Term Information

Effective Term	Spring 2023
Previous Value	*Autumn 2015*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

We request to change the course number from 5226 to 6226.

What is the rationale for the proposed change(s)?

We would like to use this as an advanced course in the curriculum of a new professional masters program, which will be proposed soon in Autumn 2021. This course in its current form contains advanced topics that is suitable to professional masters students.

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

In the attached explanation document entitled Geography Curriculum Mapping: Summary of Changes, we explain that such a change will not affect the coverage of the proficiencies of our undergraduate program.

Is approval of the requrest contingent upon the approval of other course or curricular program request? No

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Geography
Fiscal Unit/Academic Org	Geography - D0733
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Course Number/Catalog	6226
Previous Value	*5226*
Course Title	Spatial Simulation and Modeling in GIS
Transcript Abbreviation	GIS Sim&Modeling
Course Description	Fundamental modeling and simulation techniques in GIS, including cellular automata, diffusion models, and agent-based models, and their applications in social, environmental, and natural resources research.
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week, 12 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	Yes
Is any section of the course offered	100% at a distance
Previous Value	*No*
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No

Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	
Exclusions	Not open to students with credit for 5221 or 5226
Previous Value	Not open to students with credit for 5221 or 685.
Electronically Enforced	No

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	27.0303
Subsidy Level	Doctoral Course
Intended Rank	Masters, Doctoral
Previous Value	*Junior, Senior, Masters, Doctoral*

Requirement/Elective Designation

Required for this unit's degrees, majors, and/or minors
The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Understand the nature of complexity and complexity in nature
- Understand the nature of computational techniques
- Understand computational science as a tool for scientific investigation
- Understand and use spatial simulation techniques

Content Topic List

- Fundamental modeling and simulation techniques in GIS
- Cellular automata
- Diffusion models
- Agent-based models
- Applications in social, environmental, and natural resources research

Sought Concurrence No

Attachments

- GEOG6226-inperson.docx: Syllabus (in-person)

  (Syllabus. Owner: Xiao,Ningchuan)

- GEOG6226-online-spatial-simulation-modeling.docx: Syllabus (online)

  (Syllabus. Owner: Xiao,Ningchuan)

- GEOG6226-online-asctech-review.docx: ASCTech review (online)

  (Other Supporting Documentation. Owner: Xiao,Ningchuan)

- Curriculum_map_GEOG_GIS_ONLY.pdf: Curriculum maps

  (Other Supporting Documentation. Owner: Xiao,Ningchuan)

- Curriculum_map_summary_GIS-all.docx: Summary of changes in curriculum maps

  (Other Supporting Documentation. Owner: Xiao,Ningchuan)

- GEOG5226-inperson.docx: Syllabus (in-person, current)

  (Syllabus. Owner: Xiao,Ningchuan)

Comments

- The course number has not been changed in curriculum.osu.edu *(by Vankeerbergen,Bernadette Chantal on 11/12/2021 09:38 AM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Xiao,Ningchuan	11/09/2021 12:57 AM	Submitted for Approval
Approved	Xiao,Ningchuan	11/09/2021 12:58 AM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	11/12/2021 09:41 AM	College Approval
Submitted	Xiao,Ningchuan	11/12/2021 09:53 AM	Submitted for Approval
Approved	Xiao,Ningchuan	11/12/2021 09:56 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	11/12/2021 10:22 AM	College Approval
Pending Approval	Cody,Emily Kathryn Jenkins,Mary Ellen Bigler Hanlin,Deborah Kay Hilty,Michael Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	11/12/2021 10:22 AM	ASCCAO Approval

GEOG 6226 Spatial Simulation and Modeling in GIS (Online) Syllabus

Instructor Information

- Instructor: Dr. Yang Song, song.630@osu.edu
- Office Hours: TBD

Teaching Assistant Information

- Teaching Assistant:
- Office Hours:

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 computational 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 explore three major types of "building-blocks" at the core of many dynamic spatial models: i) spatial aggregation and segregation processes; ii) random walks and mobile entities, and; iii) percolation and growth processes. We will also discuss issues such as the role of spatial simulation in geographic information science, representation of space and time, how to build more complete models of human, physical and linked human-physical dynamic spatial processes, and how to evaluate model performance and uncertainty.

This course is 100% online, and there is no required log-in to Carmen at a scheduled time. The course is divided into weekly modules which are released weekly. Students are expected to keep up with weekly deadlines. This is a 3-credit hour class. For each week, students should expect approximately 3 hours spent on online lectures and labs, and 6 hours of independent study such as textbook reading, online quizzes, lab assignments and preparation for the exam to earn a C grade.

Materials

- Textbook (required):
  - O'Sullivan, D. and Perry, G. (2013) *Spatial Simulation: Exploring Pattern and Process,* Wiley. Available at university bookstore; also available in e-book format from Amazon.
- Readings:
  - Additional readings and webpages will be posted at the Canvas course website. These resources will provide additional background material as

well as deeper dives into the science behind the models discussed in class.

- Data storage:
  - A portable memory device (with 16GB or larger storage) or a cloud drive (Box, Dropbox etc.) is needed for data storage.

Evaluation:

- Assignments – 50%
  - There will be a series of NetLogo-based lab assignments throughout the semester. All lab assignments will be submitted via the course website and count toward your final grade of the course. Most lab assignments are due one week after each lab session (at 6:00pm of the due day). Lab 4 will be given two weeks to finish.
- Exams – 50%
  - There will be 4 short examinations (20 -25 questions) during the semester. Exam questions will be drawn from the lectures, textbooks and labs. Exams will be online using Carmen, but will occur during normal class times using the computers in our normal classroom.
- Grading Scale (OSU standard scale):

A	93-100%	B-	80-82%	D+	67-69%
A-	90-92%	C+	77-79%	D	60-66%
B+	97-89%	C	73-76%	E	0-59%
B	83-86%	C-	70-72%		

  - Your final grade as seen on the course website will be rounded to the nearest whole number (e.g. an 89.49 is a B+ while an 89.50 is an A) before being submitted to the University Registrar at the end of the semester.

Course Policies:

- Email correspondence policy
  - You are responsible for all course related emails, so be sure to check your inbox on a daily basis.
  - When emailing your instructor or TA, please always begin the subject of the email with the course number (GEOG6226) and your name (first name followed by last name). This is important as your instructor and TA teach multiple classes and need to know to which class you are referring. A proper email subject should be like this:

    GEOG6226_John Smith_Schedule a make-up exam
- Course website policy
  - You are responsible for all announcements, additional readings, assignments and other material posted on the course website. Be sure to check it frequently.
- Lab questions policy
  - Please send your lab-related questions as least 24 hours before the day/time the lab is due to allow your TA time to respond.
- Late submission policy

    - Lab assignments will be penalized 10% for each day late.
    - Extensions will not be granted due to lost work. Be sure you back up and keep all your work.
- Exam policy
    - Exams must be taken at the scheduled time, unless you have informed your instructor before the exam with proper reasons and documents, and got approved by the instructor. Please contact your instructor in advance of the scheduled exam to schedule a make-up exam, except in the case of emergency.
    - You are expected to finish all exams on time. Exams begin when schedule class time begins, and exams end when the scheduled time ends. At the end of the scheduled class time, you are to stop working and turn in your exam. You may not continue working on your exam after the scheduled class time.
- Disability services policy
    - Students with disabilities that have been certified by the Office for Disability Services (SLDS) will be appropriately accommodated and should inform the instructor as soon as possible of their needs.
        - Address: 098 Baker Hall, 113 W. 12th Ave, Columbus, OH 43210
        - Telephone: 614-292-3307
        - Website: http://slds.osu.edu/
    - Registration with SLDS does not grant accommodations automatically. You need to bring the accommodation form provided by SLDS to the instructor to work out a plan for accommodations. Please contact the instructor as soon as you are registered with SLDS for attendance, assignment and/or exam accommodations.
- Academic Misconduct policy
    - 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.
    - Collaboration for the purposes of troubleshooting is highly encouraged in this course, but everyone is expected to submit their own unique work. For example, asking a classmate how to resolve an unexpected error message is OK, but using another classmate’s work (e.g. screen captures, etc.) as your own is NOT ok, regardless of whether or not they provide consent for the use of their materials. (Note: There are many other acceptable/unacceptable actions than those exemplified here.) If you have any questions or concerns about acceptable/unacceptable actions, ask your instructor for clarification/permission.

