International Workshop for Building Disease-modeling Capacity in India: A Report

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Abstract— Data-driven and model-driven understanding of diseases can help us study the spatial and temporal patterns of their outbreaks. We can gain insights into dynamic aspects of epidemics and public health, thus leading to timely and informed policy-making. Towards this, an international training workshop was conducted at the Indian Council of Medical Research (ICMR) headquarters in New Delhi by researchers from the Public Health Dynamics Laboratory of University of Pittsburgh.

Index Terms— Agent based modeling, FRED, synthetic population, microsimulation, disease clustering, Tycho, capacity building

1 Introduction

A 3-day international workshop on Public Health Dynamics (PHD 2018) was held on March 5-7, 2018, at the Indian Council of Medical Research (ICMR) headquarters in New Delhi, India. PHD 2018 was co-organized by Public Health Dynamics Laboratory (PHDL) of the Graduate School of Public Health (GSPH), University of Pittsburgh, USA, the Indian Council of Medical Research (ICMR) - National Institute of Medical Statistics (NIMS), New Delhi, and SHARE India. PHD 2018 was funded by GSPH Dean's grant from the U.S. National Institutes of Health (NIH) Fogarty International Center, and support from ICMR.

Scientists from more than a dozen ICMR institutes and other Indian organizations working in the fields of public health, epidemiology, biostatistics, applied mathematics and statistics, health services research, immunology, etc., attended the workshop. The 3-day workshop primarily focused on building disease modeling capabilities, supporting evidence-based health policies, health planning, and epidemic responses in India.

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2 Day 1

Dr. M. Vishnu Vardhana Rao, Director, and Dr. D.K. Shukla, the former Director-in-charge of ICMR-NIMS, inaugurated the PHD 2018 workshop. The sessions on Day 1 focused on FRED[1] (A Framework for Reconstructing Epidemiological Dynamics), a well-known agent based computational disease modeling platform developed at PHDL. PHDL programmers Mr. David Galloway, Mr. Robert Frankeny and Dr. Mary Krauland taught a hands-on session on setting up FRED, defining parameter settings for simulation, visualizations, building synthetic populations and disease transmission modes, etc.

Case studies were used to demonstrate multiple applications of FRED including H1N1 pandemic influenza simulation, effectiveness of school closings and vaccine distribution during the influenza epidemic, mitigation of dengue in Colombia, measles and the effects of vaccine coverage, and examples of non-infectious disease models for asthma and opioid use.

The day concluded with a poster session where workshop participants presented their work on disease modeling.

3 Day 2

Prof. Mark S. Roberts, Director, PHDL, presented model-driven approaches to public health such as FRED. The modeling platform was used for simulation of flu epidemics, opioid epidemic in the US, and

vaccination coverage to inform policymaking. Further, he described data-driven approaches including Project TYCHO[2], MOIRA[3] (Mortality Informatics and Research Analytics), ISSAC[4] (Indicators for Stress Adaptation AnalytiCs) and LENA[5] (LEgal Network Analyzer).

Hands-on training on FRED continued where participants learned how to modify existing FRED models to analyze changes on influenza transmission and the effects of variation in vaccine delivery coverage, methods for assigning risks to subpopulations, methods for tracking health dynamics within a population, etc.

Prof. Saumyadipta Pyne, Scientific Director of PHDL, University of Pittsburgh, described different disease clustering techniques - a challenging task in public health surveillance. Prof. Pyne provided an overview of general clustering theory in the context of epidemiology and also discussed a R package 'DCluster' for exploratory analysis of epidemiological data and detection of spatial clusters. He also highlighted bootstrap sampling to analyze spatial health events.

In the following session, Prof. Pyne provided an overview of spatial microsimulation methods to analyze complex spatial phenomena in situations where data availability is limited. He expanded upon combining individual and aggregate level data, generating synthetic populations, specifying target constraints, and matching the population marginal distributions via combinatorial optimization.

Dr. Raheel Sayeed from Harvard Medical School, USA, presented a case study on synthetic population creation for Telangana. Dr. Sayeed identified issues and challenges of data collection and described methods for generating a synthetic population that is statistically equivalent to the real population. Discussion on micro-level data collection included data repositories such as Census India (census.gov.in) for population aggregates, IPUMS National Sample Survey for microdata samples (Census USA), Unified District Information System for Education (udise.in) for school level data, School location mapping (Department of School Education & Literacy, Government of India) and Open Street Maps (openstreetmap.org) for geographic data.

The day concluded with a panel discussion on responsible conduct of research led by Prof. Joanne Russell, Director, Center of Global Health, GSPH, University of Pittsburgh.

4 Day 3

Dr. Guru Rajesh Jammy from SHARE India, Hyderabad, described an agent-based modeling application for the HIV epidemic in Telangana State, India. Dr. Jammy addressed spatial microdata collection from districts, geographical data collection, demographic data and several theoretical aspects for the agent-based modeling. Dr. Indranil Mukhopadhyay from Indian Statistical Institute, Kolkata discussed the study of critical community size (CCS) for communicable diseases using FRED.



PHD 2018 Workshop Speakers and Participants

Dr. Wilbert van Panhuis from PHDL, University of Pittsburgh discussed a data-driven approach, namely, "Project Tycho™: Improved Access to Global Health Data for Epidemic Modeling". Dr. Panhuis focused on the importance of data collection, standardization and reporting for computational modeling. He highlighted challenges in procuring, accessing and standardizing available disease surveillance data.

Dr. Marc Choisy from University of Montpellier, France, discussed about his work in Southeast Asia where he created pipelines for data integration to enable dengue modeling through the region. Post tea break, Dr. Panhuis and Dr. Choisy guided workshop participants to standardize a dataset into the Project Tycho™ format.

Prof. Clareann Bunker from University of Pittsburgh, Dr. M. Vishnu Rao and Dr. D.K. Shukla from ICMR-NIMS presented the certificates of participation to workshop attendees.

5 Conclusion

PHD 2018 was conceived in a brainstorming meeting at ICMR on May 25, 2017, on "Big data analysis in health research" between Prof. Saumyadipta Pyne and Dr. Soumya Swaminathan, the former Director General of ICMR and its leadership. The workshop concluded with vote of thanks by Dr. Ajit Mukherjee from ICMR-NIMS to Prof. S. Pyne, Dr. Meghana Aruru, Ms. Sharon Crow of University of Pittsburgh as well as the other organizers for the workshop's success. The workshop participants were introduced to some of the cutting-edge tools in computational modeling and simulation that may help them address public health challenges for the Indian population.

Workshop materials and details are available at: https://www.phdl.pitt.edu/index.php/events-main/2018-phd-workshop

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