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OR Society Short Course
Co-Creation of Agent-Based Simulation Models

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Delivered by Dr Peer-Olaf Siebers

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Length: 1 Day
Date/Time: 8 Nov 2023 @ 9-5pm
Delivery mode: Face to Face
Cost: £696.00 incl. VAT
Location: The OR Society HQ @ 12 Edward Street, Birmingham, B1 2RX, UK

Summary: In this intermediate course you will learn how to design agent-based simulation models using a co-creation approach, for analysing systems where human behaviour plays a key role. We also take a quick look at how to implement such models using the simulation toolkit AnyLogic PLE.

Description: This is a practical course for people from academia, non-governmental and governmental organisations, and industry, interested in developing expertise in the conceptualisation process in agent-based modelling for the purpose of simulating systems where humans and their behaviours and decisions play a key role. This course uses a novel structured co-creation approach by adopting the "Engineering Agent-Based Social Simulation" (EABSS) framework. Attendees will learn the basic concepts of agent-based modelling and will gain some practical experience in how to develop such models with the help of the EABSS. We will also take a quick look at how to implement such models using the simulation toolkit AnyLogic PLE. At the end attendees will have the opportunity to discuss their own simulation project ideas/plans with the tutor.
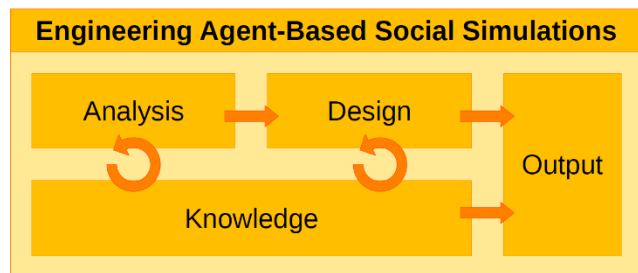
What topics are covered? This course will teach the basic concepts of agent-based simulation modelling. You will gain practical experience of how to develop such models and how they can be implemented using a simulation toolkit. A big part of the course will be spent on model conceptualisation using a novel co-creation approach. There will also be a valuable opportunity to discuss your own simulation project plans with the tutor.

What will you learn? What skills will you acquire?
- When and why to use agent-based simulation modelling.
- How to conceptualise agent-based simulation models using a co-creation approach.
- How to build and run agent-based simulation models using the simulation toolkit AnyLogic PLE.

- Correct use of data within an agent-based simulation model.
- General principles and techniques used in modelling and simulation.

Who is this course for? This is a practical short course for people from academia, non-governmental and governmental organisations, and industry, interested in developing expertise in the co-creation of agent-based simulation models.

Job roles of delegates who have attended this course? Agent-based simulation modelling consultant.

What are the benefits to your employer if you attend this course? Attendees will be able to take all relevant stakeholders' views into account when designing simulation models of human centric systems, by using a novel co-creation framework. Often, such models are designed from the modeler's perspective, missing relevant details. In addition, the co-creation framework can also be used independently for a structured discussion with stakeholders.

Online platform and software requirements? Laptops provided with AnyLogic PLE installed.

Prerequisites? There are no pre-requisites for this course. Experience in simulation would be an advantage, however there will be an introductory lecture on the topic.