    - All open-ended responses to questions, prompts, etc. must be written entirely, nearly entirely, or at least in majority using your own words. Use credible sources, and cite all sources, including those only referenced, those indirectly paraphrased, and those directly quoted, being sure to use quotation marks to identify excerpts from these credible sources. This expectation to cite all of your sources also extends to the textbook, the lab instructions, lecture slides, other course materials, online resources, etc. Please contact Center for the Study and Teaching of Writing (CSTW, https://cstw.osu.edu/writing-center) or the instructor if you have difficulties organizing language for assignments.
- Other Course Policy
    - Please refer to Student Academic Services for more academic services provided by OSU.
    - Other student services can be accessed here.

Software

Other Course Technology

Please contact OSU IT Service Desk for any help with password, university e-mail, Carmen, or any other technology issues, questions, or requests. Standard support hours are available at https://ocio.osu.edu/help/hours, and support for urgent issues is available 24x7.

- Phone: 614-688-HELP (4357)
- Email: 8help@osu.edu
- Self-Service and Chat support: http://ocio.osu.edu/selfservice

Basic technical skills necessary for this course

- Basic computer and web-browsing skills
- Navigating and utilizing Carmen

Equipment

- Computer: a Windows/Mac PC is needed.
- Webcam: built-in or external webcam, fully installed.
- Microphone: built-in laptop or tablet mic or external microphone.

Software

- NetLogo
    - It will be available on the computers in our lab. However, since it is free and open source, you can download and install NetLogo on your personal machines: https://ccl.northwestern.edu/netlogo/ *However, note that you are on your own with installations on personal machines; we cannot provide technical support*.
    - The basic NetLogo install is simple, but some of the programs we will look at this semester will use the *gradient* extension. Installing the gradient extension is easy: go to this link, download and unzip the folder called

gradient containing a single file called *gradient.jar*. Copy the entire folder to the same folder as your NetLogo models, or to the NetLogo *extensions* folder. (Some NetLogo models also require an R extension for data analysis and reporting, but we will not be using these models.) For more details on these extensions, see the textbook authors' website: http://patternandprocess.org/. You can also follow NetLogo on Twitter: https://twitter.com/NetLogo.
    - System requirements of Netlogo can be found here. There are no official privacy policies from developers of QGIS.
- NetLogo models
    - Since it is open source, NetLogo comes with a wealth of freely available models (programs) across a wide range of applications. Models sources include:
        - Models Library - available in the NetLogo software itself; look under "Files" → "Models Library"
        - User community: https://ccl.northwestern.edu/netlogo/models/community/
- Models discussed in the textbook
    - The O'Sullivan and Perry text references and discusses a large number of NetLogo models. You should experiment with these models as part of your study ***prior to class***. We will also work with some of these models in class.
    - Windows versions of the NetLogo models are available at the Canvas site: unzip the archive and copy the entire directory (including the gradient subdirectory) to your laptop or to a portable storage device for use during class.
    - Other sources for the NetLogo models, including Mac versions, include:
        - The authors' website, **Pattern and Process**: http://patternandprocess.org/.
        - O'Sullivan also maintains the most up-to-date versions of these models at a github repository: https://github.com/DOSull/model-zoo. (Note that the github repository may be incomplete: some models from the textbook may be missing.)
- Proctorio: A software to monitor online exams. More details can be found here.

Schedule

Week	Content	Reading	Note
1	Course overview		
	Lab 1 – Experimenting with NetLogo		
2	1.1. What are simulation models? 1.2. How do we use simulation models?	Chapter 1	Lab 1 Due
	1.3. Why do we use simulation models? 1.4. Why dynamic and spatial models?	Chapter 1	
3	Lab 2 – NetLogo world and agents		
	2.1 What is a pattern? 2.2. Using models to explore spatial patterns and process	Chapter 2	
4	2.2. Using models to explore pattern and process (continued)	Chapter 2	Lab 2 Due
	Exam 1		
5	Lab 3 - Programming with NetLogo		
	3.1. Background 3.2. Local averaging	Chapter 3	
6	3.3. Totalistic automata	Chapter 3	Lab 3 Due
	3.4. Interacting particle systems	Chapter 3	
7	3.5. Schelling models 3.6. Spatial partitioning 3.7. More complicated models	Chapter 3	
	Exam 2		
8	Lab 4 - Variables and Breeds		
	4.1. Background 4.2. The random walk	Chapter 4	
9	4.3. Foraging and searching	Chapter 4	
	4.4. Moving entities and landscape interaction 4.5. Entity-entity interaction	Chapter 4	
10	***Exam 3***		Lab 4 Due
	Lab 5 - NetLogo and GIS data		
11	5.1. Motivating example 5.2. Percolation models	Chapter 5	
	5.3. Growth models	Chapter 5	Lab 5 Due
12	5.3. Growth models (continued) 5.4. Applying the framework	Chapter 5	
	Lab 6 - Agent-based modeling		
13	***Exam 4***		
	Work for Lab 7, no class		Lab 7 Due

This course schedule provides a general plan for the course. Any changes will be announced by the instructor with as much advance notice as possible.

GEOG 6226 Spatial Simulation and Modeling in GIS – Autumn 2019 Syllabus

Meeting Time: MW 02:20pm – 3:40pm, Derby Hall 135

Instructor Name and Email: Dr. Yang Song, song.630@osu.edu
- Office Hours: Wednesday 11:00am-1:00pm @ 1120 Derby, or by appointment.

Teaching Assistant Name and Email: Rohit Mukherjee,mukherjee.110@osu.edu
- Office Hours: Mondays 12:00pm – 2:00pm @ 1131 Derby, or by appointment.

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 computational 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 explore three major types of "building-blocks" at the core of many dynamic spatial models: i) spatial aggregation and segregation processes; ii) random walks and mobile entities, and; iii) percolation and growth processes. We will also discuss issues such as the role of spatial simulation in geographic information science, representation of space and time, how to build more complete models of human, physical and linked human-physical dynamic spatial processes, and how to evaluate model performance and uncertainty.

Materials:
- Textbook (required):
  - O'Sullivan, D. and Perry, G. (2013) *Spatial Simulation: Exploring Pattern and Process,* Wiley. Available at university bookstore; also available in e-book format from Amazon.
- Readings:
  - Additional readings and webpages will be posted at the Canvas course website. These resources will provide additional background material as well as deeper dives into the science behind the models discussed in class.
- Data storage:
  - A portable memory device (with 16GB or larger storage), such as a portable hard drive or flash drive, is required. Please bring it with you to every lab session as all your work needs to be saved to this device.
  - You can also store your data with a cloud drive (Box, Google Drive etc.). Please remember to log out the cloud drive when you finish using a lab PC.

Evaluation:
- Assignments – 40%
  - There will be a series of NetLogo-based lab assignments throughout the semester. All lab assignments will be submitted via the course website and count toward your final grade of the course. Most lab assignments are due one week after each lab session (at 5:00pm of the due day). Lab 4 will be given two weeks to finish.

