RM03: SPATIAL ANALYSIS AND MODELLING

Supervision 2: NetLogo – urban modelling.
27-28 Feb 2020.

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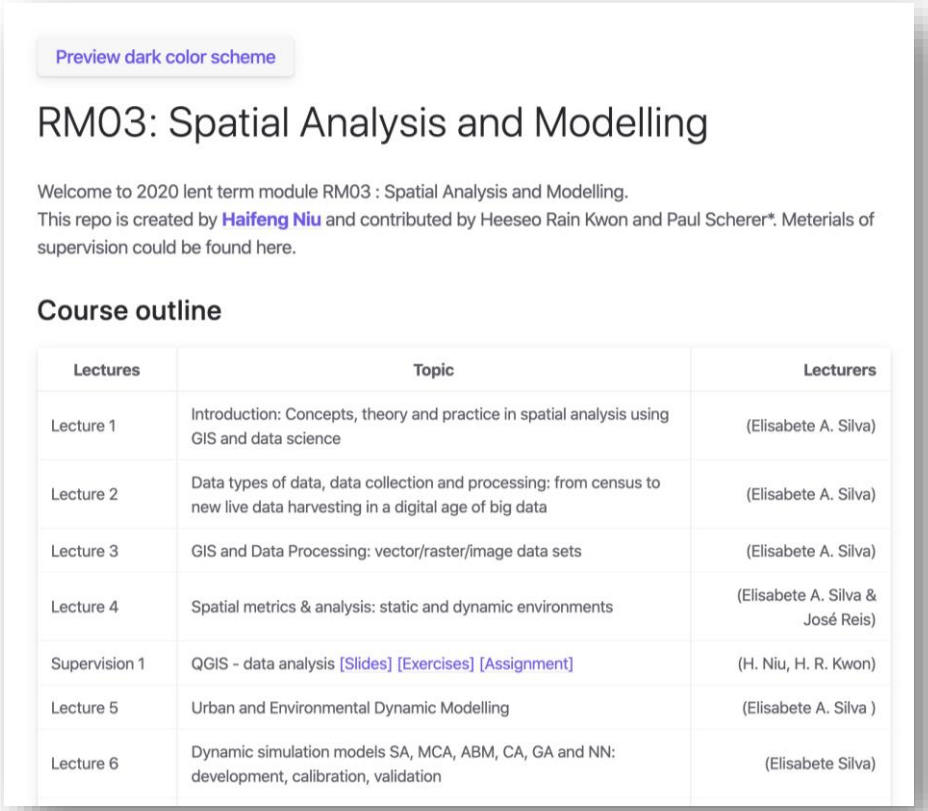
Material for supervision 2

Short Lecture (10 mins)
QGIS & NetLogo exercises (70 mins)

- **Sup2-exercises**: we will go through this together at the supervision on 27-28 February.
- **Sup2-assignment**: will be uploaded on 28 February and is due on 5 March.
- **Sup2-answers**: will be uploaded on 6 March.

- Cambridge Moodle: RM03 https://www.vle.cam.ac.uk/course/view.php?id=179012#section-2
- Online: https://hn303.github.io/CamLandEc-RM03/