Other courses that may interest you? Foundations of OR: Simulation

Engineering Agent-Based Social Simulations

User Guide v2023-09-17

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Brief Summary

What is it all about? What are successful model development strategies for complex social systems modeling? How does modelling work in large, collaborative, and multi-disciplinary projects in academia, non-governmental and governmental organisations, and industry? How do we derive new and general insights from modelling complex social systems? Anecdotal evidence suggests that the community of agent-based modellers partially suffers from a lack of structured and standardised ways for model development. To close this gap, we have created a model development framework, namely the **Engineering Agent Based Social Simulation** (EABSS) framework. It supports model development and model documentation in a structured way. Figure 1 shows a high-level overview of the latest version of the framework (EABSS 2.0). More information about the EABSS, together with an illustrative example), can be found in Siebers and Klügl (2017). Some guidance (in form of a cheat sheet) on how to use the framework can be found in Appendix A.
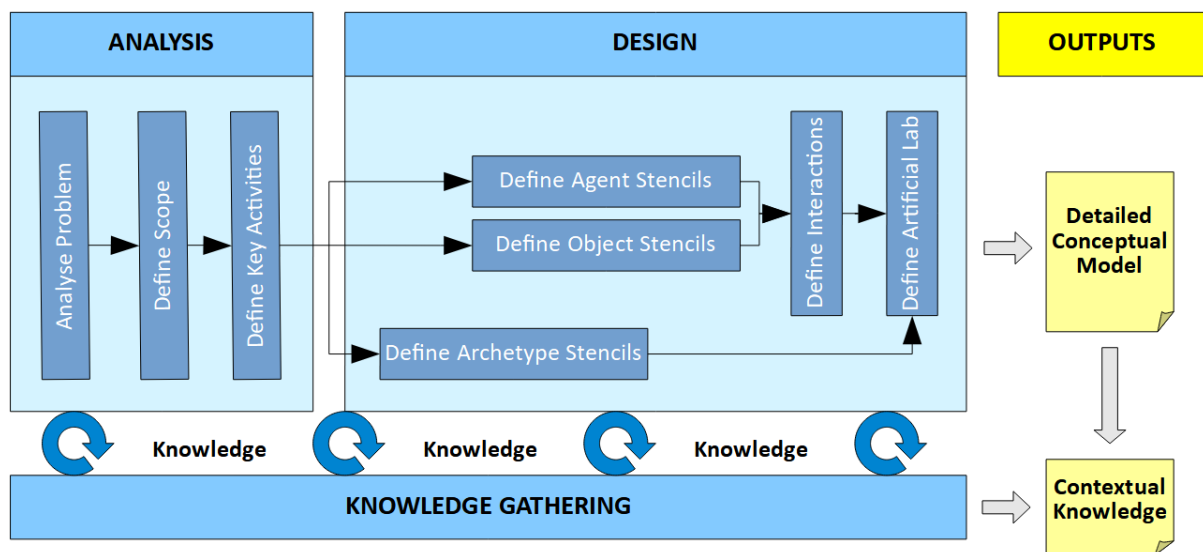

Figure 1: High level overview of the EABSS 2.0

The latest development in terms of EABSS is the EABSS toolkit (Siebers 2023), which provides access to extensive training material and other resources (e.g. case study examples).

How does it work? The EABSS is grounded in the concept of co-creation (Mitleton-Kelly 2003) and ideas from Software Engineering (Sommerville 2015). In addition it draws on elements of Kankainen's focus group approach to service design (Kankainen et al 2012). The framework implicitly provides ground rules, which is something commonly done when working with children but often forgotten when working with grownups. These grounded rules are in line with De Bono's philosophy of parallel thinking (De Bono 1985), and state that people are going to listen to each other, and that people respect each other's point of view. To capture information it uses predefined table templates, and UML (a graphical notation used in Software Engineering) as main forms of stimulating and

documenting contributions from all participating stakeholders during problem analysis and model design. It is this combination of tools and methods that makes it approachable for everyone.

When do we use it? The EABSS can be used for two different purposes: (1) for collaborative model development (from scratch or to extend/validate existing models) and (2) to stimulate and formally support discussions about philosophical questions of societal issues that need to be addressed. We have tested the framework in several domains, including Architecture, Geography, Organisational Behavior (Siebers et al 2020), and Digital Mental Healthcare (Vallejos et al 2019; Siebert et al 2020; Barnes and Siebers 2020). It is designed with the aim to look at a complex system in more detail with every further step. There is always information from previous steps that can be used to get started with the next step. This principle serves validation, as getting stuck in the current step is a good indicator that something in previous steps is not quite right and needs to be amended.

