GEOGR 5221 Spatial Simulation and Modeling - Autumn 2014	
Instructor:	Harvey J. Miller
Class meetings:	(TU) Tuesday 5:30 PM – 6:50 PM Denney Hall 0238 (TH) Thursday 5:30 PM – 6:50 PM Derby Hall 0140
Office hours:	Tuesday 2:00 PM – 3:30 PM Thursday 3:30 PM – 5:00 PM (both times in Derby 1176)
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Lab GTA:	**Bo Zhao** **Office hours:** 9:00 AM – 11:00 AM Derby Hall 0126
Texts	
Required:	1. Flake, G. W. (1999) *The Computational Beauty of Nature*, MIT Press. Available at the bookstore or Amazon.com (no e-book format; sorry). 2. Additional readings (posted at Carmen)

Course Description

This course is about the use of computational techniques to simulate the evolution of complex spatial systems such as ecosystems, transportation, weather/climate, cities, economies, societies and landscapes. These and other complex systems have a multitude of relatively simple parts interacting over space and time to create surprising, emergent behaviors. Powerful computation techniques, often linked with GIS software, allow the simulation of realistically large systems at a fine-level of granularity, providing new insights that were unavailable through traditional modeling techniques

We will study the deep linkages between the nature of computation and computation in nature. We will also study specific techniques such as fractals, chaos, cellular automata, agent-based modeling, evolutionary game theory and artificial neural networks.

We will also have hands-on, practical experience with NetLogo, a free, open source agent-based modeling software that is well-suited for simulating spatio-temporal processes.

Learning Objectives

1. **Understand the nature of complexity and complexity in nature**: The ability to describe what makes a system complex and recognize complexity in real-world spatial systems
2. **Understand the nature of computational techniques**: A basic understanding of computation, the limits of computation and the relationship between computational limits and complex behavior.
3. **Understand computational science as a tool for scientific investigation**: The ability to translate theory into simulation models and design experiments for

investigating theory; an understanding of the strengths and weaknesses of this approach to scientific investigation.

4. **Understand common simulation techniques:** A basic understanding of techniques that are especially well-suited for simulating physical and human geographic processes such as fractals, chaos, cellular automata, agent-based modeling, evolutionary game theory and artificial neural networks
5. **Design and use of spatial simulation techniques**: The ability to design a spatial simulation based on a real-world process and experiment with the model to understand that process.
6. **Spatial simulation software skills**: The ability to program and operate within the NetLogo software environment.

Evaluation

Weights	
Assignments	50% of final grade
Examinations	50% of final grade
Grading scale	(OSU standard scale) A 93-100%; A- 90-92%; B+ 87-89%; B 83-86%; B- 80-82%; C+ 77-79%; C 73-76%; C- 70-72%; D+ 67-69%; D 60-66%; E 0-59%

Assignments

There will be a series of NetLogo-based lab assignments throughout the semester. I will announce these via Carmen and in class.

Examinations

There will be 4 short examinations during the semester, including a (non-comprehensive) final examination. *Examination questions will be drawn from both the lectures and the readings.*

Exams will be online using Carmen, but will occur during normal class times using the computers in DB 0140.

Policies

1. **Disability services.** Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/

2. **Academic misconduct.** It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged

academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct: http://studentlife.osu.edu/pdfs/csc_12-31-07.pdf

3. **Technology policy:** This is the 21st century, so I will not ban the use of laptops, tablets and other digital devices. However, there are some guidelines and restrictions:
   a. **Be mindful** – when you are emailing, tweeting, texting, updating, surfing, etc. you are not paying attention. Research shows that no one can multitask that well – not even you. Paying attention and taking good notes is essential to success in this course. Why are you here?
   b. **Be courteous –** your use of digital devices should not distract other students in the class. It is unlikely that taking notes or searching class-relevant topics will be distracting. However, viewing videos of kittens or ice bucket challenges will likely distract others. Complaints about inappropriate technology use in class will result in your privileges being curtailed or revoked.
   c. **Be honest** - emailing, surfing, and the use of any other applications or technologies is not allowed during the computer-based examinations. Be aware that your activity on the lab desktop computers may be monitored during exams.

