SSCI 383L, Geospatial Modeling and Customization

Syllabus

Units: 4

Term – Day – Time: Spring, 2018, Lectures: Mon and Wed 12-1:20 pm PT; Lab: Thu 2-3:50 pm PT

Location: Lectures AHF 145D; Lab: AHF 145A

Instructor: Jennifer N Swift, Ph.D. GISP
Office: AHF B57D
Office Hours: Mon and Wed 10-11 am PT, also available most days and times by appointment via email.
Contact Info: jsswift@usc.edu, 213-740-5841 (office)

Laboratory Co-Instructor: Su Jin Lee, Ph.D. GISP
Office: AHF B55K
Office Hours: Mon 11 am-12 pm PT and Tues 2-3 pm PT, also available most days and times by appointment via email.
Contact Info: sujinlee@usc.edu, 213-740-2845 (office)

Library Help: Andy Rutkowski
Office: VKC Library 36B
Office Hours: Tue 10 am-12 pm PT and Thu 4:30-5:30 pm PT
Contact Info: arutkows@usc.edu, 213-740-6390 (office), http://bit.ly/andyhangout

IT Help: Richard Tsung
Office: AHF 146
Office Hours: By appointment
Contact Info: ctsung@usc.edu, 213-821-4415 (office)
Course Scope and Purpose

The spatial sciences now require professionals with GIS modeling and customization skills, an essential part of the career portfolio. This course provides the fundamentals of spatial modeling, and how to use GIS customization and programming, or scripting, to streamline complex spatial analysis and modeling workflows. An understanding of GIS modeling and how to create and implement customized tools is needed to successfully solve many of the critical societal and environmental challenges we face in today’s ever-changing world. Learning to program facilitates understanding of one’s use of GIS as well as how to interact with others who use GIS software. Familiarity with a GIS programming language and how it is implemented also provides in-depth insight into how other programmers create and use these tools. Helping you become comfortable with creating, coding and documenting GIS modeling workflows is a fundamental goal of this course.

Numerous examples will be used throughout the course to illustrate how spatial modeling helps us to understand spatial phenomena through expressions of how the natural world works, and the profound influence we have on our environment. The combination of class and laboratory sessions will show how, for example, effective spatial modeling combined with creative coding requires an informed and intelligent user in addition to the appropriate computer hardware and software tools.

This course is designed to serve several student audiences given its role as a required course in the B.S. in GeoDesign and Minor in Spatial Sciences. Each audience is encouraged to utilize the laboratory experience and research projects to investigate diverse geospatial resources such as spatial modeling, computer programming, remotely sensed imagery, and 2D and 3D data visualization to advance their own academic and professional goals.

Learning Objectives

Students who excel in SSCI 383L will:

- Understand fundamental spatial science concepts in the context of spatial modeling;
- Explain how spatial models can be used to solve and understand real-world problems from an interdisciplinary viewpoint;
- Program small-scale GIS-based models in Python, integrated within ArcGIS or some other geospatial software ecosystem;
- Streamline complex workflows using GIS customization techniques;
- Describe how many of the complex global challenges we face today can be addressed through the combination of spatial modeling and customization using GIS.

Prerequisite(s): SSCI 301L, SSCI 382L or Instructor Permission
Co-Requisite(s): None
Concurrent Enrollment: None
Recommended Preparation: None
Course Structure
This is a four-credit course comprised of combined lectures (two per week) and labs (one per week). The combined lecture and lab sessions are organized into learning modules that build upon core principles of geographic information science by delving into topics including spatial modeling and GIS customization, and the software systems used to explore these topics. The weekly meetings and projects are designed to broaden your practical experience and deepen your understanding of the concepts and tools of spatial science inquiry and to enhance your problem-solving skills within the framework of the scientific method. The lecture and lab sessions are designed to provide you with sound theoretical reasoning and the technical skills to investigate various physical and social processes. Your weekly assignments will be graded and returned, and the mid-term and both projects will have a laboratory component to them. Please note that all course materials and correspondence will be posted on the course Blackboard website. As a registered student you will find this course available for you to access at 10 a.m. PT on the first day of classes.

