

Ulaanbaatar, 14 October 2014, Tim.Verwaart@wur.nl



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- Introduction to agent-based modeling and simulation
- Practice with NetLogo
- Discussion



# Agent-based simulation

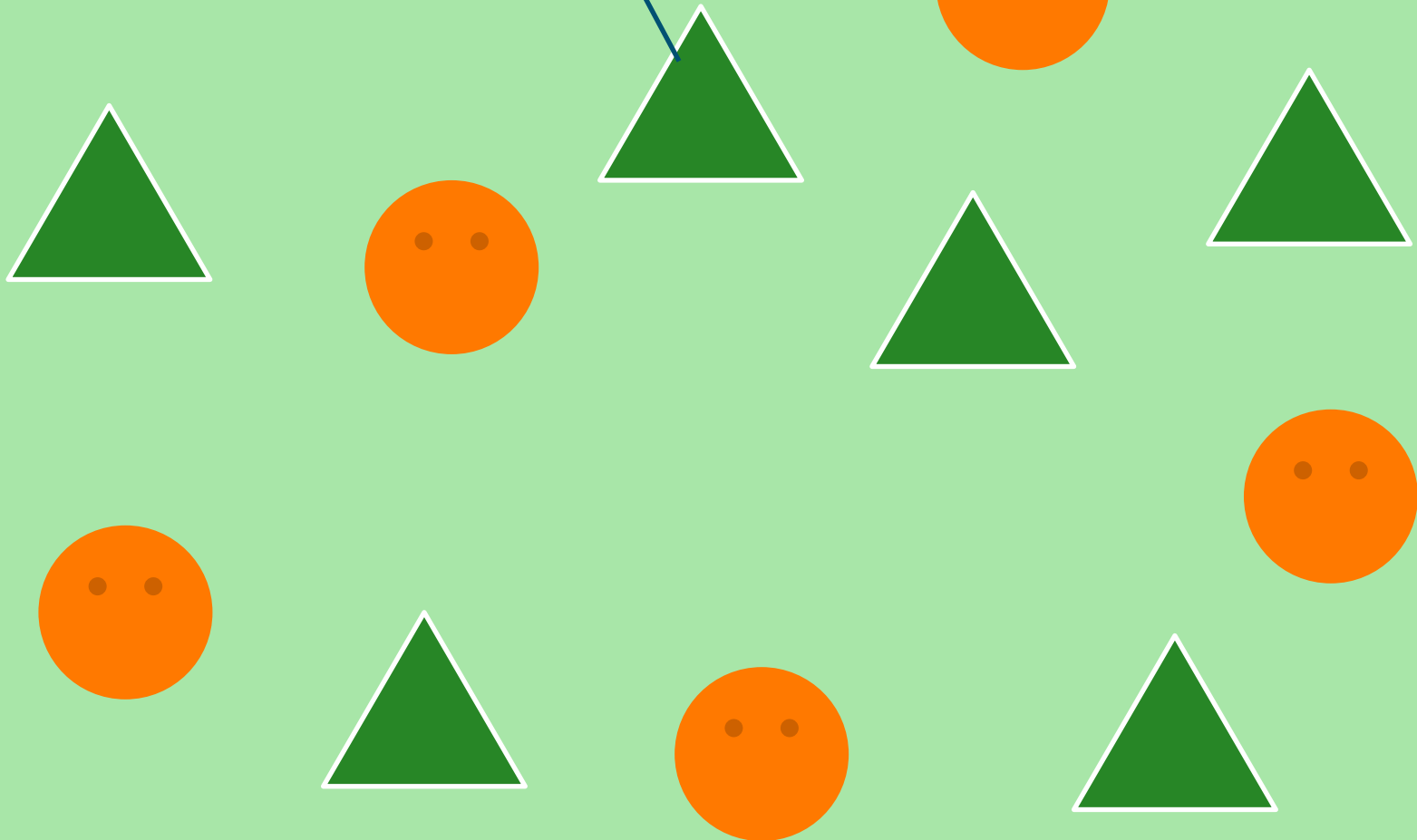
- A modelling paradigm in which
  - A population of individual actors
  - Is represented by a population of software agents
  - Situated in a simulated environment
- Emerged in the 1990s
  - Enabled by advances in computer science and
  - Advances in computer technology (capacity)



