BRIGHAM AND WOMEN'S HOSPITAL
HARVARD MEDICAL SCHOOL

181 Longwood Avenue
Boston, Massachusetts 02115-5804

Department of Medicine
Channing Division of Network Medicine

Channing Methods Seminar

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Ye Yuan, PhD
Huazhong University of Science and Technology
Wuhan, China

Data driven discovery of cyber physical systems and an interpretable mortality prediction model for COVID-19 patients

Abstract: This talk consists of two parts. The first part addresses modeling for cyber-physical systems [1]. A major cross-disciplinary challenge concerns the need to adequately model cyber-physical systems (CPSs). CPSs, which embed software into the physical world (for example, in smart grids, robotics, intelligent manufacture and medical monitoring), have proved resistant to modeling due to the intrinsic complexity arising from (a) the combination of physical and cyber components and (b) the interaction between systems. This study proposes a solution in the form of a general framework for reverse engineering CPSs from data without prior knowledge. The method, which draws from artificial intelligence, involves the identification of physical systems as well as the inference of computer logics using sparse identification. The novel framework, which has been applied successfully to a number of real-world examples, seeks to enable researchers to make predictions concerning the trajectory of CPSs based on the discovered model. Such information may prove essential for the assessment of the performance of CPS and the design of failure-proof CPS. We can also use the proposed framework for the creation of design guidelines for new CPSs. The second part deals with the prediction of criticality of COVID-19 patients. This study [2] leverages a database of blood samples from 485 infected patients in the region of Wuhan, China, to identify crucial predictive biomarkers of disease mortality. For this purpose, machine learning tools selected three biomarkers that predict the mortality of individual patients more than 10 days in advance with more than 90% accuracy: lactic dehydrogenase (LDH), lymphocyte and high-sensitivity C-reactive protein (hs-CRP). Overall, this Article suggests a simple and operable decision rule to quickly predict patients at the highest risk, allowing them to be prioritized and potentially reducing the mortality rate.

[1] https://www.nature.com/articles/s41467-019-12490-1
[2] https://www.nature.com/articles/s42256-020-0180-7

Bio: Ye Yuan received the B.Eng. degree from the Department of Automation, Shanghai Jiao Tong University, Shanghai, China, in 2008, and the M.Phil. and Ph.D. degrees from the Department of Engineering, University of Cambridge, Cambridge, U.K., in 2009 and 2012, respectively. He has been a Full Professor at the Huazhong University of Science and Technology since 2016. He was a Postdoctoral Researcher at UC Berkeley, a Junior Research Fellow at Darwin College, University of Cambridge. His research interests include system identification and control with applications to cyber- physical systems.

Hosted by Yang-Yu Liu