Preview dark color scheme

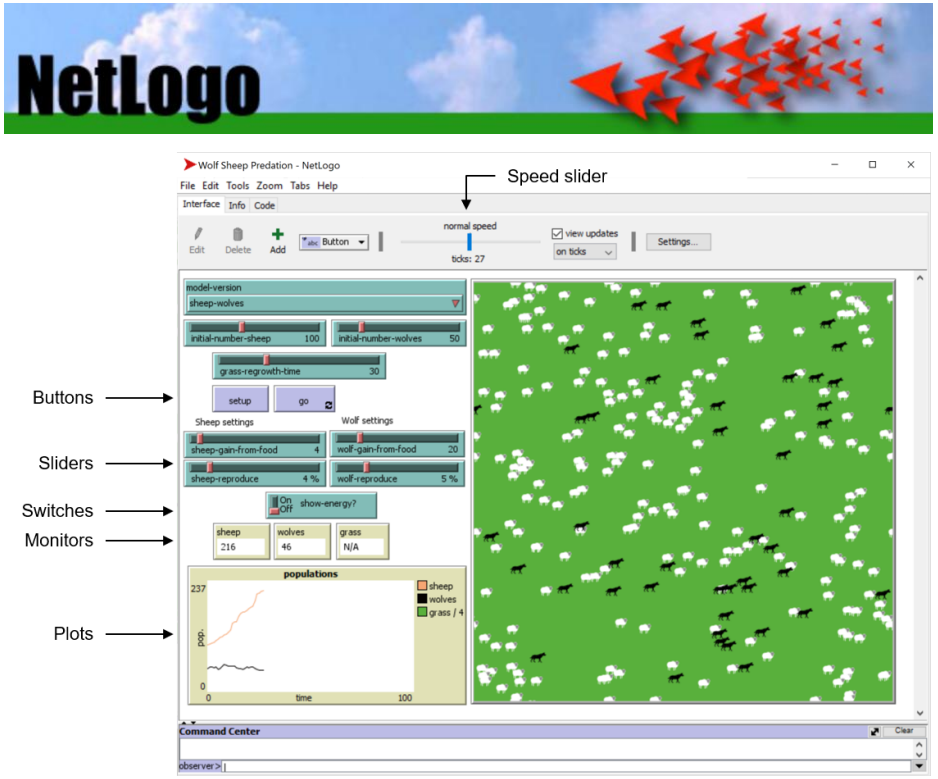
RM03: Spatial Analysis and Modelling

Welcome to 2020 lent term module RM03 : Spatial Analysis and Modelling.
This repo is created by **Haifeng Niu** and contributed by Heeseo Rain Kwon and Paul Scherer*. Meterials of supervision could be found here.

Course outline

Lectures	Topic	Lecturers
Lecture 1	Introduction: Concepts, theory and practice in spatial analysis using GIS and data science	(Elisabete A. Silva)
Lecture 2	Data types of data, data collection and processing: from census to new live data harvesting in a digital age of big data	(Elisabete A. Silva)
Lecture 3	GIS and Data Processing: vector/raster/image data sets	(Elisabete A. Silva)
Lecture 4	Spatial metrics & analysis: static and dynamic environments	(Elisabete A. Silva & José Reis)
Supervision 1	QGIS - data analysis [Slides] [Exercises] [Assignment]	(H. Niu, H. R. Kwon)
Lecture 5	Urban and Environmental Dynamic Modelling	(Elisabete A. Silva)
Lecture 6	Dynamic simulation models SA, MCA, ABM, CA, GA and NN: development, calibration, validation	(Elisabete Silva)

What is NetLogo?

