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Editorial:

Special issue on machine learning in medical imaging

1. Introduction

Machine learning plays an essential role in the medical imaging field, including computer-aided diagnosis (CAD), image segmentation, image registration, image fusion, image-guided therapy, image annotation, and image database retrieval. The main aim of this special issue is to help advance the scientific research within the broad field of machine learning in medical and biological imaging. The special issue was planned in conjunction with the 7th International Workshop on Machine Learning in Medical Imaging (MLMI) 2016 (Wang et al., 2016). The majority of the papers included in this special issue were presented in a preliminary form at the 7th MLMI, held in Athens, Greece on October 17th, 2016. Together with some other new submissions, a total of 53 submitted papers underwent two to three rounds of rigorous peer reviews. Thirteen papers were finally selected for publication in this Special Issue. Each paper was carefully reviewed by 3–4 experts in the field and went through a rigorous revision process, composed of typically two rounds of revision. There were a number of other excellent papers, which regrettably could not be included in the special issue due to the space limitations.

2. Papers included in the special issue

Sanroma et al., in their paper entitled "Learning to combine complementary segmentation methods for fetal and 6-month infant brain MRI segmentation" (Sanroma et al., 2018), propose two ensembling strategies, namely, stacking and cascading, to combine the strengths of both registration-based and learning-based segmentation techniques. Segmentation results show that either combination strategy outperforms all of the individual methods, thus demonstrating the capability of learning systematic combinations that lead to an overall improvement. In particular, the cascading strategy outperforms the ensembling one, the former one obtaining top 5, 7, and 13 results (out of 21 teams) in iSeg-2017 MICCAI Challenge (Wang et al., 2019).

Abraham et al., in their paper entitled "Computer-aided classification of prostate cancer grade groups from MRI images using texture features and stacked sparse autoencoder" (Abraham and Nair, 2018), investigate a novel method to determine the grade group in prostate cancer using multi-parametric magnetic resonance imaging biomarkers. High-level features are extracted from hand-crafted texture features using autoencoders and classified them using a logistic regression classifier. Even though an imbalanced training dataset, their method achieves a fair kappa score.

Cao et al., in their paper entitled "Efficient multi-kernel multi-instance learning using weakly supervised and imbalanced data for diabetic retinopathy diagnosis" (Cao et al., 2018), formulate weakly supervised multi-class Diabetic retinopathy grading as a multi-class multi-instance problem where each image (bag) is labeled as healthy or abnormal and consists of unlabeled candidate lesion regions (instances). Experiments results demonstrate that the proposed multi-kernel multi-instance learning framework with bi-level re-sampling can solve the problem in the imbalanced and weakly supervised data for grading diabetic retinopathy, and it improves the diagnosis performance over several state-of-the-art competing methods.

Brown et al., in their paper entitled "Predictive connectome subnetwork extraction with anatomical and connectivity priors" (Brown et al., 2019), identify anatomical subnetworks of the human connectome that are optimally predictive of targeted clinical variables, developmental outcomes or disease states. By enforcing novel backbone network and connectivity based priors along with a non-negativity constraint, the discovered subnetworks are simultaneously anatomically plausible, well connected, positively weighted and reasonably sparse. Compared to other methods, their approach achieves the best accuracies for identifying patients with autism and predicting cognitive and motor neurodevelopmental outcomes of preterm neonates.

Yang et al., in their paper entitled "Multi-dimensional proprio-proximus machine learning for assessment of myocardial infarction" (Yang et al., 2018), present a novel analysis methodology that utilizes high-resolution, multi-dimensional information to classify regions of the left ventricle after myocardial infarction. Experiments show that by using multiple features from the reference segment and its neighbouring segments, good classification performance can be achieved using even a linear classifier.

Afshari et al., in their paper entitled "Automatic localization of normal active organs in 3D PET scans" (Afshari et al., 2018), propose a deep learning method to localize and detect normal active organs visible in a 3D PET scan field-of-view. Their method adapts the deep network architecture of YOLO to detect multiple organs in 2D slices and aggregates the results to produce semantically labeled 3D bounding boxes. They evaluate the method on 479 18F-FDG PET scans of 156 patients achieving an average organ detection precision of 75–98%, recall of 94–100%, average bounding box centroid localization error of less than 14 mm, wall localization error of less than 24 mm, and a mean IOU of up to 72%.

