

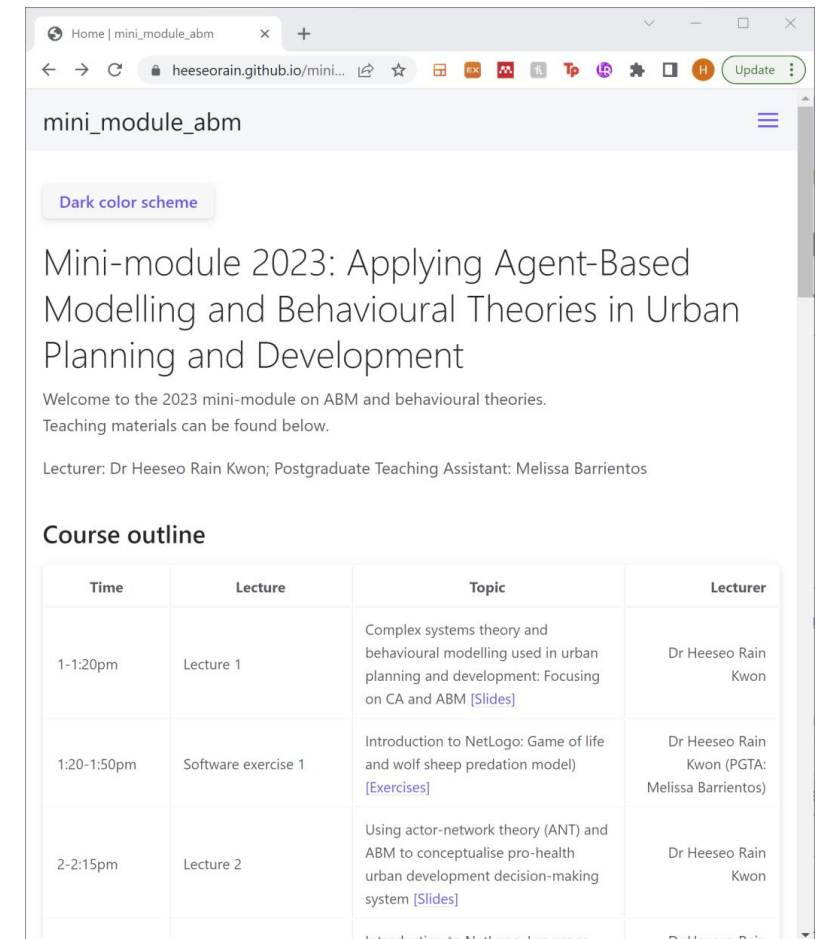
Welcome to the Mini-module 2023: Applying Agent-Based Modelling and Behavioural Theories in Urban Planning and Development!

If you haven't done so already, please install NetLogo and QGIS:

- **NetLogo 6.2.1** (for Windows, choose 64-bit):
<https://ccl.northwestern.edu/netlogo/6.2.1/>
- **QGIS 3.28 LTR** (Click the 'Looking for the more stable version? Get QGIS 3.28 LTR'):
<https://www.qgis.org/en/site/forusers/download.html#>

While we wait a little for people to arrive, you can have a look at the course material:

- https://heeseorain.github.io/mini_module_abm/



The screenshot shows a web browser displaying the 'mini_module_abm' website. The page has a dark color scheme and includes a welcome message, teaching materials, and a course outline table.

mini_module_abm

Dark color scheme

Mini-module 2023: Applying Agent-Based Modelling and Behavioural Theories in Urban Planning and Development

Welcome to the 2023 mini-module on ABM and behavioural theories.
Teaching materials can be found below.

Lecturer: Dr Heeseo Rain Kwon; Postgraduate Teaching Assistant: Melissa Barrientos

Course outline

Time	Lecture	Topic	Lecturer
1-1:20pm	Lecture 1	Complex systems theory and behavioural modelling used in urban planning and development: Focusing on CA and ABM [Slides]	Dr Heeseo Rain Kwon
1:20-1:50pm	Software exercise 1	Introduction to NetLogo: Game of life and wolf sheep predation model) [Exercises]	Dr Heeseo Rain Kwon (PGTA: Melissa Barrientos)
2-2:15pm	Lecture 2	Using actor-network theory (ANT) and ABM to conceptualise pro-health urban development decision-making system [Slides]	Dr Heeseo Rain Kwon

Welcome to the Mini-module 2023: Applying Agent-Based Modelling and Behavioural Theories in Urban Planning and Development!

