INDUSTRIAL ENGINEERING DEPARTMENT
IE 588
Agent-based Modelling and Simulation
Fall 2022

Credits/ECTS:	3 Credits / 7 ECTS
Class Schedule:	Monday 12:00-12:50 (M1181) / Wednesday 13:00-14:50 (VYKM3)
Instructor:	Gönenç Yücel (gonenc.yucel@boun.edu.tr)
	Engineering Building, Room: M4014
Prerequisite(s):	None

Course Description:
This course is designed to provide students with the tools and knowledge necessary to conduct a simulation supported analysis of socio-technical problems using agent-based models (ABMs). Students will gain understanding and awareness of the fundamental differences of agent-based modeling from other simulation modeling approaches, and nature of problems/objectives that ABMs fit the best. Besides, students will develop competency in building ABMs, analyzing and interpreting results from these models, and communicating a complete simulation supported analysis cycle to peers/clients. Example models used during the semester will be drawn from social, economic, environmental, industrial, energy and logistic/transportation problems.

As a part of the course, the students will go through a model supported analysis process as they develop an ABM to analyze a problem of their own. Following the topic selection, students will be conducting a full simulation-based policy analysis study, which includes model development, testing, analysis, reporting and presentation.

Course Outline and Conduct
The course is organized three parts and two parallel tracks. The two tracks, i.e. theoretical and applied tracks, will be running parallel throughout the three parts of the course. The default format of the conceptual part of the course will be in-class lectures. The course materials will also be posted online as much as possible. Regarding the applied track, recorded lectures and tutorials will be posted for asynchronous access, and we will be having short synchronous sessions for discussions and application-related questions.

Part 1:
In the theoretical/conceptual part, the lecture will start with an introduction to agent-based models, and what they can be used for. This involves basic introduction to simulation modeling in general, and to agent-based models in specific. Following that, we will discuss two broad classes of scientific/applied questions for which agent-based models can be used as an appropriate method. Linked to that, the first part of the theoretical track will conclude with a discussion on how to identify a good topic to tackle with this approach.

In the applied track, the simulation software, NetLogo, will be introduced. After getting to know the modelling platform, the students will be following basic tutorials in order to develop their first basic models.

Part 2:
The second part of the course will be focusing on key aspects of an agent-based model, such as decision formulation, sensing, perception implementations, evolutionary agent behavior, dynamic network structures, etc. We will be discussing alternatives, and the potential implications of choices to be made among these alternatives in a modelling study.

In the applied track, the students will be working on formulating an appropriate problem to tackle with agent-based modelling. Candidate problems will be presented and discussed during synchronous online sessions. As specific topics are determined, the student groups will be working on their own project topics. The practice sessions will be devoted to discussing formulations alternatives and modelling problems.

Part 3:
The final part of the course focuses on the concluding stages of a model-based analysis process; i.e. model verification and validation, output analysis, and communication of the model and the results to peers and/or clients. On the theoretical part, we will be discussing these topics at the general conceptual level, and in the applied part we will focus more on aspects related to these topics specific to the project models being developed.

Learning Objectives
By taking this course, students will:

- Gain a general understanding about the basic principles of agent-based simulation models, and the type of problems they suit the best
- Build competency in completing a full modeling cycle (i.e. design, implement, analyze, etc.) in a simulation supported analysis with agent-based models
- Build competency in analyzing model outcomes, and in communicating the results obtained.

Textbook:
There is no required textbook for this course. Although the course follows a slightly different flow, the following books are highly recommended as a supplementary course material:

- *"Agent-Based and Individual-Based Modeling: A Practical Introduction"* by Steven F. Railsback & Volker Grimm
- *"An Introduction to Agent-Based Modeling: Modeling Natural, Social, and Engineered Complex Systems with NetLogo"* by Uri Wilensky &William Rand

Student Background and Prerequisites
This course is appropriate for senior undergraduate and graduate students who are interested in systems modeling and simulation as well as in analyzing dynamic socio-technical problems. The course requires a background in basic simulation concepts. Therefore, IE 306

and/or IE 550 would be useful, but it is not a hard prerequisite. The modeling software to be used (i.e. NetLogo) requires a basic level of object-oriented programming/coding background. Model initialization and output analysis will require basic probability and statistics.

Grading:

The grading will be based on your responses to feedback questions (can be thought as small assignments), assignments, a final exam and a modelling project. There will be a total of 5 assignments throughout the semester. Assignments will be submitted individually. The project will be submitted as groups of 2-3 students. It involves model development, experimentation and analysis, and reporting. The project grade will be based on the report to be submitted, as well as on the in-class presentation. The final exam will be conducted in person, in class.

Feedback Questions	5%
Assignments	40%
Project	30%
Final Exam	25%

Updated by, and date of update: Gönenç Yücel, August 2022