Environment

Objects

Agents



# Agents' capabilities

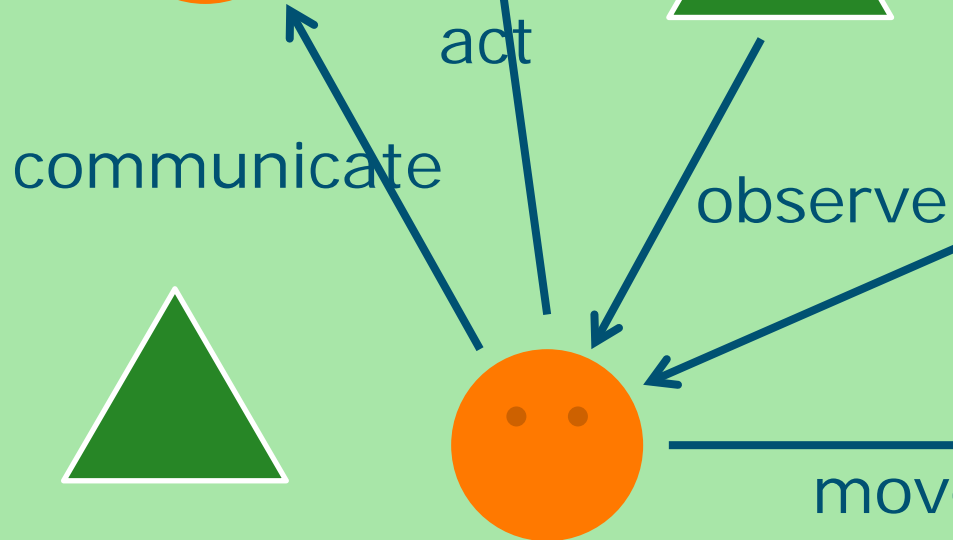
- Observe the environment
- Awareness of other agents
- Make deliberate decisions
  - Reactive
  - Pro-active (goal-driven)
- Exchange information with other agents
- Move around in the environment
- Act upon objects in the environment



Environment

Objects

Agents



# Decision making in software agents

- May be simple or complex
- May be rational (optimizing) or heuristic
- May be deterministic or stochastic
- May be diverse:
  - Different agent types,
    - e.g. farmers and consumers
  - Different decision making algorithms and criteria
  - Different values of characteristics,
    - e.g. wealth, preferences



# Advantages of agent-based simulation

- Allows for diversity of agents
  - E.g., use census data to parameterise the agent population
- Simulate effects of interactions,
  - E.g., collaboration and competition
- Allows for realistic environment
  - E.g., use actual data to represent land plots in the environment





# Agricultural research and policy application

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- Common pool problems
- Land markets
- Land use planning
- Food supply chain configuration
- Natural resources management
- Water management
- Epidemiology



# Journals / Conferences

- *Journal of Artificial Societies and Social Simulation:*  
*[jasss.soc.surrey.ac.uk](http://jasss.soc.surrey.ac.uk) (open access)*
- *[www.journals.elsevier.com/environmental-modelling-and-software/](http://www.journals.elsevier.com/environmental-modelling-and-software/) (search for applications of agent based models/simulation)*
- *Advances in Complex Systems*  
*[www.worldscientific.com/worldscinet/acs](http://www.worldscientific.com/worldscinet/acs)*
- MABS Multi-Agent-Based Simulation and some other workshops at AAMAS conferences
- world congress on social simulation
- Artificial Economics conferences
- Pan-Asian Association for Agent-based Approach in Social Systems Sciences: [www.paaa.asia](http://www.paaa.asia)



# Agent-Based Simulation in Wageningen

- Search in Google:
  - Wageningen Complex Adaptive Systems
- Wageningen University will organise the 6<sup>th</sup> Summer School of the European Social Simulation Association in September 2015



# Software for agent-based simulation

## ■ NetLogo:

- <http://ccl.northwestern.edu/netlogo/>
- Free
- Easy to learn

## ■ RePast:

- <http://repast.sourceforge.net/>
- Open Source
- Easy to learn, but Java programming skills are useful for complex simulations



# Conclusion

- Agent-based modelling and simulation is a useful addition to the toolbox for research and policy support
- It can be based on actual micro data, with diversity of actors, situated in a realistic environment, on a time scale ranging from seconds to years
- It helps to explore potential behaviours of complex social-ecological and sociotechnical systems under a diversity of scenario's and interventions
- It can be applied to test hypotheses about the internal mechanisms and decision making that drive system behaviour



# Introduction:

Nigel Gilbert (2008)  
Agent-based models.  
SAGE Publications,  
San Francisco

NetLogo User Manual  
(in the software)

Repast tutorials

(<http://repast.sourceforge.net/docs.php>)

