**GEOG 5160/6160**  
Spatial Modeling with GIS

**Professor:** Simon Brewer  
**Contact information:** simon.brewer@geog.utah.edu, OSH 270H  
**Office Hours:** Tues/Thurs 2:00-3:30pm

**Teaching Assistant:** Kenneth Dudley  
**Contact information:** Kenneth.Dudley@geog.utah.edu  
**Office Hours:** Mon 10:45-11:45am (OSH 109) and  
Mon 2:50-4:50pm (OSH 273)

**Class time and location:** Mon-Wed 11:50am-12:40pm; OSH 111  
**Lab time and location:** Mon 12:55am-2:50pm; OSH 273

**Course Description:** The power to model complex environmental systems in a geospatial framework is one of the great assets of GIS. This course places the fundamental operations and software of spatial analysis and GIS in a modeling framework. The course addresses advanced concepts and techniques in map algebra, cartographic modeling, and descriptive and predictive spatial modeling. The course has both lecture and required lab components. Graduate students should enroll in GEOG 6160 and will be held to higher standards and/or more work.

Note: This course is designed for intermediate and advanced GIS students. GEOG 5140/6140 Methods in GIS as well as sufficient proficiency in ArcGIS® (especially ArcMapTM and ArcCatalogTM) is a prerequisite for this course.

**Course objectives:** The objective of the course is to develop students’ fundamental knowledge and skills in spatial modeling in GIS environments. After successful completion of this course, students will be able to

- Describe important theories and concepts in spatial modeling  
- Explain and compare various types of spatial models  
- Discuss issues and considerations associated with spatial modeling  
- Critically review real-world applications of GIS-based spatial modeling, and  
- Design and develop prototypical spatial models in GIS environments.

This course primarily utilizes ArcGIS® as an example of GIS environments, but also includes exposure to other software for modeling spatial problems.

**Teaching & learning methods:** This course consists of lecture and lab components. The lecture component will primarily focus on theoretical aspects of spatial modeling and will include discussion of example applications. The lab component will give students hands-on experience in GIS-based spatial modeling. Reading assignments will also be given to further students’ understanding of materials presented in the lectures and labs. A final project will provide students with an
opportunity to apply theories and methods learned in the course to topics of their own interest.

Course materials:
• Textbooks
  o Other reading assignments are listed in the tentative course schedule (pages 6-8).
• Online materials
  o This course will use the Canvas system to provide students with access to course announcements, lecture note outlines, and other course-related materials. It is your own responsibility to check the site periodically to obtain necessary information in a timely manner.

Grading:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exams (2)</td>
<td>2x20</td>
</tr>
<tr>
<td>Lab assignments (10)</td>
<td>10x5</td>
</tr>
<tr>
<td>Final project</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>125</td>
</tr>
</tbody>
</table>

• Examinations (20 pts. × 2)
  o There will be two examinations at the middle and the end of the semester (scheduled on March 5 and during April 25); exam dates will be finalized at least two weeks in advance. The exams may include, but not limited to, multiple choice questions, short essay questions, interpretation tasks, calculation tasks, and problem solving questions.
  o Exam contents will emphasize theories, concepts, methods, and applications covered in lectures, labs, and assigned readings. The exams will not contain computer components, that is, there are no questions regarding “how to use ArcGIS.” The second exam might be cumulative depending on results of the first exam.
  o No “make-up” exams will be given; notify the instructor at least two weeks in advance of a scheduled exam date if an alternative date is necessary.
• Lab assignments (5 pts. × 10)
  o There will be ten lab assignments. The labs are designed to reinforce students’ understanding of materials covered in lectures and to give them hands-on experience in GIS modeling.
  o You will need some form of storage media on which to back up your data and work.
  o Lab assignments must be turned in through Canvas
• Final project (35 pts.)
Students will be required to build a prototypical spatial model using ArcGIS as a final project.
Evaluation of the final project will be based on a two-page proposal (5 pts.; due on February 21), an in-class presentation (10 pts; scheduled on April 21 and 23), and a final report (20 pts.; due on April 30). More information is given below.
Project work should be submitted using Canvas

Letter grades will be assigned following the scheme provided below, using .5 as the break point:

\[
\begin{array}{ccc}
A & 95+ & C+ \\
A- & 90~94 & C \\
B+ & 85~89 & C- \\
B & 80~84 & D \\
B- & 75~79 & E \\
\end{array}
\]

