Wageningen University

Department of Social Sciences
Information Technology Group
Hollandseweg 1
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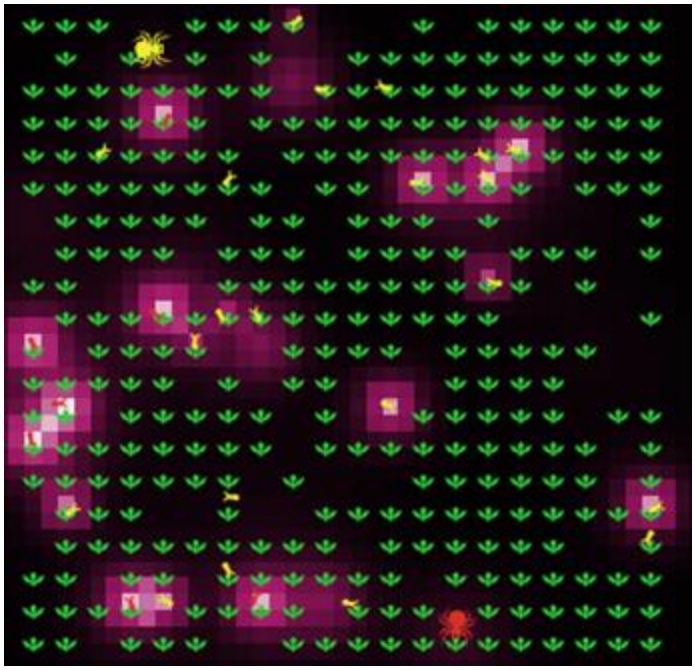
Course guide **INF-34806 Agent-Based Modelling of Complex Adaptive Systems**



Picture: Model of plants emitting volatiles to attract the mites that eat the lice that eat them.

Code:	INF-34806
Load:	6 credit points ECTS (168 hours)
Contact:	Prof. Dr ir G.J. Hofstede
Lecturers:	Prof. Dr ir G.J. Hofstede, Drs M.R. Kramer Dr S.A. Osinga
Examiners:	Prof. Dr ir G.J. Hofstede
Scheduling:	4th period
First lecture:	See TimeEdit
Language:	English
Assumed knowledge	Basic programming skills

Brightspace: INF34806_yyyy_p

Contact hrs: Full days in P4

Contents:

1. Profile of the course
2. Intended learning outcomes
3. Learning materials and resources
4. Educational activities
5. Assessment strategy (examination)
6. The principal themes of the contents
7. Outline and schedule of the programme of the course

1. PROFILE OF THE COURSE

Aim

To achieve hands-on experience in modelling a system of study in one's own sphere of interest, in a sub-discipline of the life sciences, as a complex adaptive system. This means conceiving of the system under study as consisting of agents that interact in an environment, producing self-organized, 'emergent' behaviour. This leads to a multi-level approach in which both the detail level of the agent, and the overall patterns produced by the system, are important. This perspective opens new opportunities of linking disciplines in research. It may include 'Artificial Sociality', modelling social motives of the agents.

Target group

PhD and MSc Students from Wageningen university from whatever discipline who wish to model elements of a system and their mechanisms of interaction, in order to gain knowledge on how these details shape behaviour of the system as a whole. Systems could be technical, social, biological or mixed. Agents could be plants, animals, people or other. The 2-d spatial environment may play a role.

Benefit for students

Hands-on experience with agent-based modelling gives student the possibility to assess whether this method could be useful for them in their research. For many, this can be an eye opener, particularly those who deal with systems that are in essence complex and adaptive. They are *complex* if at system level, the relation of output variables to input variables is in between chaos and linearity. They are *adaptive* if the agents in the system have some awareness about the system state and can adapt their behaviour accordingly.
Agent-based models can be used for various purposes, varying from prediction, understanding, theory exploration, to social interaction with stakeholders.

Assumed prerequisite knowledge

No specific knowledge is required. A willingness to program is an absolute must and some experience with imperative software development helps, for instance knowing what variables, loops, lists and arrays are. A capacity for abstract, creative thinking about one's topic of study is also needed. Having finished one of the courses Applied Information Technology (INF-20806), Data Management (INF-21306), or Programming in Python (INF-22306) would help.

2. INTENDED LEARNING OUTCOMES

Students are able to carry out the cycle of simulation-based research about emergence in a natural and/or social system of their own definition. Specifically they are able to

- apply the concepts from the course book.
    - This is specified in practical learning outcomes, all of which will be assessed through the students' case study.
- formulate research questions.
    - This includes selecting a theoretical or empirical question to investigate; fixing an appropriate level of analysis for agents and system; choosing an appropriate level of abstraction (abstract, stylized, or facsimile); operationalizing theoretical constructs in agent properties (perception, motion, communication, action, memory, motivation, policy) and in environment properties (heterogeneity, change); modelling agent learning (by experience, evolution, or teaching) and system learning (by emergence).
- create simulations
    - This involves developing code in NetLogo that operationalizes the research questions.
- carry out validation
    - This involves systematic sensitivity analysis of the variable space and validation against theory or empirical data, using the tools in NetLogo BehaviorSpace.
- draw conclusions
    - This involves reporting on all of the above steps for one's own project, both in a presentation that uses the simulation created, and in a report.

3. LEARNING MATERIALS AND RESOURCES

This course makes intensive use of the booklet: Agent Based Models (second edition 2020) by Nigel Gilbert, published by Sage publishers, ISBN 9781506355603. The software to be used, Netlogo 6, is installed in the scheduled PC labs and freely downloadable from http://ccl.northwestern.edu/netlogo/.

4. EDUCATIONAL ACTIVITIES

This is a self-study course, most of it carried out in pairs, with assistance on demand. During most of the scheduled hours assistance is available to help you with problems. There will be three assignments:

- A1: Explore a model from the NetLogo library and explain its behavior to the class. Include theoretical concepts and how they are represented; use model concepts from Gilbert's book.
- A2: Extend the model from A1, starting from theory
- A3: This is the main assignment. Develop your own model from scratch, starting KISS (Keep It Simple, Stupid) and extending KIDS (Keep It Descriptive). This should include sensitivity analysis and validation as far as is feasible.

Presence during the computer labs is highly recommended, although independent working is possible. In 2021, the mode of working will be online, using Brightspace and Discord.
In addition every pair is required to read and present on a poster one recent article of their choice about ABM, which is a booming area of research.

5. ASSESSMENT STRATEGY (EXAMINATION)

50% is the score for the final paper (A3), based on the following criteria: Research question, simulation design, Netlogo code, Netlogo interface, sensitivity analysis, validation, report.
50% is the participation score, based on the assignments A1 and A2, the article presentation, and on the general impression the teachers have of the student's intellectual and motivational contributions.

6. THE PRINCIPAL THEMES

Complex Adaptive Systems: what is it, what's special about it, what are its pitfalls and promises? This relates to the strategic research agenda of our university, e.g. resilience, metropolitan solutions, interdisciplinarity.
Agent-based models: what are they, why can they deal with Complex Adaptive Systems issues, how to choose a research question, how to design, build and validate agent-based models.
Hands-on work that "grows it to show it", through which the students experience first-hand what the above points mean.

7. OUTLINE AND SCHEDULE OF THE PROGRAMME OF THE COURSE

The course is offered full days in period 4.