    - Do not expect to finish all lab work during the scheduled lab time. You will need to work outside of class to complete your labs.
- Exams – 45%
    - There will be 4 short examinations (20 -25 questions) during the semester. Exam questions will be drawn from the lectures, textbooks and labs. Exams will be online using Carmen, but will occur during normal class times using the computers in our normal classroom.
- Attendance – 15%
    - Attendance is required and will be recorded at all class meetings. An attendance sheet will be passed around the classroom, and you are responsible for remembering to sign it. If you forget to sign the attendance sheet during the scheduled class time, you will be marked absent (unexcused).
        - Unexcused Absences:
            - You may miss 2 classes (including lectures and labs) without penalty. Additional unexcused absences will result in a 1-point deduction from your attendance grade. No more than 15 points can be deducted from attendance.
        - Excused Absences:
            - Please email the instructor (or TA if you can't attend a lab) for excused absences (e.g. due to illness, car trouble, conference attendance, required job training, passing away of a loved one, etc.) Proper documentation (e.g. doctor's note, bill from a mechanic, proof of conference registration, email from a supervisor, obituary, etc.) must be provided.
- Grading Scale (OSU standard scale):

A	93-100%	B-	80-82%	D+	67-69%
A-	90-92%	C+	77-79%	D	60-66%
B+	97-89%	C	73-76%	E	0-59%
B	83-86%	C-	70-72%		

    - Your final grade as seen on the course website will be rounded to the nearest whole number (e.g. an 89.49 is a B+ while an 89.50 is an A) before being submitted to the University Registrar at the end of the semester.

Course Policies:

- Email correspondence policy
    - You are responsible for all course related emails, so be sure to check your inbox on a daily basis.
    - When emailing your instructor or TA, please always begin the subject of the email with the course number (GEOG6226) and your name (first name followed by last name). This is important as your instructor and TA teach multiple classes and need to know to which class you are referring. A proper email subject should be like this:

      GEOG6226_John Smith_Schedule a make-up exam
- Course website policy
    - You are responsible for all announcements, additional readings, assignments and other material posted on the course website. Be sure to check it frequently.
- Lab questions policy
    - Please send your lab-related questions as least 24 hours before the day/time the lab is due to allow your TA time to respond.
- Late submission policy
    - Lab assignments will be penalized 10% for each day late.

    - Extensions will not be granted due to lost work. Be sure you back up and keep all your work.
- Exam policy
    - Exams must be taken at the scheduled time, unless you have informed your instructor before the exam with proper reasons and documents, and got approved by the instructor. Please contact your instructor in advance of the scheduled exam to schedule a make-up exam, except in the case of emergency.
    - You are expected to arrive to all exams on time. Students who arrive late to the exam will be permitted to begin the exam, until the first student leaves. After a student completes the exam and leaves, students who arrive late will not be permitted to begin the exam, will be asked to leave, and will be considered absent. Your absence will be considered unexcused, except in the case of emergency.
    - You are expected to finish all exams on time. Exams begin when schedule class time begins, and exams end when the scheduled class time ends. At the end of the scheduled class time, you are to stop working and turn in your exam. You may not continue working on your exam after the scheduled class time.
- Disability services policy
    - Students with disabilities that have been certified by the Office for Disability Services (SLDS) will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 098 Baker Hall, 113 W. 12th Ave, Columbus, OH 43210; telephone 614-292-3307; http://slds.osu.edu/.
    - Registration with SLDS does not grant accommodations automatically. You need to bring the accommodation form provided by SLDS to the instructor to work out a plan for accommodations. Please contact the instructor as soon as you are registered with SLDS for attendance, assignment and/or exam accommodations.
- Academic Misconduct policy
    - 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.
    - Collaboration for the purposes of troubleshooting is highly encouraged in this course, but everyone is expected to submit their own unique work. For example, asking a classmate how to resolve an unexpected error message is OK, but using another classmate’s work (e.g. screen captures, etc.) as your own is NOT ok, regardless of whether or not they provide consent for the use of their materials. (Note: There are many other acceptable/unacceptable actions than those exemplified here.) If you have any questions or concerns about acceptable/unacceptable actions, ask your instructor for clarification/permission.
    - Do NOT leave any of your work saved on the lab computers, as this presents data security and academic integrity concerns.
        - If you leave your work on the lab computers, another student could access it and use it as their own, resulting in work that is identical or nearly identical (as determined by the instructor). If this happens, both will receive zeros for the assignment, and both will be held responsible for academic misconduct.

        - If you discover work that was left on the lab computers by another student, please immediately delete the files from the computer so that they will not be available to anyone else. (You may also delete files who owners cannot be determined.)
    - All open-ended responses to questions, prompts, etc. must be written entirely, nearly entirely, or at least in majority using your own words. Use credible sources, and cite all sources, including those only referenced, those indirectly paraphrased, and those directly quoted, being sure to use quotation marks to identify excerpts from these credible sources. This expectation to cite all of your sources also extends to the textbook, the lab instructions, lecture slides, other course materials, online resources, etc. Please contact Center for the Study and Teaching of Writing (CSTW, https://cstw.osu.edu/writing-center) or the instructor if you have difficulties organizing language for assignments.

Classroom and Computers:
If you need to return to the computer lab outside of class time, please be aware that the building maybe locked at night, over weekends, and on holidays, so be sure to plan accordingly. When you do return to the computer lab outside of class time, there may be a class in session. Please attempt to avoid interrupting classes that are in session, and if there is a class in session, check the computer lab across the hall in Derby 140. It has the same software as Derby 135, and it is usually available.

If you would like to check the schedules for Derby 135 and 140, you can check the Room Matrix:
https://delegated.osu.edu/psp/csosuda_1/EMPLOYEE/CAMP/c/OSR_CUSTOM_MENU.OSR_ROOM_MATRIX.GBL

- Enter DB0135 for Derby 135 or DB0140 for Derby 140.
- Select the date under "Show Week of".

Click "Refresh Calendar".

Software:

- NetLogo
    - It will be available on the computers in our lab. However, since it is free and open source, you can download and install NetLogo on your personal machines: https://ccl.northwestern.edu/netlogo/ *However, note that you are on your own with installations on personal machines; we cannot provide technical support*.
    - The basic NetLogo install is simple, but some of the programs we will look at this semester will use the *gradient* extension. Installing the gradient extension is easy: go to this link, download and unzip the folder called *gradient* containing a single file called *gradient.jar*. Copy the entire folder to the same folder as your NetLogo models, or to the NetLogo *extensions* folder. (Some NetLogo models also require an R extension for data analysis and reporting, but we will not be using these models.) For more details on these extensions, see the textbook authors' website: http://patternandprocess.org/. You can also follow NetLogo on Twitter: https://twitter.com/NetLogo.
- NetLogo models
    - Since it is open source, NetLogo comes with a wealth of freely available models (programs) across a wide range of applications. Models sources include:
        - Models Library - available in the NetLogo software itself; look under "Files" → "Models Library"

        - User community: https://ccl.northwestern.edu/netlogo/models/community/
- Models discussed in the textbook
    - The O'Sullivan and Perry text references and discusses a large number of NetLogo models. You should experiment with these models as part of your study ***prior to class***. We will also work with some of these models in class.
    - Windows versions of the NetLogo models are available at the Canvas site: unzip the archive and copy the entire directory (including the gradient subdirectory) to your laptop or to a portable storage device for use during class.
    - Other sources for the NetLogo models, including Mac versions, include:
        - The authors' website, **Pattern and Process**: http://patternandprocess.org/.
        - O'Sullivan also maintains the most up-to-date versions of these models at a github repository: https://github.com/DOSull/model-zoo. (Note that the github repository may be incomplete: some models from the textbook may be missing.)