Dr Heeseo Rain Kwon

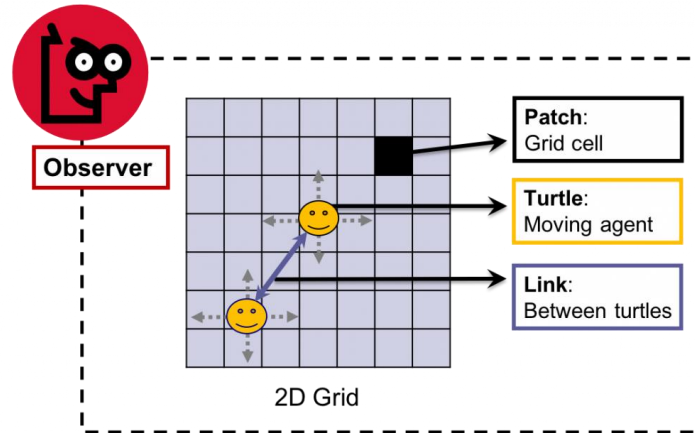
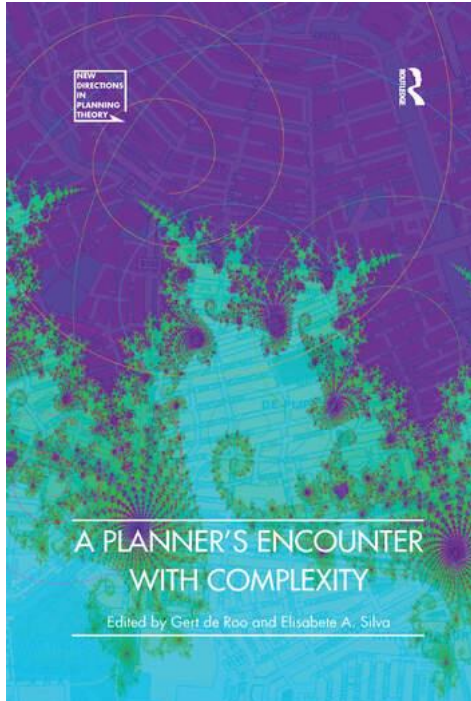
- **2010-2013:** BSc in Urban Planning, Design and Management, Bartlett School, UCL
- **2013-2016:** Researcher, Infrastructure Division, Korea Research Institute for Human Settlements (KRIHS)
- **2016-2017:** MPhil in Planning, Growth and Regeneration, Dep. of Land Economy, Univ. of Cambridge
- **2017-2020:** PhD in Land Economy, Dep. of Land Economy, Univ. of Cambridge
- **2020-2022:** Post-doc for Healthier Urban Development, Dep. of Real Estate and Planning, Univ. of Reading
- **2022-present:** BSP Post-doctoral Research Fellow, Bartlett School of Planning, UCL

Welcome to the Mini-module 2023:

Applying Agent-Based Modelling and Behavioural Theories in Urban Planning and Development!

So that I get to know you, can you briefly share:

- Your name
- Which course are you in currently?
- What are your research interests?
- What do you want to learn the most today?



Lecture 1:

Complex systems theory and behavioural modelling used in urban planning and development: Focusing on CA and ABM

Dr Heeseo Rain Kwon

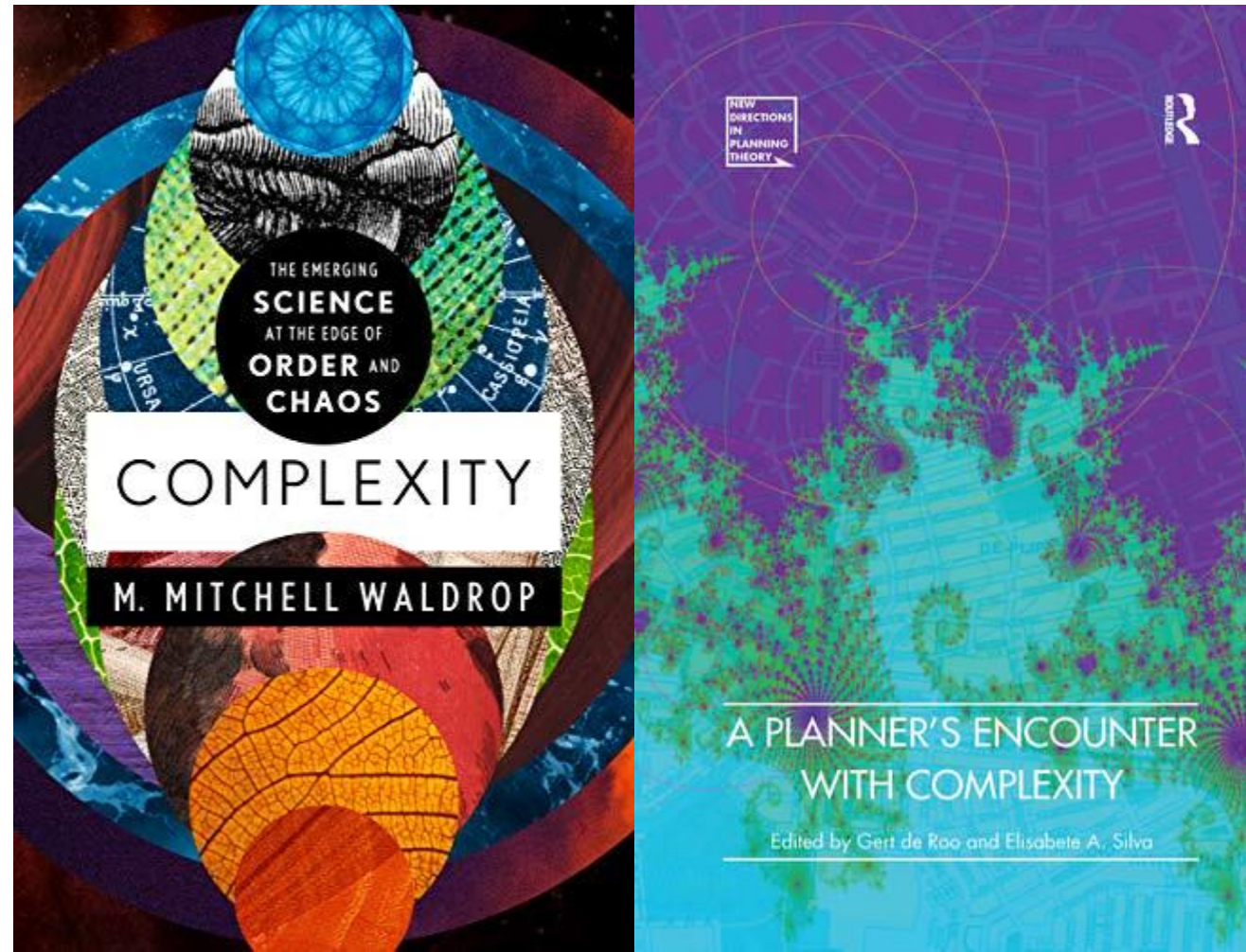
BSP Post-doctoral Research Fellow

Bartlett School of Planning, University College London

heeseo.kwon.10@ucl.ac.uk

Complexity theory (of complex systems theory)

Any idea?