Class schedule:
The tentative schedule of the course and associated reading assignments are listed in the table below. Please note that this schedule is subject to change in the event of extenuating circumstances.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-Jan</td>
<td>Course introduction</td>
<td>Syllabus</td>
<td>No lab</td>
</tr>
<tr>
<td>8-Jan</td>
<td>Introduction to spatial modeling</td>
<td>GSAM Chapters 1&amp;21</td>
<td></td>
</tr>
<tr>
<td>13-Jan</td>
<td><em>Instructor away</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-Jan</td>
<td><em>Introduction to Python (lab)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-Jan</td>
<td><em>MLK Day</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22-Jan</td>
<td>Geosimulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27-Jan</td>
<td>Cellular automata I</td>
<td>GS Chapter 2&amp;5; GSAM Chapter 8</td>
<td>Cellular automata</td>
</tr>
<tr>
<td>29-Jan</td>
<td>Cellular automata II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Feb</td>
<td>Agent-based models I</td>
<td>GSAM Chapter 19</td>
<td>Agent-based models</td>
</tr>
<tr>
<td>5-Feb</td>
<td>Agent-based models II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-Feb</td>
<td>Dynamic raster modeling I</td>
<td>GSAM Chapter 16</td>
<td>Dynamic raster models 1</td>
</tr>
<tr>
<td>12-Feb</td>
<td>Dynamic raster modeling II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-Feb</td>
<td><em>Presidents’ Day</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Topic</td>
<td>Page</td>
<td>Notes</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------</td>
<td>-------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>19-Feb</td>
<td>Dynamic raster modeling III</td>
<td>TBA</td>
<td>Dynamic raster models 2</td>
</tr>
<tr>
<td>24-Feb</td>
<td>Dynamic raster modeling IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-Feb</td>
<td>Map algebra review I</td>
<td>GMR Chapters 3-5</td>
<td></td>
</tr>
<tr>
<td>3-Mar</td>
<td>Map algebra review II</td>
<td>Automation with Python</td>
<td></td>
</tr>
<tr>
<td>5-Mar</td>
<td></td>
<td>Exam 1</td>
<td></td>
</tr>
<tr>
<td>10-Mar</td>
<td></td>
<td>Spring break</td>
<td></td>
</tr>
<tr>
<td>12-Mar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-Mar</td>
<td>GIS modeling environment and Modelbuilder</td>
<td>GSAM Chapter 2</td>
<td>Uncertainty 1</td>
</tr>
<tr>
<td>19-Mar</td>
<td>Uncertainty in GIS modeling I</td>
<td>GISS Chapter 6; GSAM Chapter 4</td>
<td></td>
</tr>
<tr>
<td>24-Mar</td>
<td>Uncertainty in GIS modeling III</td>
<td></td>
<td>Uncertainty 2</td>
</tr>
<tr>
<td>26-Mar</td>
<td>Uncertainty in GIS modeling III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-Mar</td>
<td>Spatial interaction modeling I</td>
<td>SI Chapters 1-2; GSAM Chapter 11 (GT Chapter 7)</td>
<td>Spatial interaction 1</td>
</tr>
<tr>
<td>2-Apr</td>
<td>Spatial interaction modeling II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-Apr</td>
<td>Spatial interaction modeling III</td>
<td>GSAM Chapter 13; (GT Chapter 8)</td>
<td>Spatial interaction 2</td>
</tr>
<tr>
<td>9-Apr</td>
<td>Group project work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-Apr</td>
<td>Time geography I</td>
<td>TBA</td>
<td>Time geography</td>
</tr>
<tr>
<td>16-Apr</td>
<td>Time geography II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-Apr</td>
<td>Final project presentation I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-Apr</td>
<td>Final project presentation II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-Apr</td>
<td></td>
<td>Exam 2</td>
<td></td>
</tr>
</tbody>
</table>

Textbook title abbreviations:

Guidelines for the final project: Students will be required to conduct a group final project and build a prototypical spatial model. The objective of the final project is to provide students with an opportunity to solidify conceptual and technical topics learned in class by actually developing their own models within a GIS environment. Ideally, this experience will help them enhance their professional portfolio as they apply for jobs or graduate schools.