GEOG 6226 Spatial Simulation and Modeling in GIS – Autumn 2019

Schedule

Week	Date	Content	Reading	Note
1	W 08/21	Course overview		
2	M 08/26	Lab 1 – Experimenting with NetLogo		
	W 08/28	1.1. What are simulation models? 1.2. How do we use simulation models?	Chapter 1	
3	M 09/02	Labor Day, no class		Lab 1 Due
	W 09/04	1.3. Why do we use simulation models? 1.4. Why dynamic and spatial models?	Chapter 1	
4	M 09/09	Lab 2 – NetLogo world and agents		
	W 09/11	2.1 What is a pattern? 2.2. Using models to explore spatial patterns and process	Chapter 2	
5	M 09/16	2.2. Using models to explore pattern and process (continued)	Chapter 2	Lab 2 Due
	W 09/18	***Exam 1***		
6	M 09/23	Lab 3 - Programming with NetLogo		
	W 09/25	3.1. Background 3.2. Local averaging	Chapter 3	
7	M 09/30	3.3. Totalistic automata	Chapter 3	Lab 3 Due
	W 10/02	3.4. Interacting particle systems	Chapter 3	
8	M 10/07	3.5. Schelling models 3.6. Spatial partitioning 3.7. More complicated models	Chapter 3	
	W 10/09	***Exam 2***		
9	M 10/14	Lab 4 - Variables and Breeds		
	W 10/16	4.1. Background 4.2. The random walk	Chapter 4	
10	M 10/21	4.3. Foraging and searching	Chapter 4	
	W 10/23	4.4. Moving entities and landscape interaction 4.5. Entity-entity interaction	Chapter 4	
11	M 10/28	***Exam 3***		Lab 4 Due
	W 10/30	Lab 5 - NetLogo and GIS data		
12	M 11/04	5.1. Motivating example 5.2. Percolation models	Chapter 5	
	W 11/06	5.3. Growth models	Chapter 5	Lab 5 Due
13	M 11/11	Veterans Day, no class		
	W 11/13	5.3. Growth models (continued) 5.4. Applying the framework	Chapter 5	
14	M 11/18	Lab 6 - Agent-based modeling		
	W 11/20	***Exam 4***		
15	M 11/25	Lab 7: Using BehaviorSpace to manage experiments		Lab 6 Due
	W 11/27	Thanksgiving Day, no class		
16	M 12/02	Work for Lab 7, no class		Lab 7 Due

This course schedule provides a general plan for the course. Any changes will be announced by the instructor with as much advance notice as possible.

GEOG 5226 Spatial Simulation and Modeling in GIS – Autumn 2019 Syllabus

Meeting Time: MW 02:20pm – 3:40pm, Derby Hall 135

Instructor Name and Email: Dr. Yang Song, song.630@osu.edu
- Office Hours: Wednesday 11:00am-1:00pm @ 1120 Derby, or by appointment.

Teaching Assistant Name and Email: Rohit Mukherjee,mukherjee.110@osu.edu
- Office Hours: Mondays 12:00pm – 2:00pm @ 1131 Derby, or by appointment.

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 computational 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 explore three major types of "building-blocks" at the core of many dynamic spatial models: i) spatial aggregation and segregation processes; ii) random walks and mobile entities, and; iii) percolation and growth processes. We will also discuss issues such as the role of spatial simulation in geographic information science, representation of space and time, how to build more complete models of human, physical and linked human-physical dynamic spatial processes, and how to evaluate model performance and uncertainty.

Materials:
- Textbook (required):
  - O'Sullivan, D. and Perry, G. (2013) *Spatial Simulation: Exploring Pattern and Process,* Wiley. Available at university bookstore; also available in e-book format from Amazon.
- Readings:
  - Additional readings and webpages will be posted at the Canvas course website. These resources will provide additional background material as well as deeper dives into the science behind the models discussed in class.
- Data storage:
  - A portable memory device (with 16GB or larger storage), such as a portable hard drive or flash drive, is required. Please bring it with you to every lab session as all your work needs to be saved to this device.
  - You can also store your data with a cloud drive (Box, Google Drive etc.). Please remember to log out the cloud drive when you finish using a lab PC.

Evaluation:
- Assignments – 40%
  - There will be a series of NetLogo-based lab assignments throughout the semester. All lab assignments will be submitted via the course website and count toward your final grade of the course. Most lab assignments are due one week after each lab session (at 5:00pm of the due day). Lab 4 will be given two weeks to finish.

    - Do not expect to finish all lab work during the scheduled lab time. You will need to work outside of class to complete your labs.
- Exams – 45%
    - There will be 4 short examinations (20 -25 questions) during the semester. Exam questions will be drawn from the lectures, textbooks and labs. Exams will be online using Carmen, but will occur during normal class times using the computers in our normal classroom.
- Attendance – 15%
    - Attendance is required and will be recorded at all class meetings. An attendance sheet will be passed around the classroom, and you are responsible for remembering to sign it. If you forget to sign the attendance sheet during the scheduled class time, you will be marked absent (unexcused).
        - Unexcused Absences:
            - You may miss 2 classes (including lectures and labs) without penalty. Additional unexcused absences will result in a 1-point deduction from your attendance grade. No more than 15 points can be deducted from attendance.
        - Excused Absences:
            - Please email the instructor (or TA if you can't attend a lab) for excused absences (e.g. due to illness, car trouble, conference attendance, required job training, passing away of a loved one, etc.) Proper documentation (e.g. doctor's note, bill from a mechanic, proof of conference registration, email from a supervisor, obituary, etc.) must be provided.
- Grading Scale (OSU standard scale):

A	93-100%	B-	80-82%	D+	67-69%
A-	90-92%	C+	77-79%	D	60-66%
B+	97-89%	C	73-76%	E	0-59%
B	83-86%	C-	70-72%		

    - Your final grade as seen on the course website will be rounded to the nearest whole number (e.g. an 89.49 is a B+ while an 89.50 is an A) before being submitted to the University Registrar at the end of the semester.

Course Policies:

- Email correspondence policy
    - You are responsible for all course related emails, so be sure to check your inbox on a daily basis.
    - When emailing your instructor or TA, please always begin the subject of the email with the course number (GEOG5226) and your name (first name followed by last name). This is important as your instructor and TA teach multiple classes and need to know to which class you are referring. A proper email subject should be like this:

      GEOG5226_John Smith_Schedule a make-up exam
- Course website policy
    - You are responsible for all announcements, additional readings, assignments and other material posted on the course website. Be sure to check it frequently.
- Lab questions policy
    - Please send your lab-related questions as least 24 hours before the day/time the lab is due to allow your TA time to respond.
- Late submission policy
    - Lab assignments will be penalized 10% for each day late.

    - Extensions will not be granted due to lost work. Be sure you back up and keep all your work.
- Exam policy
    - Exams must be taken at the scheduled time, unless you have informed your instructor before the exam with proper reasons and documents, and got approved by the instructor. Please contact your instructor in advance of the scheduled exam to schedule a make-up exam, except in the case of emergency.
    - You are expected to arrive to all exams on time. Students who arrive late to the exam will be permitted to begin the exam, until the first student leaves. After a student completes the exam and leaves, students who arrive late will not be permitted to begin the exam, will be asked to leave, and will be considered absent. Your absence will be considered unexcused, except in the case of emergency.
    - You are expected to finish all exams on time. Exams begin when schedule class time begins, and exams end when the scheduled class time ends. At the end of the scheduled class time, you are to stop working and turn in your exam. You may not continue working on your exam after the scheduled class time.
- Disability services policy
    - Students with disabilities that have been certified by the Office for Disability Services (SLDS) will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 098 Baker Hall, 113 W. 12th Ave, Columbus, OH 43210; telephone 614-292-3307; http://slds.osu.edu/.
    - Registration with SLDS does not grant accommodations automatically. You need to bring the accommodation form provided by SLDS to the instructor to work out a plan for accommodations. Please contact the instructor as soon as you are registered with SLDS for attendance, assignment and/or exam accommodations.
- Academic Misconduct policy
    - 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.
    - Collaboration for the purposes of troubleshooting is highly encouraged in this course, but everyone is expected to submit their own unique work. For example, asking a classmate how to resolve an unexpected error message is OK, but using another classmate’s work (e.g. screen captures, etc.) as your own is NOT ok, regardless of whether or not they provide consent for the use of their materials. (Note: There are many other acceptable/unacceptable actions than those exemplified here.) If you have any questions or concerns about acceptable/unacceptable actions, ask your instructor for clarification/permission.
    - Do NOT leave any of your work saved on the lab computers, as this presents data security and academic integrity concerns.
        - If you leave your work on the lab computers, another student could access it and use it as their own, resulting in work that is identical or nearly identical (as determined by the instructor). If this happens, both will receive zeros for the assignment, and both will be held responsible for academic misconduct.

        - If you discover work that was left on the lab computers by another student, please immediately delete the files from the computer so that they will not be available to anyone else. (You may also delete files who owners cannot be determined.)
    - All open-ended responses to questions, prompts, etc. must be written entirely, nearly entirely, or at least in majority using your own words. Use credible sources, and cite all sources, including those only referenced, those indirectly paraphrased, and those directly quoted, being sure to use quotation marks to identify excerpts from these credible sources. This expectation to cite all of your sources also extends to the textbook, the lab instructions, lecture slides, other course materials, online resources, etc. Please contact Center for the Study and Teaching of Writing (CSTW, https://cstw.osu.edu/writing-center) or the instructor if you have difficulties organizing language for assignments.

Classroom and Computers:
If you need to return to the computer lab outside of class time, please be aware that the building maybe locked at night, over weekends, and on holidays, so be sure to plan accordingly. When you do return to the computer lab outside of class time, there may be a class in session. Please attempt to avoid interrupting classes that are in session, and if there is a class in session, check the computer lab across the hall in Derby 140. It has the same software as Derby 135, and it is usually available.

If you would like to check the schedules for Derby 135 and 140, you can check the Room Matrix:
https://delegated.osu.edu/psp/csosuda_1/EMPLOYEE/CAMP/c/OSR_CUSTOM_MENU.OSR_ROOM_MATRIX.GBL

- Enter DB0135 for Derby 135 or DB0140 for Derby 140.
- Select the date under “Show Week of”.

Click “Refresh Calendar”.

Software:

- NetLogo
    - It will be available on the computers in our lab. However, since it is free and open source, you can download and install NetLogo on your personal machines: https://ccl.northwestern.edu/netlogo/ *However, note that you are on your own with installations on personal machines; we cannot provide technical support*.
    - The basic NetLogo install is simple, but some of the programs we will look at this semester will use the *gradient* extension. Installing the gradient extension is easy: go to this link, download and unzip the folder called *gradient* containing a single file called *gradient.jar*. Copy the entire folder to the same folder as your NetLogo models, or to the NetLogo *extensions* folder. (Some NetLogo models also require an R extension for data analysis and reporting, but we will not be using these models.) For more details on these extensions, see the textbook authors’ website: http://patternandprocess.org/. You can also follow NetLogo on Twitter: https://twitter.com/NetLogo.
- NetLogo models
    - Since it is open source, NetLogo comes with a wealth of freely available models (programs) across a wide range of applications. Models sources include:
        - Models Library - available in the NetLogo software itself; look under “Files” → “Models Library”

        - User community: https://ccl.northwestern.edu/netlogo/models/community/
- Models discussed in the textbook
    - The O'Sullivan and Perry text references and discusses a large number of NetLogo models. You should experiment with these models as part of your study ***prior to class***. We will also work with some of these models in class.
    - Windows versions of the NetLogo models are available at the Canvas site: unzip the archive and copy the entire directory (including the gradient subdirectory) to your laptop or to a portable storage device for use during class.
    - Other sources for the NetLogo models, including Mac versions, include:
        - The authors' website, **Pattern and Process**: http://patternandprocess.org/.
        - O'Sullivan also maintains the most up-to-date versions of these models at a github repository: https://github.com/DOSull/model-zoo. (Note that the github repository may be incomplete: some models from the textbook may be missing.)

GEOG 5226 Spatial Simulation and Modeling in GIS – Autumn 2019

Schedule

Week	Date	Content	Reading	Note
1	W 08/21	Course overview		
2	M 08/26	Lab 1 – Experimenting with NetLogo		
	W 08/28	1.1. What are simulation models? 1.2. How do we use simulation models?	Chapter 1	
3	M 09/02	Labor Day, no class		Lab 1 Due
	W 09/04	1.3. Why do we use simulation models? 1.4. Why dynamic and spatial models?	Chapter 1	
4	M 09/09	Lab 2 – NetLogo world and agents		
	W 09/11	2.1 What is a pattern? 2.2. Using models to explore spatial patterns and process	Chapter 2	
5	M 09/16	2.2. Using models to explore pattern and process (continued)	Chapter 2	Lab 2 Due
	W 09/18	***Exam 1***		
6	M 09/23	Lab 3 - Programming with NetLogo		
	W 09/25	3.1. Background 3.2. Local averaging	Chapter 3	
7	M 09/30	3.3. Totalistic automata	Chapter 3	Lab 3 Due
	W 10/02	3.4. Interacting particle systems	Chapter 3	
8	M 10/07	3.5. Schelling models 3.6. Spatial partitioning 3.7. More complicated models	Chapter 3	
	W 10/09	***Exam 2***		
9	M 10/14	Lab 4 - Variables and Breeds		
	W 10/16	4.1. Background 4.2. The random walk	Chapter 4	
10	M 10/21	4.3. Foraging and searching	Chapter 4	
	W 10/23	4.4. Moving entities and landscape interaction 4.5. Entity-entity interaction	Chapter 4	
11	M 10/28	***Exam 3***		Lab 4 Due
	W 10/30	Lab 5 - NetLogo and GIS data		
12	M 11/04	5.1. Motivating example 5.2. Percolation models	Chapter 5	
	W 11/06	5.3. Growth models	Chapter 5	Lab 5 Due
13	M 11/11	Veterans Day, no class		
	W 11/13	5.3. Growth models (continued) 5.4. Applying the framework	Chapter 5	
14	M 11/18	Lab 6 - Agent-based modeling		
	W 11/20	***Exam 4***		
15	M 11/25	Lab 7: Using BehaviorSpace to manage experiments		Lab 6 Due
	W 11/27	Thanksgiving Day, no class		
16	M 12/02	Work for Lab 7, no class		Lab 7 Due

This course schedule provides a general plan for the course. Any changes will be announced by the instructor with as much advance notice as possible.

Arts and Sciences Distance Learning Course Component Technical Review Checklist

Course: Geog 6226 DL
Instructor: Yang Song
Summary: Spatial Simulation and Modeling in GIS

Standard - Course Technology	Yes	Yes with Revisions	No	Feedback/ Recomm.
6.1 The tools used in the course support the learning objectives and competencies.	X			• Carmen • Office 365 • NetLogo
6.2 Course tools promote learner engagement and active learning.	X			• Carmen Discussion Boards • Zoom • Proctorio
6.3 Technologies required in the course are readily obtainable.	X			All are available for free via OSU agreements.
6.4 The course technologies are current.	X			All are updated regularly
6.5 Links are provided to privacy policies for all external tools required in the course.	X			No third party tools requiring an account are used.
Standard - Learner Support				
7.1 The course instructions articulate or link to a clear description of the technical support offered and how to access it.	X			Links to 8HELP are provided.
7.2 Course instructions articulate or link to the institution's accessibility policies and services.	X			a
7.3 Course instructions articulate or link to an explanation of how the institution's academic support services and resources can help learners succeed in the course and how learners can obtain them.		X		Add statement b
7.4 Course instructions articulate or link to an explanation of how the institution's student services and resources can help learners succeed and how learners can obtain them.	X			c
Standard – Accessibility and Usability				
8.1 Course navigation facilitates ease of use.	X			Recommend using the Carmen Distance Learning "Master Course" template developed by ODEE and available in the Canvas Commons to provide student-users with a consistent user experience in terms of navigation and access to course content.
8.2 Information is provided about the accessibility of all technologies required in the course.	X			All technologies are covered by OSU policies.
8.3 The course provides alternative means of access to course materials in formats that meet the needs of diverse learners.	X			Instructions are present.
8.4 The course design facilitates readability	X			

8.5 Course multimedia facilitate ease of use.	X			All assignments and activities that use the Carmen LMS with embedded multimedia facilitates ease of use. All other multimedia resources facilitate ease of use by being available through a standard web browser

Reviewer Information

- Date reviewed: 10/5/20
- Reviewed by: Ian Anderson

Notes: Add dates to the weekly breakdown. Consider using the ASC DL Syllabus Template. Please specify method of office hours and online lectures (I presume both to be Zoom, but it should be stated).

