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PRedictive Intelligence in MEdicine

First International Workshop, PRIME 2018
Held in Conjunction with MICCAI 2018
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Proceedings

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Preface

Big and complex data is fuelling diverse research directions in the research fields of medical image analysis and computer vision. These 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 predicting observations at earlier time-points (i.e., predicting the past for missing data completion). For instance, a method that 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 or disorder develops over time.

Why Predictive Intelligence?

It would constitute a stunning progress in the MICCAI research community if, in a few years, we contribute to engineering a 'predictive intelligence' able to map both low-dimensional and high-dimensional medical data onto the future with high precision. This workshop is the first endeavor 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 20 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 do so exponentially in the coming years), this 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 Kind of Research Problems Do We Aim to Solve?

The main aim of PRIME-MICCAI is to propel the advent of predictive models in a broad sense, with application to medical data. Particularly, the workshop accepted 8- to 10-page papers describing new cutting-edge predictive models and methods that solve challenging problems in the medical field. We hope that the PRIME workshop

becomes 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 included but were not limited to predictive methods dedicated to the following topics:

- 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 and 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 outcome from medical data (genomic, imaging data, etc)

In-brief

This workshop mediated ideas from both machine learning and mathematical, statistical, and physical modeling research directions in the hope of providing a deeper understanding of the foundations of predictive intelligence developed for medicine, as well as showed where we currently stand and what we aspire to achieve through this field. PRIME-MICCAI 2018 featured a single-track workshop with keynote speakers with deep expertise in high-precision predictive medicine using machine learning and other modeling approaches which are believed to stand at opposing directions. Our workshop also included technical paper presentations, poster sessions, and demonstrations. Eventually, this helps steer a wide spectrum of MICCAI publications from being ‘only analytical’ to being ‘jointly analytical and predictive’.

We received a total of 23 submissions. All papers underwent a rigorous double-blinded review process by at least 2 members (mostly 3 members) of the Program Committee composed of 30 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, the 20 best papers were accepted for presentation at the workshop and chosen to be included in the present proceedings. The authors of the selected papers were invited to submit an

extended version to the PRIME special issue in the *IEEE Journal of Biomedical and Health Informatics* (J-BHI).

July 2018

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Contents