Technological Requirements
The computational software and geospatial data required for course assignments will be accessed using computing resources provided by the Spatial Sciences Institute.

Required Readings and Supplementary Materials
The required textbooks for this course are:


The required tasks will be supplemented with the following materials:


Description and Assessment of Assignments

Your grade in this class will be determined on the basis of several different assessments:

Assignments (15%): Students will be expected to complete three assignments focused on assigned readings, engagement in lectures, sharing and discussion of course assignments, and in-class “worksheets,” among other forms of active engagement in the course.

Laboratory Assignments (30%): This course includes a laboratory component each week to develop technical competency with geospatial software platforms and analytic tools. There will be a total of ten laboratory assignments over the course of the semester.

Mid-term Exam (15%): The mid-term exam will consist of multiple-choice, short answer, and simple problem questions. Students will be expected to take the exam at the indicated time.

Individual Project (20%) - The individual project is a capstone report and presentation for this course, and students will be expected to draw upon course lectures, discussions, lab assignments, readings, and outside sources to organize and deliver a self-directed study on a topic of interest utilizing spatial modeling and geospatial technologies. The report is limited to 15 pages (with 12-point font, 1 inch margins, single-spacing for text) and will include one or more maps, tables, and other diagrams as well as a list of references. The presentation will include slides and will be limited to 10 minutes per student.

Final Exam (20%): The final exam will consist of multiple-choice, short answer, and simple problem questions. Students will be expected to take the exam at the indicated time.

Grading Breakdown

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Number</th>
<th>Points Each</th>
<th>Total Points</th>
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</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Laboratory Assignments</td>
<td>10</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>Mid-term Examination</td>
<td>1</td>
<td>15</td>
<td>15</td>
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<tr>
<td>Final Examination</td>
<td>1</td>
<td>20</td>
<td>20</td>
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<tr>
<td>Individual Project Components</td>
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<tr>
<td>Individual Project Report</td>
<td>1</td>
<td>15</td>
<td>15</td>
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<tr>
<td>Individual Project Presentation</td>
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<td>5</td>
<td>5</td>
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<tr>
<td>Total</td>
<td>17</td>
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<td>100 points</td>
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Assignment Submission Policy

Assignments will be submitted for grading via Blackboard by the due dates specified in the Course Schedule below.
Additional Policies

Students are expected to attend and participate in every class session and to complete and upload all assignments before the deadlines detailed in the Course Schedule. Late work will be assessed a penalty of 10% per day and zero grades will be assigned for work that is more than seven days late.