[a]The following statement about disability services (recommended 16 point font): Students with disabilities (including mental health, chronic or temporary medical conditions) that have been certified by the Office of Student Life Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office of Student Life Disability Services is located in 098 Baker Hall, 113 W. 12th Avenue; telephone 614- 292-3307, slds@osu.edu; slds.osu.edu.

[b]Add to the syllabus this link with an overview and contact information for the student academic services offered on the OSU main campus. http://advising.osu.edu/welcome.shtml

[c]Add to the syllabus this link with an overview and contact information for student services offered on the OSU main campus. http://ssc.osu.edu. Also, consider including this link in the “Other Course Policies” section of the syllabus.

Campus

Levels indicated for proficiencies:	Codes for mapping proficiencies to your courses:
B: beginning I: intermediate A: advanced Course colors: green: courses taught by the same person blue: courses among which students	**y**: yes, covered and evaluated **c**: covered but not currently evaluated OR *could be* covered and evaluated blank: not covered; no intention to cover

	GIS															GIS 2 (to be proposed)																														
	Geog 4103	Geog 5200	Geog 5201	Geog 5210	Geog 5212	Geog 5222	Geog 5223	Geog 5225	Geog 5225	**Required**	Geog 4191	Geog 5103	Geog 5226	Geog 5229		Geog 4103	Geog 5200	Geog 5210	Geog 5225	Geog 5225	Geog 5101	**Core**	Geog 4191	Geog 5103	Geog 5201	Geog 5212	Geog 5222	Geog 5229	**Intermediate**		Geog 5501	Geog 5502	Geog 5503	Geog 5300	Geog 5301		**Urban**	Geog 3597.03	Geog 3702	Geog 3800	Geog 5402	Geog 5700	Geog 5802	Geog 5803		**ustainabilit**
Instructor	DL	EC	YS	EC	EC	NX	NX	YS	DL	**Total "y"**	NE	ER	YS	YQ	**Total "y"**	DL	EC	EC	YS	DL		**Total "y"**	NE	ER	YS	EC	NX	YQ	**Total "y"**	**Total "y"**	MD	NE	MW	HL	HM	Total "y"	Total "y"	JW	ER	BKM	DM	JW	MD	YQ	Total "y"	**Total "y"**
Goal A: Human, Environmental, and Spatial Concepts **Students understand various conceptual approaches and their context to interpret patterns, processes and their relation.**																																														
1. Conceptualize human, environmental, or spatial problems																																														
a. Describe the spatial and historical context of a problem (B)	y	c	c	c		y	c	c	y	**2**			c	c	**0**	y	c	c	c	y		**1**			c		y	c	**1**	**2**	y	y	y	y	y	5	7	y	y	y	y	y	y	y	7	9
b. Identify the 'ecological fallacy' (the inappropriate homogenization or aggregation of differentiated phenomena within a unit of analysis, using scale as an analytical unit) (B)	y			c		y	c	y	y	**3**		y	y		**2**	y		c	y	y		**2**		y			y		**2**	**4**	y	y				2	6			c	c		y		1	5
c. Examine dynamics within a place's or system's boundaries, and implications for real-world problems (I)	c				c			y	c	**0**			y	c	**1**	c			y	c		**0**				c		c	**0**	**0**	y	y	y		y	4	4	y	y	y	y	y	y	y	7	7
d. Examine dynamics that connect places or systems across space, and implications for real-world problems (I)					c			y	c	**0**			y	c	**1**				y	c		**0**				c		c	**0**	**0**	y	y	y	y	y	5	5	y	y	y	y	y	y	y	7	7
e. Evaluate processes that operate at different scales and their effects (A)	c							c	c	**0**		y	y	c	**2**	c			c	c		**0**		y				c	**1**	**1**	y	y	y	y	y	5	6	y	c	y	y	y	y	c	5	6
2. Critically evaluate different approaches to describe, explain, or predict real-world experience																																														
a. Describe the strengths and weaknesses of various approaches for their utility in interpreting real-world experience (B, I)	y	y	y	y	y	y	y	y	y	**8**		y	y	c	**2**	y	y	y	y	y	y	**5**		y	y	y	y	c	**4**	**9**	y	y	y	y		3	12	y	y	y	y	y	y		6	15
b. Explain the contexts in which various approaches were developed (A)	c	c	c		c	y	y	c	c	**2**			c	c	**0**	c	c		c	c	y	**1**			c	c	y	c	**1**	**2**	y	y	c	y		3	5	c		y		c	y		2	4
c. Critically evaluate various approaches in their field of study (A)	c	y	y		c	y	y	y	y	**5**		y	c		**1**	c	y		y	y	y	**3**		y	y	c	y		**3**	**6**	y	y	y	c		3	9	y		y		y	y		4	10
3. Appraise the relation between concepts and real-world experience																																														
a. Interpret patterns (B)	y	c		y		c		y	y	**3**		y	y	y	**3**	y	c	y	y	y		**3**		y			c	y	**2**	**4**	y	y	y	y		4	8	c		y	y	c	y	y	4	8
b. Critique how knowledges in their fields are used in developing solutions to real-world problems (I)	c	c	y	c				y	c	**1**		c	c	c	**0**	c	c	c	y	c	y	**1**		c	y			c	**1**	**2**	y	y		y		3	5	c	c	y		y	y	y	4	6
c. Relate research findings to debates about different approaches to research (A)						c		c	c	**0**			c	c	**0**				c	c	y	**1**					c	c	**0**	**1**	y	y	y		c	3	4			y		c	y		2	3
d. Relate patterns to processes to assess causal relations (A)	c								c	**0**		y	y	c	**2**	c				c	y	**1**		y				c	**1**	**2**	y	y	y	c		3	5	c	c			y	y	c	2	4
Goal B: Research Strategies, Methods and Data **Students are able to apply appropriate methods and data, to transform data into actionable knowledges to support ethical scholarship and decision making.**																																														
1. Gather information regarding data and their context to draw conclusions																																														
a. Identify relevant data sources and their quality (B)	y	c	y	c		c	c	y	y	**3**				c	**0**	y	c	c	y	y		**2**			y		c	c	**1**	**3**			y	c		1	4	c	c		c	y		c	1	4
b. Collect data from relevant sources (I)	c	c	y	c		c	c	y	y	**2**				c	**0**	c	c	c	y	y		**1**			y		c	c	**1**	**2**			y			1	3		c			y		c	1	3
c. Design feasible data-collection procedures (I)	y							y	y	**2**				c	**0**	y			y	y		**2**						c	**0**	**2**			y	c		1	3					c		y	1	3
d. Explain how context shapes conclusions drawn from data (A)		c						c		**0**				c	**0**		c		c		y	**1**						c	**0**	**1**		y	c			1	2	c				c		y	1	2
2. Evaluate research strategies and methods to engage problems																																														
a. Identify available research strategies and methods (B)						y	y	c		**2**		y	c	c	**1**				c		y	**1**		y			y	c	**2**	**3**		y	y	y		3	6	c			y	c		c	1	4
b. Explain how strategies and methods may be used constructively and destructively in real-world applications (B, I)						c	y	c		**1**		c		c	**0**				c		y	**1**		c			c	c	**0**	**1**		y	c	y		2	3	c			y	c		c	1	2
c. Provide empirical examples of constructive and destructive applications of methods (I)							c	c		**0**		c			**0**				c		y	**1**		c					**0**	**1**		y	c	c		1	2					c		c	0	1
d. Assess the strengths and limitations of available research strategies and methods (I, A)						y	y	c		**2**		y	c		**1**				c		y	**1**		y			y		**2**	**3**		y	c	c		1	4	c				c		c	0	3
3. Apply strategies and methods																																														
a. Visualize patterns through mapping, graphing, or using GIS techniques (B)	y	y	y	y	y	y	y	y	y	**8**		y	y	y	**3**	y	y	y	y	y		**4**		y	y	y	y	y	**5**	**8**				y		1	9		c					y	1	9
b. Identify sources of uncertainty or partial knowledges (B, I)	y	c	y	y		c		c	y	**3**		y			**1**	y	c	y	c	y	y	**3**		y	y		c		**2**	**5**				c		0	5	c				c			0	5
c. Analyze how errors propagate through data processing (I)	c		c						y	**0**		c			**0**	c				y		**0**		c	c				**0**	**0**				c		0	0								0	0
d. Examine the impacts of sources of uncertainty or partial knowledges on the reliability of data (I)	c	c	c					c	c	**0**		c			**0**	c	c		c	c	y	**1**		c	c				**0**	**1**						0	1								0	1
e. Apply interactive and dynamic visualization techniques (I, A)	c		y			y	y	y	y	**4**			y	c	**1**	c			y	y		**1**			y		y	c	**2**	**3**						0	3								0	3
f. Analyze patterns using appropriate methods (I, A)	y		y	y		y	c	y	y	**5**		y	y	c	**2**	y		y	y	y		**3**		y	y		y	c	**3**	**6**						0	6	c				c			0	6
