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Predictive Intelligence in Medicine

5th International Workshop, PRIME 2022
Held in Conjunction with MICCAI 2022
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Proceedings

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Preface

It would constitute a stunning progress in medicine if, in a few years, we contribute to engineering a predictive intelligence able to predict missing clinical data with high precision. Given the outburst of big and complex medical data with multiple modalities (e.g., structural magnetic resonance imaging (MRI) and resting function MRI (rsfMRI)) and multiple acquisition timepoints (e.g., longitudinal data), more intelligent predictive models are needed to improve diagnosis of a wide spectrum of diseases and disorders while leveraging minimal medical data. Basically, predictive intelligence in medicine (PRIME) primarily aims to facilitate diagnosis at the earliest stage using minimal clinically non-invasive data. For instance, PRIME would constitute a breakthrough in early neurological disorder diagnosis as it would allow accurate early diagnosis using multimodal MRI data (e.g., diffusion and functional MRIs) and follow-up observations all predicted from only T1-weighted MRI acquired at baseline timepoint.

Existing computer-aided diagnosis methods can be divided into two main categories: (1) analytical methods and (2) predictive methods. While analytical methods aim to efficiently analyze, represent, and interpret data (static or longitudinal), predictive methods leverage the data currently available to predict observations at later time-points (i.e., forecasting the future) or predict observations at earlier time-points (i.e., predicting the past for missing data completion). For instance, a method which only focuses on classifying patients with mild cognitive impairment (MCI) and patients with Alzheimer's disease (AD) is an analytical method, while a method which predicts if a subject diagnosed with MCI will remain stable or convert to AD over time is a predictive method. Similar examples can be established for various neurodegenerative or neuropsychiatric disorders, degenerative arthritis, or in cancer studies, in which the disease/disorder develops over time.

Following the success of the past editions of PRIME MICCAI, the fifth edition of the workshop (PRIME MICCAI 2022) aimed to drive the field of 'high-precision predictive medicine', where late medical observations are predicted with high precision, while providing explanation via machine and deep learning, and statistically, mathematically- or physically-based models of healthy, disordered development and aging. Despite the terrific progress that analytical methods have made in the last twenty years in medical image segmentation, registration, or other related applications, efficient predictive intelligent models and methods are somewhat lagging behind. As such predictive intelligence develops and improves – and this is likely to happen exponentially in the coming years – it will have far-reaching consequences for the development of new treatment procedures and novel technologies. These predictive models will begin to shed light on one of the most complex healthcare and medical challenges we have ever encountered, and, in doing so, change our basic understanding of who we are.

What are the Key Challenges We Aim to Address?

The main aim of PRIME MICCAI is to propel the advent of predictive models in a broad sense, with application to medical data. To this end, the workshop accepts paper of 8–12 pages in length describing new cutting-edge predictive models and methods that solve challenging problems in the medical field. We envision that the PRIME MICCAI workshop will become a nest for high-precision predictive medicine, one that is set to transform multiple fields of healthcare technologies in unprecedented ways. Topics of interests for the workshop include but are not limited to predictive methods dedicated to the following:

- Modeling and predicting disease development or evolution from a limited number of observations;
- Computer-aided prognostic methods (e.g., for brain diseases, prostate cancer, cervical cancer, dementia, acute disease, neurodevelopmental disorders);
- Forecasting disease or cancer progression over time;
- Predicting low-dimensional data (e.g., behavioral scores, clinical outcome, age, gender);
- Predicting the evolution or development of high-dimensional data (e.g., shapes, graphs, images, patches, abstract features, learned features);
- Predicting high-resolution data from low-resolution data;
- Prediction methods using 2D, 2D+t, 3D, 3D+t, ND, and ND+t data;
- Predicting data of one image modality from a different modality (e.g., data synthesis);
- Predicting lesion evolution;
- Predicting missing data (e.g., data imputation or data completion problems);
- Predicting clinical outcomes from medical data (genomic, imaging data, etc).

Key Highlights

This year's workshop mediated ideas from both machine learning and mathematical/statistical/physical modeling research directions in the hope of providing a deeper understanding of the foundations of predictive intelligence developed for medicine, as well as to where we currently stand and what we aspire to achieve through this field. PRIME MICCAI 2022 featured a single-track workshop with keynote speakers with deep expertise in high-precision predictive medicine using machine learning and other modeling approaches – PRIME MICCAI which are believed to stand in opposing directions. The workshop was organized as a hybrid event (in-person and virtual), and keynote talks were streamed live due to the COVID-19 pandemic. Pre-recorded videos of accepted papers and keynote presentations were posted on the PRIME web page[1]. Eventually, this will increase the outreach of PRIME publications to a broader audience while steering a wide spectrum of MICCAI publications from being 'only analytical' to being 'jointly analytical and predictive.'

We received a total of 20 submissions and accepted 19 papers. All papers underwent a rigorous double-blind review process, with at least two (and mostly four) members of

[1] http://basira-lab.com/prime-miccai-2022/.

the Program Committee reviewing each paper. The Program Committee was composed of 21 well-known research experts in the field. The selection of the papers was based on technical merit, significance of results, and relevance and clarity of presentation. Based on the reviewing scores and critiques, all but one PRIME submission was scored highly by reviewers, i.e., had an average score above the acceptance threshold.

Diversity and inclusion have been one of main focuses of PRIME MICCAI, and the workshop continues to strongly support gender balance and geographic diversity in the Program Committee. The authors of this year's accepted papers were affiliated with institutions in four continents: Africa, Europe, America, and Asia. We also provided a BASIRA Scholarship[2] to register the paper of a talented minority student in a low-middle income country. The eligibility criteria of the BASIRA Scholarship were included in the CMT submission system, and the scholarship was ultimately awarded to a student from Africa. We will strive to continue this initiative in the upcoming years and hope to see a similar trend in other conferences and workshops.

August 2022

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[2] https://basira-lab.com/.

Organization

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