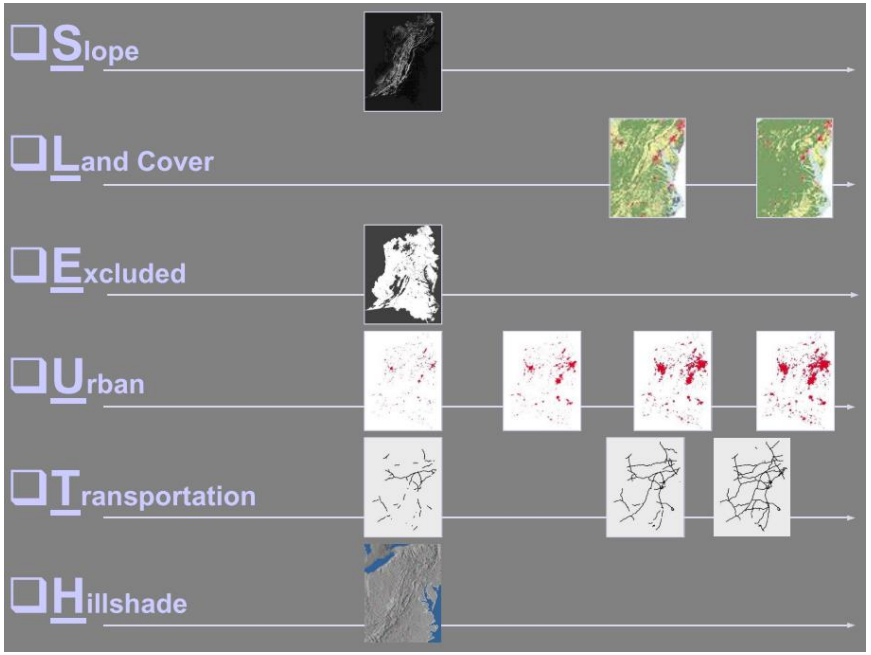


- NetLogo is a multi-agent programmable modeling environment for simulating natural and social phenomena
  - Well-suited for modeling complex systems developing over time
- Modelers can give instructions to hundreds or thousands of "agents" all operating independently
  - Making it possible to explore the connection between the micro-level behavior of individuals and the macro-level patterns that emerge from their interaction.
- In short, mobile agents (turtles) move over a grid of stationary agents (patches)
- Advantages: much easier to code compared to other languages (e.g. C++, Python…), easy to distribute the model to others as it is an open-source software

Source: (Wilensky, 2019)

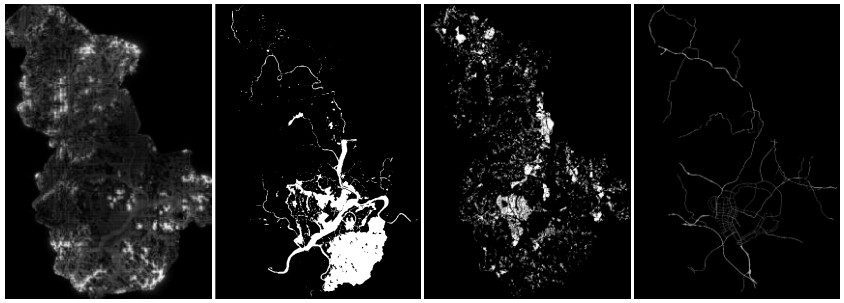
SLEUTH Urban Growth Model

- SLEUTH is a Cellular Automata (CA) based urban growth model developed by K.C. Clarke.
  - Stands for slope, land use, exclusion, urban, transportation, and hillshade layers which form the model input (Silva & Clarke, 2002).
- It originally uses C++ language but it is being translated to NetLogo including calibration (Kwon, Silva, Scherer & Clarke, forthcoming).
- SLEUTH requires one slope, two land-use (if land use change is to be simulated), one exclusion, four urban, three transport, and one hillshade layers with control years as well as calibration (brute force, Monte Carlo methods).



Source: Clarke (2019)

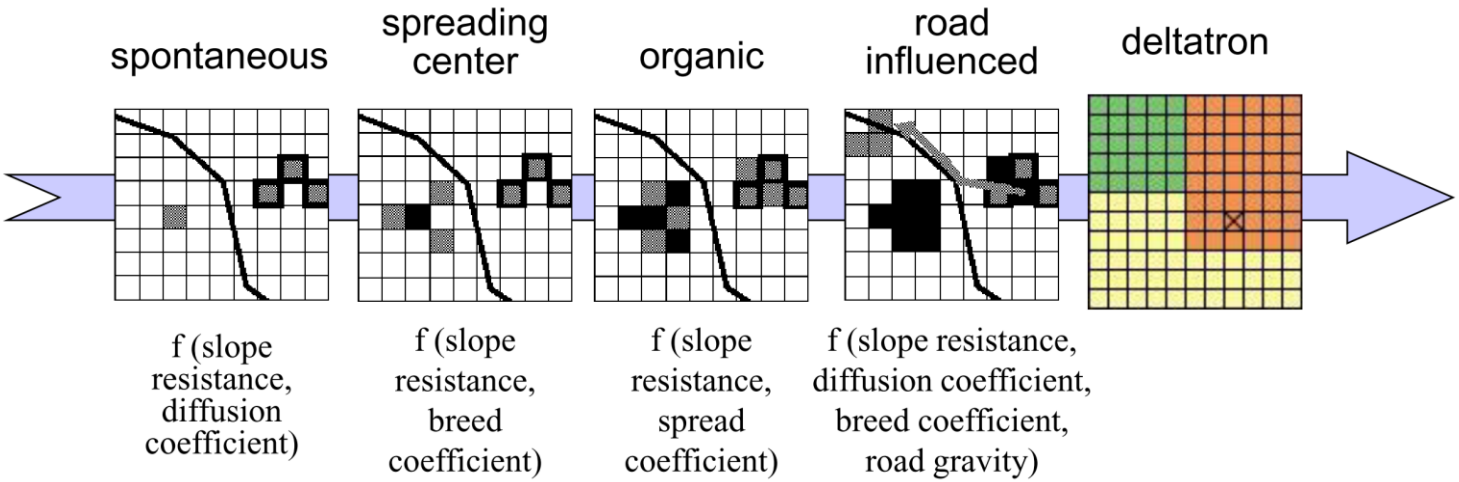
- For the sake of a simple exercise, we will prepare four raster maps (.asc) on QGIS as input layers for SLEUTH model in NetLogo without calibration.