Gunasundari et al., in their paper entitled "Multiswarm heterogeneous binary PSO using win-win approach for improved feature selection in liver and kidney disease diagnosis" (Gunasundari et al., 2018), propose new Multiswarm Heterogeneous Binary Particle Swarm Optimization algorithm using a Win-Win approach to improve the performance of Binary Particle Swarm Optimiza-

tion algorithm for feature selection. The proposed algorithms are applied for feature selection of liver and kidney cancer data. Result reveals that the performance of the classifier in liver and kidney CAD systems is improved with the elite feature set.

Wang et al., in their paper entitled "Evaluation of accuracy of automatic out-of-plane respiratory gating for DCEUS-based quantification using principal component analysis" (Wang et al., 2018), develop a fully automated respiratory gating scheme by using principal component analysis to remove distortions and disturbances in free-breathing DCEUS-based quantification. The quantitative comparisons demonstrated that the severe distortion and other negative disturbances induced by the respiratory kinetics on DCEUS-based quantification were removed effectively.

Mahapatra et al., in their paper entitled "Image super-resolution using progressive generative adversarial networks for medical image analysis" (Mahapatra et al., 2019), present an image super-resolution method using progressive generative adversarial networks (P-GANs) that can take as an input a low-resolution image and generate a high resolution image of desired scaling factor. Experiments show that their proposed multi stage P-GAN outperforms competing methods and baseline GANs.

Mahbod et al., in their paper entitled "Fusing fine-tuned deep features for skin lesion classification" (Mahbod et al., 2019), describe a fully automatic computerised method to classify skin lesions from dermoscopic images. Their approach is based on a novel ensemble scheme for convolutional neural networks (CNNs) that combines intra-architecture and inter-architecture network fusion. Evaluated on the 600 test images of the ISIC 2017 skin lesion classification challenge, the proposed algorithm outperforms the top-ranked methods of the challenge while being simpler compared to them.

Hai et al., in their paper entitled "Multi-level features combined end-to-end learning for automated pathological grading of breast cancer on digital mammograms" (Hai et al., 2019), propose to discriminate the pathological grades directly on digital mammograms instead of pathological images. Low-level features from supervised LASSO logistic regression and high-level semantic features from CNN are combined to optimize the new CNN for end-to-end learning. Results demonstrate that their proposed algorithm is superior to other CNN models and obtain comparable performance compared with pathological images.

Gadermayr et al., in their paper entitled "CNN cascades for segmenting sparse objects in gigapixel whole slide images" (Gadermayr et al., 2019), propose two different CNN cascade approaches which are subsequently applied to segment the glomeruli in whole slide images of the kidney and compared with conventional fully-convolutional networks. Their work facilitates accurate automated segmentation of renal whole slide images and consequently would allow fully-automated big data analyses for the therapeutics assessment.

Brahim et al., in their paper entitled "A decision support tool for early detection of knee OsteoArthritis using X-ray imaging and machine learning: Data from the OsteoArthritis Initiative" (Brahim et al., 2019), propose a fully developed CAD system for early knee OsteoArthritis detection using knee X-ray imaging and machine learning algorithms. Their approach is validated on 1024 knee X-ray images from the public database OsteoArthritis Initiative with a good predictive classification rate.

3. Conclusion

In this editorial, we briefly introduce thirteen exciting machine learning-based papers selected for this Special Issue. We hope that these timely scholarly works could inspire further innovative ideas for translational research and advance the field of machine learning in medical imaging. In closing, we would like to thank all the authors who submitted their valuable manuscripts for consideration. Their support and enthusiasm has made this Special Issue a profound success. We would also like to express our gratitude to all the reviewers for their timely and professional comments. We would also like to thank Prof. Stephen Wong, the Editor-in-Chief of the Computerized Medical Imaging and Graphics. Without his strong support of this Special Issue, nothing would have happened.

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