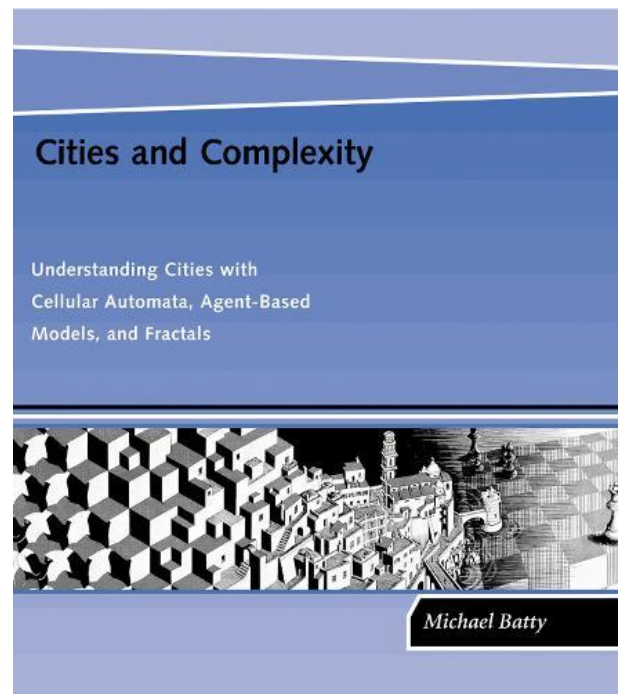


According to de Roo and Silva (2010), **complexity** “represents **dynamic realities** and **non-linear behavior**”.

- The debate on “complex systems and their ‘evolutionary’ behaviour” has numerous origins such as “systems science, cybernetics, fractal geometry, fuzzy logic, **agent-based modelling**, **cellular automata**, meteorology, physics and biology” (p.2, 8)



“Cities are complex systems par excellence, more than the sum of their parts and developed through a multitude of individual and collective decisions from the bottom up to the top down.”
(Batty et al., 2012: 483)



Eur. Phys. J. Special Topics **214**, 481–518 (2012)
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DOI: [10.1140/epjst/e2012-01703-3](https://doi.org/10.1140/epjst/e2012-01703-3)

**THE EUROPEAN
PHYSICAL JOURNAL
SPECIAL TOPICS**

Regular Article

Smart cities of the future

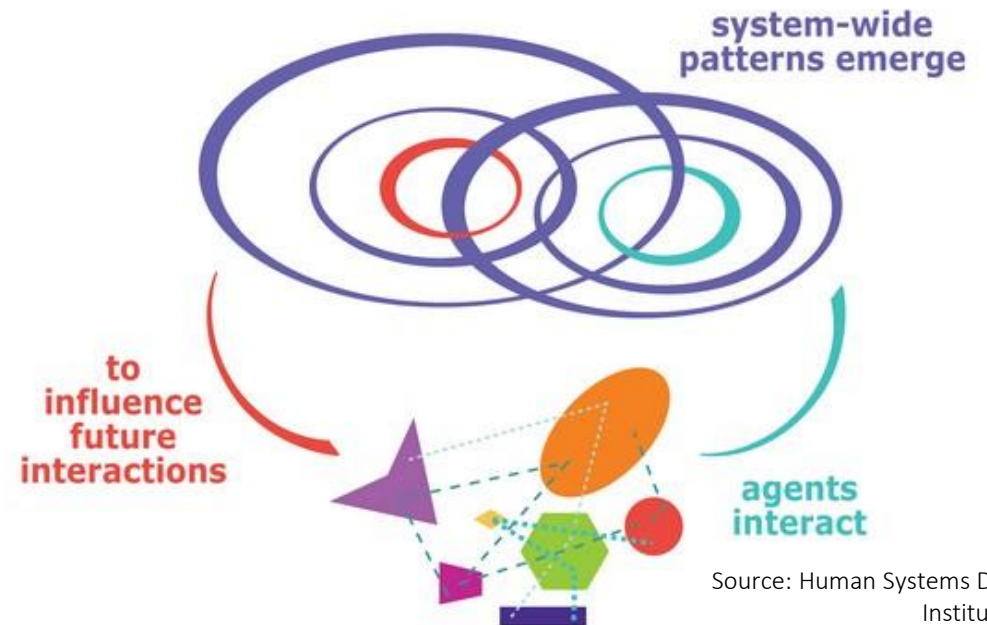
M. Batty^{1,a}, K.W. Axhausen², F. Giannotti³, A. Pozdnoukhov⁴, A. Bazzani⁵,
M. Wachowicz⁶, G. Ouzounis⁷, and Y. Portugali⁸

Applying complexity theory in urban planning to inform policies for positive behavioural change

- **Emergence**
 - Patterns/phenomena that arise (often unexpectedly) from behaviour and interactions of individual agents
- **Non-linearity**
 - Dynamics where output is difficult to be predicted from inputs
- **Feedback loops**
 - Where behaviours reinforce one another e.g., virtuous or vicious cycle
- **Micro-interactions**
 - e.g., human-human and human-environment interactions