Students will be asked to form groups of three or four, based on their application/research interests (e.g., transportation, urban development, earthquakes, environmental conservation, and wildfire). Each group will choose a topic, determine a spatial problem to solve, collect data, and develop a spatial model. The final project is primarily a self-directed exercise that will require you to synthesize your GIS knowledge and creativity. Be sure to choose a topic/spatial problem that you are really interested in and start early.

• Students may use the same data and/or references that they have used/will use in their other projects. However, the final products to be presented or submitted for this course should be independent of any other projects.
• Examples of potential topics:
  o A gravity model that predicts migration flows from/to Utah
  o A spatial interaction model to evaluate accessibility to hospitals among county residents
  o An urban growth/land use change model for a town you live in
  o A transportation model to predict future congestion levels in the highway system in Utah
  o A model of West Nile virus risk potential
  o A watershed based hydrological model

Evaluation of the final project will be based on (1) a two-page proposal of the project, (2) an in-class presentation, and (3) a final report describing functions implemented in the model and background science. The proposal and presentation should be completed by the group. A final report should be completed and submitted by each student.
• Two-page proposal will include:
  o Description of a general topic that a group has chosen to work on
  o Description of a more specific spatial problem to solve via GIS-based spatial modeling
  o Work plan of the group (e.g., who will do what)
  o Tentative list of references for the topic and the spatial problem
  o Tentative list of data sets to be used in the project
Spring 2014 GEOG 5160/6160 Spatial Modeling with GIS

- **Note**: If you want to change topics or spatial problems, please contact the instructor. Substantial changes may require a new proposal to be submitted

- Final report (must be typed; 10-15 pages; double space, 10-12 fonts) will include:
  - Introduction to the general topic of the group project
  - Description of the specific spatial problem that your model attempts to solve and the objectives of the modeling exercise
  - Review of the literature on similar models previously developed
  - Conceptual framework upon which your model is built
  - Description of GIS data sets (real or synthetic) to be used to run your model
  - A description of the model, with sufficient detail to allow reproduction of your code. [If possible, submit actual data and the model in electronic format.]
  - Sample results from model runs
  - Discussion relating your results to the problem under investigation
  - Conclusions
  - Bibliography that lists all the references “cited” in the report

- Do not include references that you read for the project but are not cited.

- Your in-class presentation will be a condensed version of the final report. Use of PowerPoint presentation or like is strongly recommended.

- Important dates:
  - Two-page project proposal due: **February 21, 2012**
  - Final report due: **April 30, 2012**
  - Final presentation days: **April 21 and 23, 2012**

**Class policies:**

- **Evaluation-related policies**
  - Individual extra credit will not be assigned.
  - There will be no “make-up” exams, quizzes, or assignments.
  - An “incomplete” grade will be given only in extreme cases when conditions beyond the student’s control require an extended period of absence.
  - Any assignments, including the final project report, submitted to the instructor after its due date will be worth only half of the earned points.
  - Materials to be turned into the instructor must be typed, and turned in using Canvas.
  - Students are encouraged to help each other in their work. However, final products turned into the instructor must display evidence of individual initiative and creativity. If not, no credits will be given to the particular work.

- **Attendance**
  - Full attendance is strongly recommended. The amount of material
covered in class meetings is significant and the content of the course is progressive, meaning you must know the material from previous class meetings in order to understand subsequent material. When missing classes, students are responsible for seeking help to catch up with the class progress in a timely manner, if they need to.

- **Email correspondence**
  - Students must copy themselves on any email to the instructor to ensure documentation of submission date and time. Doing so will assist the student when system outrages occur.
  - Senders must also validate that all files are in readable format. Corrupted files are the responsibility of the sender and corrupted-file assignments will be marked as late.

- **Cell phones**
  - Please turn off your cell phones or use vibrate/silence mode during class meetings.

- **Student responsibilities**
  - All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook of the University of Utah (http://www.acs.utah.edu/sched/handbook/toc.htm). Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.
  - Academic misconduct will not be tolerated. Penalties may include failure of an assignment, the entire course, and/or the filing of formal charges with appropriate university authorities. Academic misconduct includes, but is not limited to, cheating, misrepresenting one’s work, and plagiarism.
  - The instructor may elect to use a plagiarism detection service in this course, in which case you will be required to submit your paper to such a service as part of your assignment.

- **Liability warning**
  - Students are responsible for all activities on their computer accounts. Keep your user name and password confidential.

- **Equal access policy**
  - The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building.
581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations.