolutional neural networks based efficient approach for classification of lung diseases" proposed a spectrogram image-based technique to create time–frequency transformation from the lung sounds for the automatic diagnosis of lung diseases. The aim of the study was to improve the classification performance for ICBHI 2017 database as it is quite difficult. These spectrogram images were used as input to the deep feature extraction and transfer learning. The results were compared with some of the existing results. The proposed schemes improved the classification performance of the lung sound discrimination.

In the article, titled: "An efficient approach for physical actions classification using surface EMG signals" Chada et al. focused on the Physical actions classification through surface electromyography (sEMG) signals. In this study, authors used tunable-Q factor wavelet transform (TQWT) based algorithm for decomposing EMG signals into sub-bands and then a number of features such as entropy, mean, negentropy, AAC, maximum value, first and third quartile features were selected from each of the sub bands. These features were fed into multiclass least squares support vector machine classifier using two non-linear kernel functions for classifying surface EMG signals. The proposed method can be used in practical man–machine interface system to help patients for restoring the lost motor functionality.

In the paper, titled: "A novel weighted compressive sensing using L1-magic recovery technique in medical image compression" Alaa et al. reported a new discrete cosine transform (DCT) based weighted compressed sensing (CS) method to improve the compression performance without dividing the image into blocks or using an iterative singular value decomposition (SVD). To advance the medical image recovery, a weighted L1-magic reconstruction in the CS was proposed using a threshold based on the image content, where high weight was given to the significant details in the image. In the proposed method, the L1-magic was applied to the proposed weighted image to recover the original image. The simulation results proved that weighted L1-magic achieved the best results in comparison to the weighted orthogonal matching pursuit (OMP) and the traditional principle component analysis (PCA).

Conclusions

The papers presented in this S.I. provide a glimpse of the latest research advancements in the field of HI, where AI has been evident, including data processing, analysis and decision making. All of the papers selected for this S.I. contribute to advance understanding of current research challenges, modeling and implementation of AI in health systems that will be of great benefit to clinicians, patients and researchers worldwide to solve a variety of clinical and health problems. It is expected that these papers can provide researchers with valuable resources and motivations to work on the challenging issues in this research theme and also the papers will assist technologist to build up the ideas of new AI technologies in mordern health applications.

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