Opinion

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A Note on Computational Modelling and Epidemiology

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Introduction

Computational modeling is the use of computers to simulate and study complex systems using mathematics, physics and computer science. A computational model contains numerous variables that characterize the system being studied. Simulation is done by adjusting the variables alone or in combination and observing the outcomes. Computer modeling allows scientists to conduct thousands of simulated experiments by computer. The thousands of computer experiments identify the handful of laboratory experiments that are most likely to solve the problem being studied.

Weather forecasting models make predictions based on numerous atmospheric factors. Accurate weather predictions can protect life and property and help utility companies plan for power increases that occur with extreme climate shifts. Flight simulators use complex equations that govern how aircraft fly and react to factors such as turbulence, air density, and precipitation. Simulators are used to train pilots, design aircraft, and study how aircraft are affected as conditions change. Earthquake simulations aim to save lives, buildings, and infrastructure. Computational models predict how the composition, and motion of structures interact with the underlying surfaces to affect what happens during an earthquake.

Tracking infectious diseases. Computational models are being used to track infectious diseases in populations, identify the most effective interventions, and monitor and adjust interventions to reduce the spread of disease. Identifying and implementing interventions that curb the spread of disease are critical for saving lives and reducing stress on the healthcare system during infectious disease pandemics. Clinical decision support. Computational models intelligently gather, filter, analyze and present health information to provide guidance to doctors for disease treatment based on detailed characteristics of each patient. The systems help to provide informed and consistent care of a patient as they transfer to appropriate hospital facilities and departments and receive various tests during their course of treatment. Predicting drug side effects. Researchers use computational modeling to help design drugs that will be the safest for patients and least likely to have side effects. The approach can reduce the many years needed to develop a safe and effective medication. Modeling infectious disease spread to identify effective interventions. Modeling infectious diseases accurately relies on numerous large sets of data. For example, evaluation of the efficacy of social distancing on the spread of flu-like illness must include information on friendships and interactions of individuals, as well as standard biometric and demographic data. NIBIB-funded researchers are developing new computational tools that can incorporate newly available data sets into models designed to identify the best courses of action and the most effective interventions during pandemic spread of infectious disease and other public health emergencies. Tracking viral evolution during spread of infectious disease.

RNA viruses such as HIV, hepatitis B, and coronavirus continually mutate to develop drug resistance, escape immune response, and establish new infections. Samples of sequenced pathogens from thousands of infected individuals can be used to identify millions of evolving viral variants. NIBIB-funded researchers are creating computational tools to incorporate this important data into infectious disease analysis by health care professionals. The new tools will be created in partnership with the CDC and made available online to researchers and health care workers. The project will enhance worldwide disease surveillance and treatment and enable development of more effective disease eradication strategies.