Slope (2014) Exclusion (2014) Urban (2018) Transport (2018)

Growth rules in SLEUTH

Rules for cell behaviour

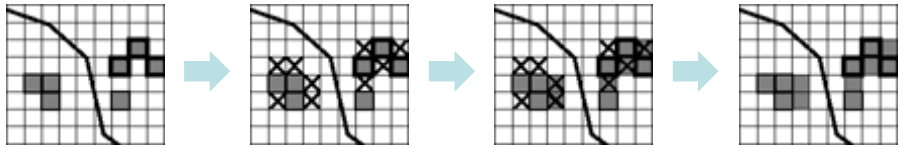


- **Spontaneous growth**: defines the occurrence of random urbanisation of land
- **Spreading centre growth**: determines whether any of the new, spontaneously urbanised cells will become new spreading centres.
- **Edge growth**: defines the part of the growth that stems from existing spreading centres.
- **Road-influenced growth**: determined by the existing transportation infrastructure as well as the most recent urbanisation done under previous three steps.
- * **Deltatron** can be added for modelling land cover change (not just urbanisation).

Source: Clarke (2019)

Growth rules in SLEUTH

Example: Behaviour rule for edge growth



```
151 to edge_growth
152   ask patches with [urban = 1]
153     [let x random max_coefficient
154       if ( x < spread_coefficient) and ( count neighbors with [urban = 1] > 1 ) and (count neighbors with [urban = 0] > 0)
155         [ask n-of 1 neighbors with [urban = 0]
156           [if suitable = 1 [set urban 1 set new_urbanized 1] ]
157         ]]
158 end
```

*Usually, we write 0= no, 1=yes

- If a patch is urban,
- If [a positive random integer less than the max_coefficient (i.e.100)] is smaller than the spread_coefficient,
- If at least two urban neighbours exist,
- And if at least one non-urban neighbour is available for urbanisation,
- Randomly select one non-urban neighbour,
- If the selected cell is suitable to build, urbanise the cell and set it as “new_urbanized” for the next step (road-influenced growth).

Source: Clarke (2019)

Useful links

- Wilensky, U. (2019) NetLogo User Manual version 6.1.1, Available at: https://ccl.northwestern.edu/netlogo/docs/

- USGS and UCSB (2017) Project Gigalopolis, Available at: http://www.ncgia.ucsb.edu/projects/gig/About/about.html

- Silva, E.A. and Clarke, K.C. (2005) 'Complexity, Emergence and Cellular Urban Models: Lessons Learned from Applying Sleuth to Two Portuguese Metropolitan Areas', European Planning Studies, 13(1), pp. 93–115. Available at: http://www.tandfonline.com/doi/pdf/10.1080/09654310420003124 24?needAccess=true

- Silva, E.A. and Clarke, K.C. (2002) 'Calibration of the SLEUTH urban growth model for Lisbon and Porto, Portugal', Computers, Environment and Urban Systems, 26(2002), pp. 525–552. Available at: https://www.sciencedirect.com/science/article/pii/S01989715010001 4X