Modelling of individual agent behaviours and their interactions
in feedback loops with system-level behaviour

— Complex Adaptive System (CAS) —

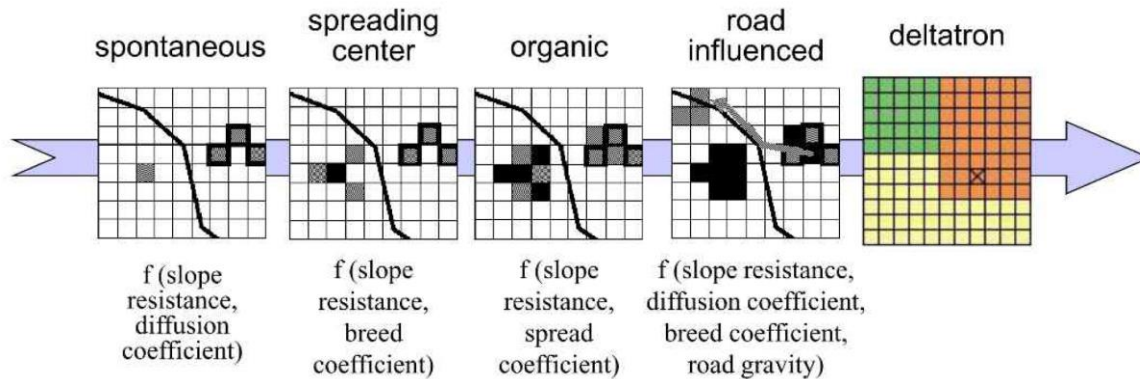


Source: Human Systems Dynamics
Institute, 2016

Cellular Automata (CA) and Agent-Based Modelling (ABM): Different Strengths

Cellular Automata (e.g. SLEUTH urban growth model)

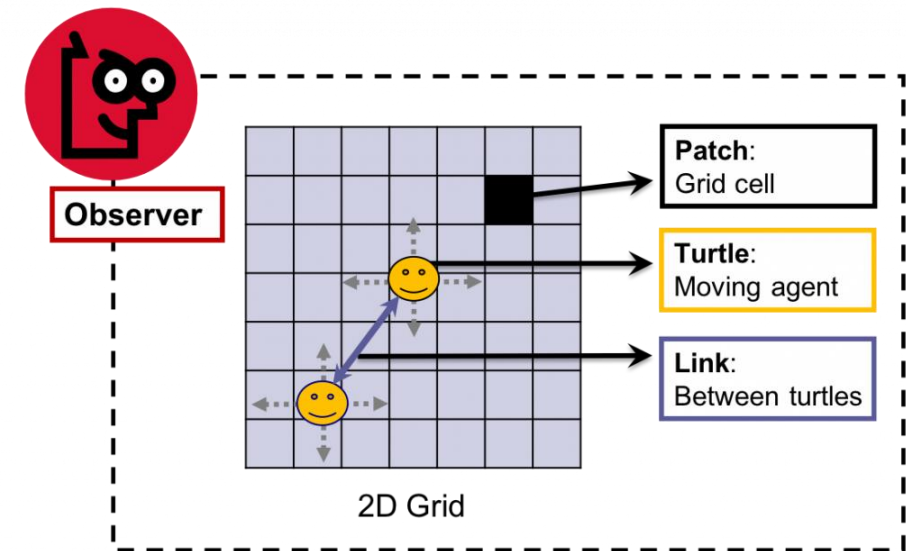
Particularly effective in modelling the spatial dynamics (e.g., land change)



Source: Clarke., 2019

Agent-Based Model (e.g. on NetLogo platform)

Particular strength in simulating human decision-making dynamics and interaction with the environment



Source: Izquierdo et al., 2019

Cellular Automata (CA)



Cellular Automata

Cellular automata is “a collection of cells on a grid of specified shape that evolves over time according to a set of rules driven by the state of the neighboring cells [45], [70],” [69].

From: *Building and Environment*, 2017

Related terms:

Geomorphological Response, Land Use Change, Urban Growth , Land Cover Change, Tungsten, Markov Chain, Geographic Information System

