Agent-Based Models for Population Health

COURSE DURATION
Material for this on-line, distance learning course and material will be available from:
Friday, June 1, 2019 – Saturday, June 30, 2019

INSTRUCTOR
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COURSE DESCRIPTION
This course will provide an introduction to agent-based models and their application to population health research and health policy. Agent-based models utilize stochastic computer simulations to observe the population-level outcomes and patterns of behavior produced when heterogeneous agents interact with other agents and their environment according to preset rules. These models circumvent many of the limitations of traditional analytic approaches and are increasingly used to investigate the spread of health behaviors and outcomes, as well as to compare interventions and policies to promote population health. Topics covered will include the properties of agent-based models, including illustrations from the health and social sciences; the types of questions best answered by agent-based models; the steps involved in developing, calibrating, and validating agent-based models; and the presentation and interpretation of model results. NetLogo software will be used to demonstrate and practice agent-based modeling techniques. Participants will also have the opportunity to propose and receive feedback on an agent-based model addressing their own research question of interest.

PREREQUISITES
Some introductory epidemiology and biostatistics knowledge will be assumed. No prior experience with agent-based modeling or NetLogo is expected. Participants will need access to a computer with high-speed Internet access and NetLogo software (version 5.3.1 or higher). NetLogo is available for both Windows and Mac operating systems and can be downloaded for free at https://ccl.northwestern.edu/netlogo/download.shtml.

COURSE LEARNING OBJECTIVES
The primary objective of this course is to provide students with an understanding of the properties and uses of agent-based models for public health policy and research. To reach that objective, participants will gain exposure to classic and current agent-based models in the
health and social science literature, review best practices in the development and description of agent-based models, and practice building a simple agent-based model using NetLogo software. By the end of the course, participants will be able to:

1. Discuss the properties of agent-based models and their strengths and limitations for population health research.
2. Formulate research questions that can feasibly be evaluated using agent-based models.
3. Describe the steps involved in developing and verifying agent-based models, including parameterization, calibration, validation, and sensitivity analyses.
4. Identify the optimal presentation of results from an agent-based model.
5. Critically review studies using agent-based models.
6. Plan and begin programming an agent-based model to address a particular research question.

COURSE READINGS
The following readings provide an introduction to the need for and use of agent-based models for population health research, as well as examples that will be discussed in class:

The following textbook provides an excellent introduction to agent-based modeling and the use of NetLogo and will be referenced throughout the course:

Extensive documentation for NetLogo software is available at the following website:
https://ccl.northwestern.edu/netlogo/index.shtml

COURSE STRUCTURE
This is a month-long digital course, equivalent to approximately 20 hours of classroom instruction. Lectures and course material will be presented online in roughly weekly segments. The flexible format will include video or audio recordings of lecture material, file sharing and topical discussion, self-assessment exercises, and access to the instructor for feedback during the course. The course utilizes the learning management software, Canvas (https://canvas.instructure.com/login); participants will receive an e-mail inviting them to join on the first day of the course. Any additional information about technical requirements and access to the course will be shared in the weeks before the course begins.
## COURSE SCHEDULE

### Module 1 – Properties and uses of agent-based models

| June 1 – June 5 |
| Learning objectives: Understand the properties of agent-based models and how to formulate appropriate research questions to be addressed with agent-based models. Introduce model description using the ODD protocol and model development using NetLogo. |

**ABM concepts:** purpose; entities; scales.

**Recommended reading:** Tracy et al, 2018 Introduction-Limitations (pp. 1-11); Auchincloss & Garcia, 2015 Introduction and Modeling Guide (pp. 1-6); Kumar et al., 2013 Introduction (pp. 1406-1407); Yonas et al., 2013 Introduction (pp. 87S-88S); Railsback & Grimm, Ch. 1-3.

### Module 2 – Agent characteristics and behaviors

| June 6 – June 10 |
| Learning objectives: Understand the range of possible agent populations, how to parameterize agent characteristics and behaviors, and how to observe the influence of agent behaviors on population-level outcomes. Practice assigning agent behaviors and varying parameters in NetLogo. |

**ABM concepts:** state variables; initialization; scheduling; learning; adaptation; prediction; emergence.

**Recommended reading:** Kumar et al., 2013 Methods (pp. 1407-1408); Yonas et al., 2013 Methods (pp. 88S-92S); Railsback & Grimm, Ch. 8, 11, 12, 14.

### Module 3 – Physical environment and network structures

| June 11 – June 16 |
| Learning objectives: Understand model topology options and possible network structures and the influence of the physical environment and agent interactions on agent behaviors and population-level outcomes. Practice modifying the physical environment and adding agent interactions in NetLogo. |

**ABM concepts:** sensing; interaction; collectives.

**Recommended reading:** Kumar et al., 2013 Results and Discussion (pp. 1408-1411); Yonas et al., 2013 Results and Discussion (pp. 92S-95S); Railsback & Grimm, Ch. 10, 13, 16.

### Module 4 – Calibration, validation, and working with model output

| June 17 – June 23 |
| Learning objectives: Understand what kind of output is needed to evaluate the model results. Learn strategies for model verification, calibration, and validation. |

**ABM concepts:** stochasticity; observation.
| June 24 – June 30 | **Learning objectives:** Understand how to develop and implement experimental model scenarios to answer research questions and how to conduct sensitivity analyses. Review best practices for presenting model output and results of model comparisons.

   **Recommended reading:** Tracy et al. Future Directions (11-13); Railsback & Grimm, Ch. 22-24. |