g. Apply strategies to mitigate or constructively engage the effects of uncertainty or partial knowledges (A)	c	c	c						y	**0**		y			**1**	c	c			y	y	**1**		y	c				**1**	**2**						0	2	c							0	2
h. Interpret data and results using appropriate methods (A)	y	c	y	y	y	y		y	y	**6**		y	y	y	**3**	y	c	y	y	y		**3**		y	y	y	y	y	**5**	**7**		y				1	8							y	1	8
Goal C: Communication and Engagement **The successful student will be able to share and receive knowledge by engaging with diverse audiences, participants, and stakeholders.**																																														
1. Disseminate knowledges																																														
a. Identify modes by which knowledges can be disseminated (B)		c		c		y	y			**2**				c	**0**		c	c				**0**					y	c	**1**	**1**				c		0	1	c		c			c		0	1
b. Recognize that different audiences will have different degrees of familiarity with subject being presented (B)		c		c	c	c	c			**0**				c	**0**		c	c			y	**1**				c	c	c	**0**	**1**	y			c		1	2	c		c	y		c		1	2
c. Summarize an author's argument in their own words (B)										**0**					**0**						y	**1**							**0**	**1**	y	y	y	y	y	5	6	y		y	y	y	y		5	6
d. Deliver oral presentations (B)		c		c	c	c	c		y	**0**				y	**1**		c	c		y	y	**1**				c	c	y	**1**	**1**	y	y	y	y	y	5	6	c			y		y	y	3	4
e. Adjust the language and technical level of oral or written presentation relative to different audiences (B, I)						c				**0**				y	**1**						y	**1**					c	y	**1**	**1**	y			c		1	2			y			c		1	2
f. Evaluate the standard modes of dissemination of knowledges for their strengths and weaknesses in a given context (I)		c								**0**					**0**		c					**0**							**0**	**0**						0	0								0	0
g. Use visual methods to enhance oral or written presentation (B, I)		c		c	c	y	y			**2**		y		y	**2**		c	c				**0**		y		c	y	y	**3**	**2**	y		y	c	y	3	5				y		y	y	3	5
h. Construct other output or products using diverse media, art, activism, or other strategies to convey messages from academic research (I)										**0**					**0**							**0**							**0**	**0**	c	c	c		y	1	1						y		1	1
i. Synthesize material from several sources (I)						c	c			**0**				c	**0**							**0**					c	c	**0**	**0**	y	y	y	y	y	5	5	c		y	y	y	y		4	4
j. Generate a document that develops an argument drawing from multiple sources (A)										**0**					**0**							**0**							**0**	**0**	y	y	y	y	y	5	5	c		y	y	y	y		4	4
2. Collaborate in learning and research																																														
a. Demonstrate responsiveness to others (B)		c		c	c	c	c		c	**0**				c	**0**		c	c		c		**0**				c	c	c	**0**	**0**	y	c	y	y	c	3	3	c	y	c	y		y		3	3
b. Demonstrate ability to work with a division of labor in a collaborative project (B, I)		c		c	c		c		c	**0**					**0**		c	c		c		**0**				c			**0**	**0**	y	c	y	c		2	2		y		y		y		3	3
c. Demonstrate ability to work with people of varying cultures, backgrounds, abilities, ideas, ideals, and status (B, I)							c			**0**				c	**0**							**0**						c	**0**	**0**	y	c	y	c		2	2	c	y	c	c		y		2	2
d. Employ teamwork to achieve results (B, I, A)		c		c	c		c		y	**0**				y	**1**		c	c		y		**0**				c		y	**1**	**0**	y	c	c	y		2	2		y		y		y		3	3
Goal D: Critical Thinking and Ethical Engagement **The successful student is intellectually curious, interested in scrutinizing their assumptions, and is aware of the ethical dimensions of their professional activity regarding real-world problems to work towards justice.**																																														
1. Critically engage real-world problems																																														
a. Identify multiple sides of a problem (B)		c		c		y	y			**2**				c	**0**		c	c			y	**1**					y	c	**1**	**2**	y	y	y	y	y	5	7	y	y	y	y	c	y	c	5	7
b. Explain multiple sides of a problem (I)		c				y	y			**2**				c	**0**		c				y	**1**					y	c	**1**	**2**	y	y	y	y	c	4	6	y	y	y	y	y	y	c	6	8
c. Explain the real-world consequences of different positions regarding a problem (A)		c								**0**				c	**0**		c				y	**1**						c	**0**	**1**	y	y		c	c	2	3	y	y	y	y	c	y		5	6
d. Develop a position based on an understanding of multiple sides of a problem (A)		c								**0**					**0**		c				y	**1**							**0**	**1**	c	y	y	c	c	2	3	y	y	c	y	y	y		5	6
e. Identify linkages among apparently discrete problems (A)						y				**1**				c	**0**						y	**1**					y	c	**1**	**2**	c	c	c		y	1	3	y	c	y	c	c	y		3	5
2. Appraise ethical issues in research																																														
a. Explain how strategies and methods may be used constructively and destructively in real-world applications (B, I) [identical to b.2.b]		c					y			**1**				c	**0**		c				y	**1**						c	**0**	**1**	y	y		c		2	3	c	c	y	y	c	c		2	3
b. Perceive that everyone, including researchers, implicitly have biases and partial knowledges that can have negative effects on subjects under study (B, I)		c					y			**1**					**0**		c				y	**1**							**0**	**1**	y	y	y	c		3	4	c	c	y	y	c	c		2	3
c. Perceive that subjects under study and those encountered in the field, their values, and their privacy require respect (B, I)										**0**					**0**						y	**1**							**0**	**1**	c					0	1				c		c		0	1
d. Analyze their positionality regarding, for example, class, race/ethnicity, gender, age, citizenship, occupation, and the like relative those under study or encountered in the field (I, A)										**0**					**0**						y	**1**							**0**	**1**	c	c	c			0	1						c		0	1
e. Integrate ethical considerations into formulation of questions and applications of their knowledges (S)							y			**1**					**0**						y	**1**							**0**	**1**	c		c			0	1			c		c	c		0	1
Goal E: Professional Development **The successful student understands how to make use of the skills and knowledges developed in their undergraduate program towards securing a job and pursuing a career.**																																														
1. Make use of their values to guide their careers																																														
a. Identify their value systems relative to career opportunities (B)										**0**	c				**0**						y	**1**	c						**0**	**1**						0	1							c	0	1
b. Describe tensions between their ideals and career realities (I)										**0**	y				**1**						y	**1**	y						**1**	**2**						0	2								0	2
c. Appraise the variety of options and trade-offs in career paths relative to their value systems (A)										**0**	c				**0**						y	**1**	c						**0**	**1**						0	1								0	1
2. Deploy their skills relative to a changing job market																																														
a. Identify the range of their skills relative to a variety of career paths (B)				c			c			**0**	c				**0**			c			y	**1**	c						**0**	**1**						0	1							c	0	1
b. Identify the strengths and limitations of their range of skills relative to various professional opportunities (I)				c			c			**0**	c				**0**			c			y	**1**	c						**0**	**1**						0	1								0	1
c. Demonstrate the ability to learn new skills (A)							c			**0**	c	y			**1**						y	**1**	c	y					**1**	**2**						0	2				y			c	1	3
3. Creatively use skills to solve problems beyond those encountered in formal training																																														
a. Apply knowledge from formal training to examine a problem (B)		c	y	c		c	c	c		**1**	y	y	c		**2**		c	c	c		y	**1**	y	y	y		c		**3**	**4**				y		1	5	c					c		0	4
b. Integrate diverse skills from formal training (I)			y	c				c		**1**	c		c		**0**			c	c		y	**1**	c		y				**1**	**2**				y		1	3	c			c				0	2
c. Integrate knowledges from formal training with those acquired independently (A)			y					c		**1**	c		c		**0**				c		y	**1**	c		y				**1**	**2**						0	2						c		0	2