<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/cellular-automata>

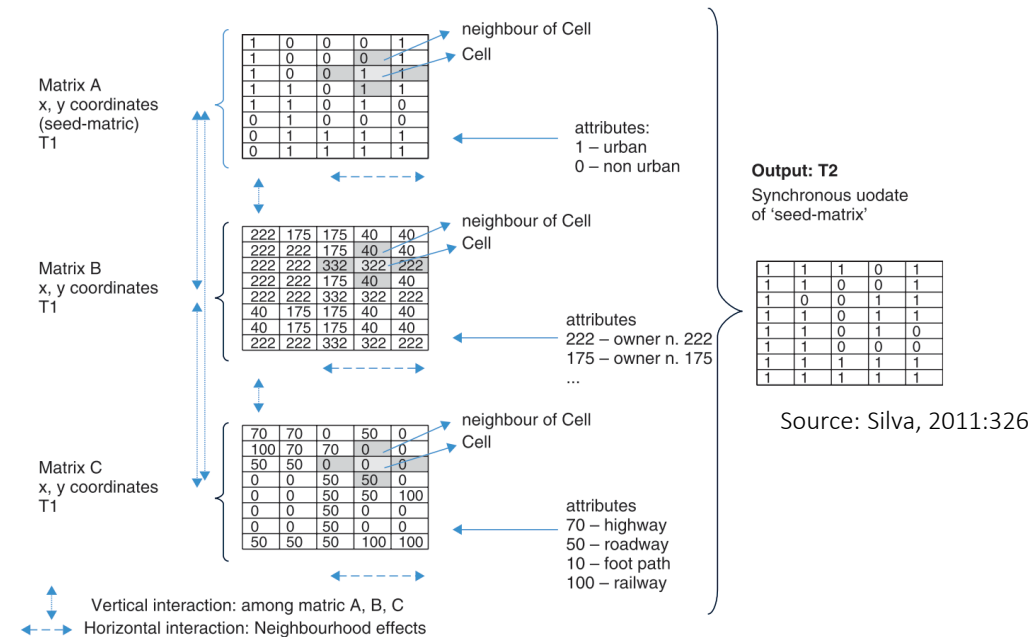
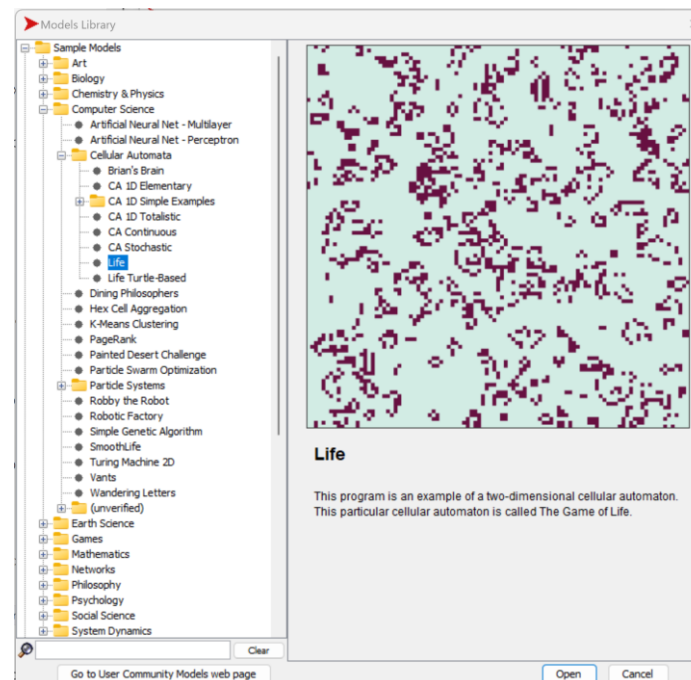


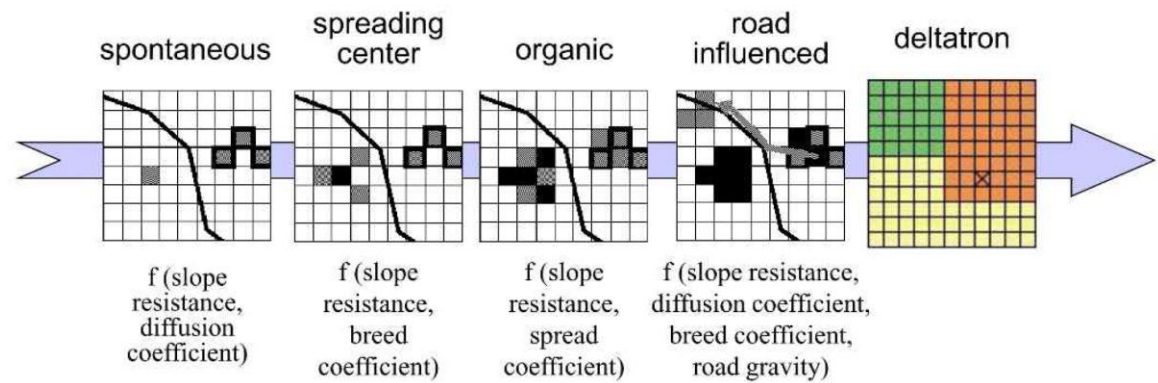
FIGURE 22.3 The cellular environment.



Good example of CA:
Conway's Game of Life

Cellular Automata (CA)

SLEUTH Urban Growth Model



Source: Clarke., 2019

European Planning Studies Vol. 13, No. 1, January 2005



Complexity, Emergence and Cellular Urban Models: Lessons Learned from Applying Sleuth to Two Portuguese Metropolitan Areas

ELISABETE A. SILVA^{1,*} & KEITH C. CLARKE²

¹Lisbon Technical University CESUR, Instituto Superior Técnico Lisboa, Portugal, ²Geography Department, University of California Santa Barbara, Santa Barbara, USA.