What do we get out of it? The outcome of an EABSS session is a structured record of the key points of the focus group discussions, in a format that is easy to understand by all stakeholders, and easy to extend. With a little effort this can often be translated into an agent-based social simulation model, which can then be used by the stakeholders as a "what-if" analysis tool.

What is our experience so far? Interestingly we found that each of the academics involved in running the focus groups finds EABSS supportive in a different way, perhaps embedded within the research method used in their domain (for more on the topic see Siebert et al 2020). So the concept itself can be seen as interdisciplinary, while it was originally only intended to support social simulation model development. It has now been used for model development, reverse engineering of existing models for validity checking, discussions to extend existing models and confirm their validity, debates to analyse research topics and work on defining new directions for research.

Where are we going from here? More recently I got interested in the philosophical debates of Richard David Precht, a German Philosopher who debates about "the digital revolution of society". I would like to use the EABSS to test some of his future visions and to see if we can visualise his worlds with the help of ABSS. I would like to approach this in a more systematic way - i.e. to build a kind of toolbox that allows us to build this new genre of models easier. In the end we could have a collection of templates that allow the community to put together models for tackling philosophical questions - perhaps in form of a toolbox as an extension to existing simulation packages.

References

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Appendix A: EABSS 2.0 Guidance (for moderators)

Small print orange remarks are meant to guide the focus group moderator regarding the re-use of information; purple remarks list the tools to be used in that particular step.

Analyse Problem {also clarify terminology and come up with a common pool of term definitions}
- Clarify the "Purpose" of the model
- Define a list of "Hypotheses" to be tested
- Define a list of "Experimental Factors" to allow creating scenarios relevant to testing those hypotheses {look at objectives/hypotheses to work these out}
- Define a list of "Responses" to accept/reject hypotheses {look at objectives/hypotheses to work these out}

Define Scope {look for nouns in previous text to find elements}
- Define the level of abstraction
- List entities (key actors - represented by the role they play, and key objects) and concepts {key actors can also represent social/economic units, as for example families or firms}
- Indicate if these should be included/excluded in the model and justify your decision
- Use pre-defined table (headers: Category; Sub-Category; Element; Decision; Justification {while categories are provided, sub-categories are flexible and depend on the context}; categories: Actor; Physical Environment; Social and Psychological Aspects; Other)

Define Key Activities {actors come from scope table; use cases come from hypotheses and by creating user stories}
- Assign key actors to relevant activities (use cases)
- Use UML use case diagram

Define Archetype Stencils {these allow to define behaviour of actors}
- Come up with categorisation schemata for relevant key actors (agents) that will allow to separate a simulated population into behaviourally different groups
- Use habit template(s) and/or demographics and/or utility function(s)

Define Entity (Agent/Object) Stencils {attributes can be derived from archetype criteria, theory parameters, methods can be derived from the states in the related state charts} {states can often be derived from use cases}
- Create templates by defining key states an entity can be in, how these are linked, and what triggers transitions (note that this might not be required for all entities)
- List variables that ought to be tracked at the micro/meso level in order to gain insight about the issues identified during the problem analysis
- Use UML state machine diagram(s); transition table(s); class definition(s)/diagram(s)

Define Interactions {all elements defined in the agent/object stencil step need to be listed on the horizontal axis} {use cases could be listed on the vertical axis}
- Define sequences of interactions that can take place between agents and between agents and objects in specific use case realisations
- Use UML sequence diagram(s)

Define Artificial Lab {attributes provide storage for all agents/objects and initialisation parameters required for experimental factors; methods related to responses}
- List entities that need to be created; listing variables that ought to be tracked at the macro level in order to gain insight about the issues identified during the problem analysis
- Define order of execution (if relevant)
- Use UML class definition(s)/diagram(s) and sequence diagram(s)