Geography Curriculum Mapping: Summary of Changes

Ningchuan Xiao
November 8, 2021

The Department of Geography is proposing to change our undergraduate Geographic Information Science (GIS) major and to create a new professional masters degree in Geographic Information Science and Technology. The department went through an undergraduate curriculum mapping process in 2019 and 2020. Throughout the process, the faculty have agreed upon a set of program goals, outcomes, and proficiencies, which are detailed in the left column in the attached PDF file (Curriculum_map_GEOG_GIS_ONLY.pdf). After the proficiencies were set, the faculty then mapped their courses to each of the proficiencies. The attached spreadsheet in PDF includes the mapping result for the courses of the Geographic Information Science (GIS) major, under the grouped column called GIS.

It became clear to the GIS faculty that proficiencies under Goals D and E are not sufficiently covered in the current curriculum by our required courses nor by the electives. This is one of the motivations we decided to revise our GIS major curriculum. The courses in the revised curriculum are listed in the attached PDF (under a grouped column called GIS 2).

There are a few main changes in the new curriculum. First, a new course GEOG 5101 (GIST Professionalism and Ethics) is added to provide sufficient coverage of proficiencies in Goals D and E. Second, the new curriculum has a set of 5 core courses that are required, a set of 6 intermediate courses from which students must take at least 3, and several options for students to focus on different substantive areas such as urban and sustainability (see the attached curriculum map for details). Third, two courses in the current curriculum, 5223 and 5226, become 6000 level courses that will be used in a new professional masters program, which will be proposed soon. The following table shows the coverages of the program proficiencies of the current and new curriculums (please note because the electives in the new curriculum have different options, only the core and immediate courses are summarized in the table). It clearly shows sufficient coverage for proficiencies in Goals D and E by the proposed curriculum. Also, the curriculum changes do not affect the proficiencies that are already covered, with the only exception in proficiencies A1c and A1d that are covered by the current electives but not by the core or intermediate courses in the proposed. However, these two proficiencies are covered by most electives (see the attached spreadsheet in PDF). One benefit of moving two 5000 level courses to 6000 level is that such change makes it possible for the department to develop a new professional masters degree in GIS with graduate level courses (the proposal for this program will be submitted soon in Autumn 2021).

Table 1. Coverage of the proficiencies by the courses of the current GIS curriculum (Required and Electives) and the proposed new GIS curriculum. Numbers are the number of times each proficiency is covered by the courses labeled in each column. The actual proficiency descriptions can be found in the attached curriculum map PDF. Electives for the proposed curriculum are not listed, but can be found in the attached spreadsheet in PDF.

			Current		New	
Goals	**Outcomes**	**Proficiencies**	**Required**	**Electives**	**Core**	**Intermediate**
A: Human, Environmental, and Spatial Concepts	1. Conceptualize human, environmental, or spatial problems	a.	2	0	1	1
		b.	3	2	2	2
		c.	0	**1**	0	0
		d.	0	**1**	0	0

		e.	0	2	0	1
	2. Critically evaluate different approaches to describe, explain, or predict real-world experience	a.	8	2	5	4
		b.	2	0	1	1
		c.	5	1	3	3
	3. Appraise the relation between concepts and real-world experience	a.	3	3	3	2
		b.	1	0	1	1
		c.	**0**	**0**	1	0
		d.	0	2	1	1
B: Research Strategies, Methods, and Data	1. Gather information regarding data and their context to draw conclusions	a.	3	0	2	1
		b.	2	0	1	1
		c.	2	0	2	0
		d.	**0**	**0**	1	0
	2. Evaluate research strategies and methods to engage problems	a.	2	1	1	2
		b.	1	0	1	0
		c.	**0**	**0**	1	0
		d.	2	1	1	2
	3. Apply strategies and methods	a.	8	3	4	5
		b.	3	1	3	2
		c.	0	0	0	0
		d.	**0**	**0**	1	0
		e.	4	1	1	3
		f.	5	2	3	4
		g.	0	1	1	2
		h.	6	3	3	5
C: Communication and Engagement	1. Disseminate knowledges	a.	2	0	0	1
		b.	0	0	1	0
		c.	0	0	1	0
		d.	0	1	1	1
		e.	0	1	1	1
		f.	0	0	0	0
		g.	2	2	0	3
		h.	0	0	0	0
		i.	0	0	0	0
		j.	0	0	0	0
	2. Collaborate in learning and research	a.	0	0	0	0
		b.	0	0	0	0
		c.	0	0	0	0
		d.	0	1	0	1
D: Critical Thinking and Ethical Engagement	1. Critically engage real-world problems	a.	2	0	1	1
		b.	2	0	1	1
		c.	**0**	**0**	1	0
		d.	**0**	**0**	1	0
		e.	1	0	1	1
	2. Appraise ethical issues in research	a.	1	0	1	0
		b.	1	0	1	0
		c.	**0**	**0**	1	0
		d.	**0**	**0**	1	0
		e.	1	0	1	0

E: Professional Development	1. Make use of their values to guide their careers	a.	**0**	**0**	1	0
		b.	**0**	1	1	1
		c.	**0**	**0**	1	0
	2. Deploy their skills relative to a changing job market	a.	**0**	**0**	1	0
		b.	**0**	**0**	1	0
		c.	0	1	1	1
	3. Creatively use skills to solve problems beyond those encountered in formal training	a.	1	2	1	3
		b.	1	0	1	1
		c.	1	0	1	1