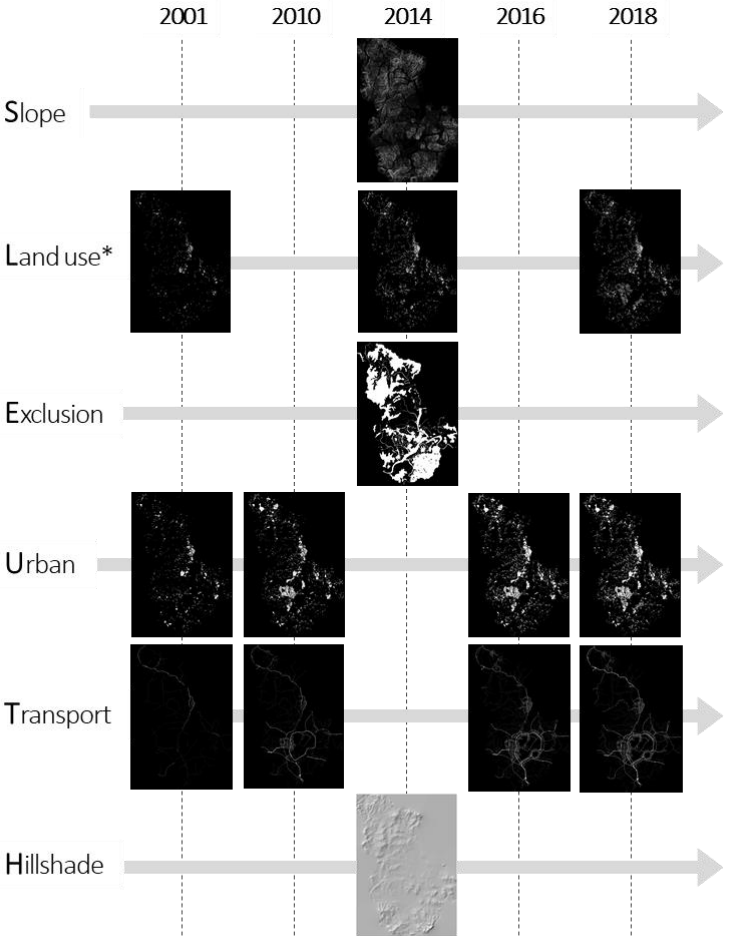
Environment and Planning B: Planning and Design 1997, volume 24, pages 247 - 261

A self-modifying cellular automaton model of historical urbanization in the San Francisco Bay area

K C Clarke, S Hoppen
Department of Geology and Geography, Hunter College, The City University of New York
Graduate School and University Center, 695 Park Avenue, New York, NY 10021;
[e-mail: kclarke@geog.UCSB.EDU](mailto:kclarke@geog.UCSB.EDU)

L Gaydos
US Geological Survey, EROS Data Center, NASA-Ames Research Center, Moffett Field,
CA 94035; [e-mail: lgaydos@mail.arc.nasa.gov](mailto:lgaydos@mail.arc.nasa.gov)
Received 23 January 1995; in revised form 24 July 1995

Input layers of NL-SLEUTH-LUTI (30*30m raster)

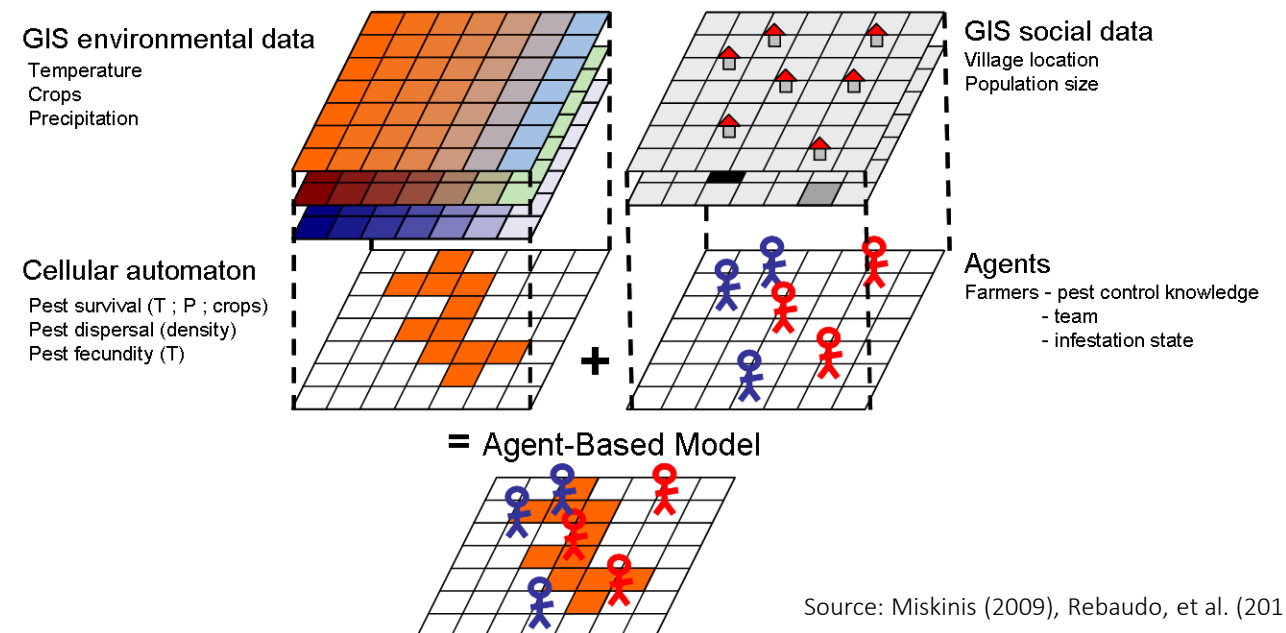
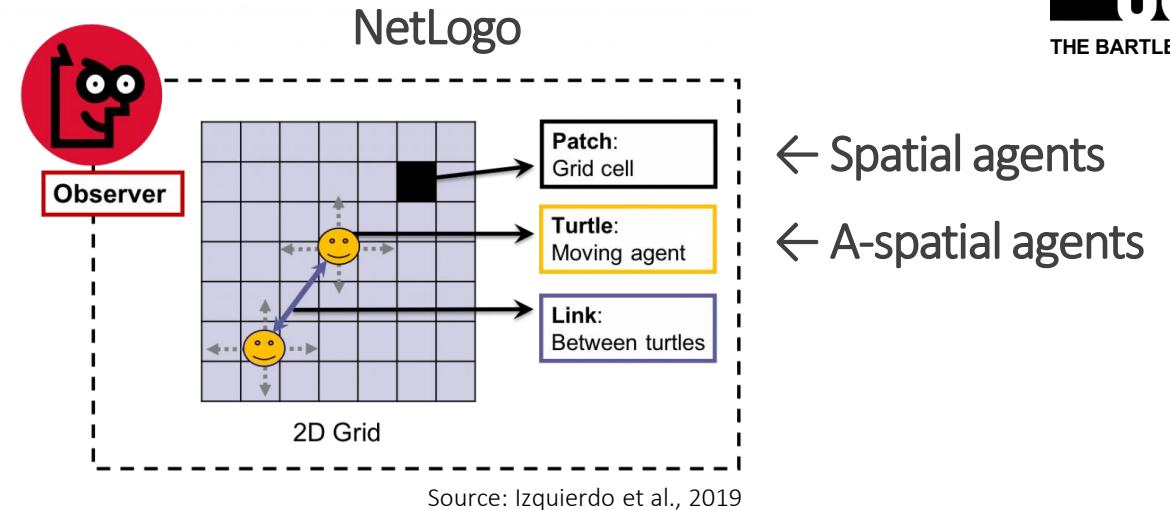