Carmen

This course will make use of the Carmen online learning system. I will be posting slides from my lectures, readings, interesting websites, assignments and project milestones. Students are responsible for all material and announcements posted at Carmen.

NetLogo

NetLogo is a **free, open-source** multiagent simulation environment. It is especially well-suited for modeling geographic processes over time. NetLogo will be available on the computers in Derby Hall 0140. Also feel free to download and install NetLogo on your personal machines: http://ccl.northwestern.edu/netlogo/

Computer Lab

DB 0140 is a secure computer lab. Please be sure to logout of your computer and close the door when you leave. Please do not prop the door open.

Date	Topics/activities	Readings/Labs
28 Aug (TH)	Course overview; NetLogo	Lab 1
2 Sept (TU)	Computational science and geocomputation	CBN Chp. 1; Couclelis (1998); Miller (2007)
4 Sept (TH)	The NetLogo World and its Agents	Lab 2
9 Sept (TU)	Number systems and infinity	CBN Chp. 2
11 Sept (TH)	Programming with NetLogo	Lab 3
16 Sept (TU)	Computability and incomputability	CBN Chp. 3 and 4
18 Sept (TH)	**Exam 1- Computational science, geocomputation and nature**	
23 Sept (TU)	Self-similarity and fractal geometry	CBN Chp. 5
25 Sept (TH)	Variables and Breeds in NetLogo	Lab 4
30 Sept (TU)	L-systems and fractal growth	CBN Chp. 6

2 Oct (TH)	Drawing fractals with NetLogo	Lab 5
7 Oct (TU)	Affine transformation fractals	CBN Chp. 7
9 Oct (TH)	L-systems and fractal growth	Lab 6
14 Oct (TU)	The Mandlebrot set and Julia sets	CBN Chp. 8 and 9
16 Oct (TH)	**Exam 2 - Fractals**	
21 Oct (TU)	Nonlinear dynamics	CBN Chp. 10
23 Oct (TH)	Moving data between NetLogo and ArcGIS	Lab 7
28 Oct (TU)	Strange attractors	CBN Chp. 11
30 Oct (TH)	Modeling system dynamics using NetLogo	Lab 8
4 Nov (TU)	Producer-consumer dynamics	CBN Chp. 12 and 14
6 Nov (TH)	**Exam 3 – Nonlinear dynamics and chaos**	
11 Nov (TU)	Veteran's Day – No Classes	
13 Nov (TH)	Using BehaviorSpace	Lab 9
18 Nov (TU)	Cellular automata	CBN Chp. 15
20 Nov (TH)	Cellular automata in NetLogo	Lab 10
25 Nov (TU)	Cellular automata	Brown et al. (2005); Tobler (1979)
27 Nov (TH)	Thanksgiving Day – no classes	
2 Dec (TU)	Autonomous agents and self-organization	CBN Chp. 16
4 Dec (TH)	Agent-based modeling in NetLogo	Lab 11
9 Dec (TU)	Competition and cooperation	CBN Chp. 17
16 Dec (TU)	**Exam 4 - Complex systems** (Note: 8:00pm-9:45pm in DB 0140)	

OTHER READINGS

- Brown, D.G., Riolo, R., Robinson, D. T., North, M. and Rand, W. (2005) "Spatial process and data models: Toward integration of agent-based models and GIS," *Journal of Geographical Systems*, 2, 25-47.
- Couclelis H., (1998) ``Geocomputation and space" *Environment and Planning B: Planning and Design* (25th anniversary issue), 25, S41 - S47
- Miller, H. J. (2007) "Geocomputation," in A. S. Fotheringham and P.A. Rogerson (eds.) *Handbook of Spatial Analysis*, Sage Publications.
- Tobler, W. R. 1979. "Cellular geography," in S. Gale and G. Olsson (eds.) *Philosophy in Geography*, 379-386.