Note: Land use maps are not included in SLEUTH because the model concerns non-urban → urban only. Instead, building use is used to calculate “mixed-use” as a variable for resident behaviour.

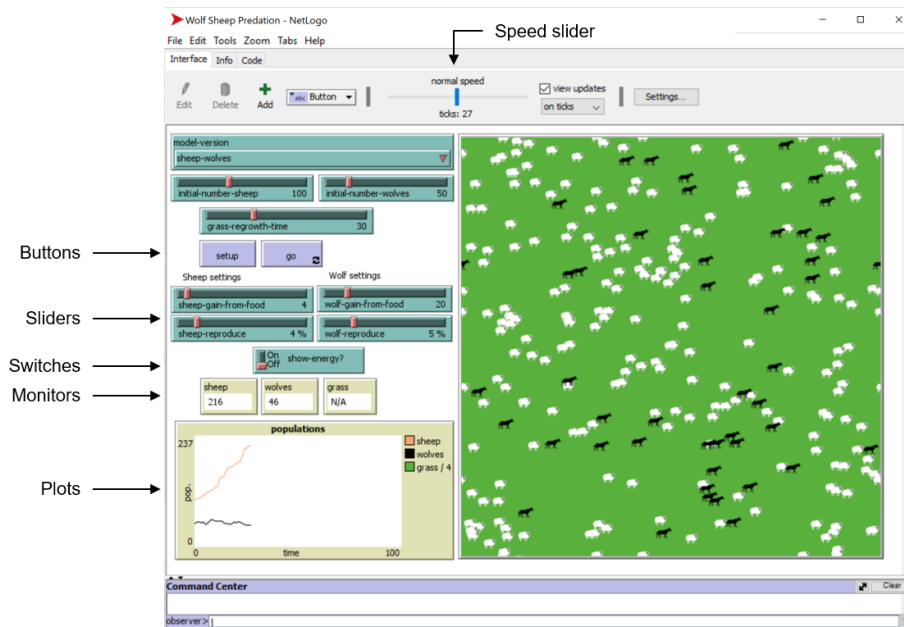
Source: Kwon et al., forthcoming a

Agent-Based Modelling (ABM)

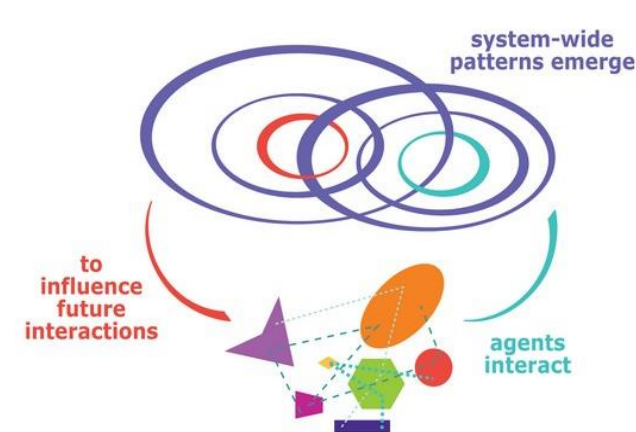
- ABMs assess the impact of autonomous agent behaviours on complex systems based on a set of behavioural rules
 - In urban planning, often used to link the physical environment and socio-economic data with agent behaviour to **simulate the change of a city over time**
 - Agents can represent various actors (land parcels, trees, people, businesses, governments...) and their behaviour can be affected by and affect the urban space



What is NetLogo?



- NetLogo is a **multi-agent programmable modeling environment** for simulating natural and social phenomena
 - Well-suited for modeling **complex systems** developing over time
- Modelers can give **instructions** to hundreds or thousands of “agents” all operating independently (**autonomous agents**)
 - Making it possible to explore the connection between the **micro-level behavior** of individuals and the **macro-level patterns** that emerge from their interaction.



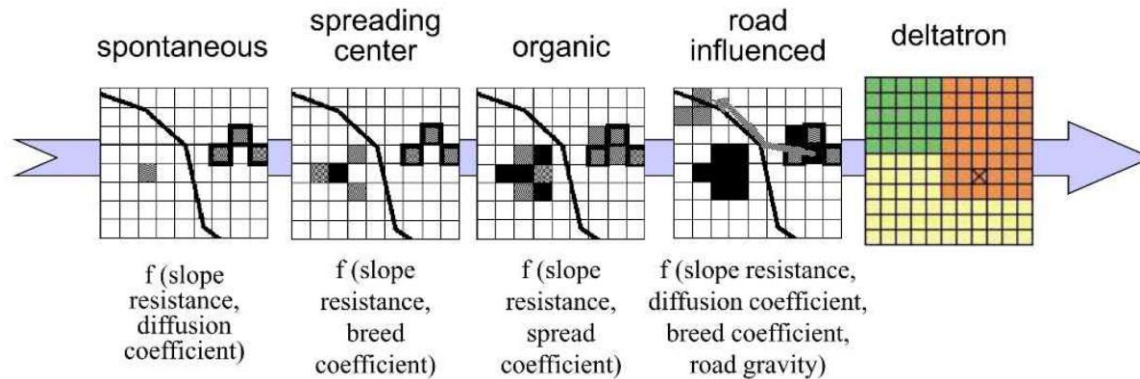
Source: (Wilensky, 2019)

Source: Human Systems Dynamics Institute, 2016

Cellular Automata (CA) and Agent-Based Modelling (ABM): Different Strengths

Cellular Automata (e.g. SLEUTH urban growth model)

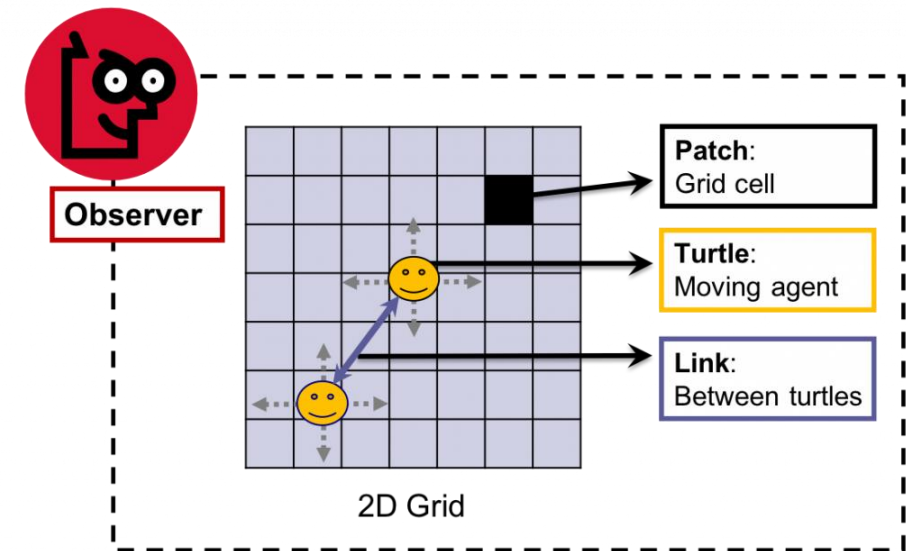
Particularly effective in modelling the spatial dynamics (e.g., land change)



Source: Clarke., 2019

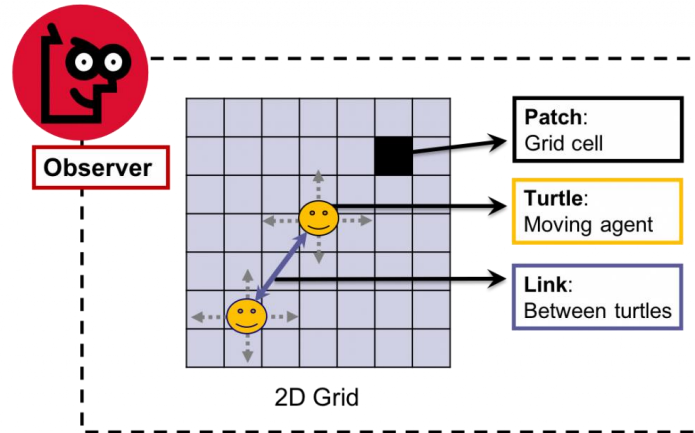
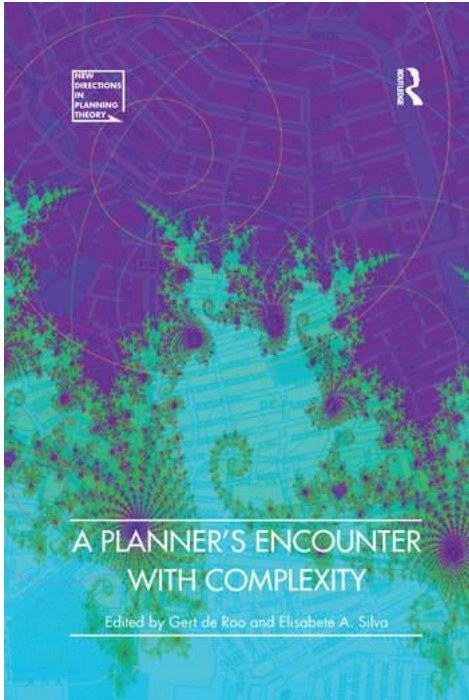
Agent-Based Model (e.g. on NetLogo platform)

Particular strength in simulating human decision-making dynamics and interaction with the environment



Source: Izquierdo et al., 2019

Hybrid CA-ABM models



Lecture 1:

Any questions?

Dr Heeseo Rain Kwon

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Bartlett School of Planning, University College London

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Home | mini_module_abm

heeseorain.github.io/mini...

mini_module_abm

Dark color scheme

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		Introduction to NetLogo: Language	Dr Heeseo Rain

Now, it's time for NetLogo!

https://heeseorain.github.io/mini_module_abm/