Schedule

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Topics</th>
<th>Readings and Assignments</th>
<th>Deliverables/Due Dates</th>
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<tbody>
<tr>
<td>1/8</td>
<td><strong>Introduction to the Course</strong>&lt;br&gt;Brief introductions coupled with discussions of class goals, lab assignments, projects, and technologies.</td>
<td>Longley et al. (2015) Ch. 6, pp. 128-151, Ch. 9, pp. 194-204</td>
<td>Complete by 1/16: Assignment 1: Introduction to object oriented spatial databases</td>
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<tr>
<td>1/10</td>
<td><strong>Introduction to Geographic Databases</strong>&lt;br&gt;Introduction to the role of database management in geographic information systems, use of Structured Query Language (SQL), and key geographic database types and functions.</td>
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<tr>
<td>Week 2</td>
<td><strong>Geographic Databases: Semantics and Ontology</strong>&lt;br&gt;Examination of the primacy of words and the logic of language as applied to GIS data and geographic database design, key techniques for creating topology and indexing, and multiuser editing and versioning.</td>
<td>Longley et al. (2015) Ch. 9, pp. 205-215</td>
<td>Complete by 1/22: Lab 1: Introduction to geographic database design, spatial queries, and multi-user databases</td>
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<tr>
<td>1/15 is a University holiday</td>
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<tr>
<td>1/17</td>
<td><strong>Geocoding</strong>&lt;br&gt;Exploration of the problems associated with place-names, street addresses and other human systems and how to define real-world locations.</td>
<td>Longley et al. (2015) Ch. 4, pp. 77-98</td>
<td>Complete by 1/29: Lab 2: Geocoding and georeferencing spatial data in GIS</td>
</tr>
<tr>
<td>Week 3</td>
<td><strong>Georeferencing</strong>&lt;br&gt;Introduction to georeferencing, geotagging and georegistration using vector and raster spatial data models.</td>
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<td>Week 4</td>
<td>Topics</td>
<td>Readings and Assignments</td>
<td>Deliverables/Due Dates</td>
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| 1/29    | Network Analysis  
| 1/31    | Optimization  
Analysis of spatial decision support and methods of statistical inference applied to geographic data and optimization of network connectivity. | | |
| Week 5  | 3D Visualization  
Investigation of core concepts in creating 3D geographic representations of the real world to facilitate understanding our world. | Longley et al. (2015) Ch. 10, pp. 217-235, Ch. 12, pp. 266-288 | Complete by 2/12: Lab 3: 3D Visualization and spatial analysis techniques using Esri ArcGIS Pro |
| 2/5     | 3D Spatial Analysis  
Introduction to methods to quantitatively analyze the spatial distribution of real and simulated objects within 3D space. | | |
| 2/7     | Core Concepts of Spatial Modeling  
Introduction to the fundamental concepts of spatial modeling. | Longley et al. (2015) Ch. 14, pp. 326-337, Ch. 15, pp. 339-343 | Complete by 2/20: Assignment 3: Comparison of different types of spatial models |
| 2/12    | Types of Models  
Discussion of the different types of spatial models and why we use them, including linear regression models and geographically weighted regression (GWR). | | |
| 2/14    | Spatial Modeling in GIS  
Exploration of spatial modeling in the context of geographic information systems and remote sensing using software that supports modeling. | Longley et al. (2015) Ch. 15, pp. 344-345 | Complete by 2/26: Lab 4: Introduction to dynamic spatial modeling and decision support using IDRISI TerrSet |
| Week 7  | 2/19 is a University holiday | | |
| 2/21    | Agent-Based Modeling  
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Readings and Assignments</th>
<th>Deliverables/Due Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/28</td>
<td></td>
<td><strong>Spatial Decision Making</strong></td>
<td>Introduction to methods for developing decision models that can resolve resource allocation decisions.</td>
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<td><strong>Mid-Semester Review</strong></td>
<td>No Lab. Review for Mid-Term</td>
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<td>Week 9</td>
<td>3/5</td>
<td><strong>Mid-Term Exam</strong></td>
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<td>3/7</td>
<td><strong>Spatial Modeling and Decision Support</strong></td>
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<td><strong>Collaborative Spatial Problem Solving</strong></td>
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<td><strong>GIS Automation and Customization</strong></td>
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<td>3/21</td>
<td><strong>Extending GIS Through Programming</strong></td>
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<td>3/28</td>
<td><strong>Wrapping Models in GIS Add-Ins</strong></td>
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<td><strong>Open Source Programming and Customization</strong></td>
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<td>Complete by 4/9: Lab 8: Using Python/Numpy and ArcGIS to extract land surface variables and features from DEMs</td>
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<tr>
<td>Week 13</td>
<td>4/2</td>
<td><strong>Spatial Modeling Using Big Data</strong></td>
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<td>Complete by 4/18: Lab 9: Introduction to Whitebox GAT remote sensing and change detection techniques</td>
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<tr>
<td></td>
<td></td>
<td><strong>Spatial Modeling Using Big Data</strong></td>
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**Notes:**
- iCode Academy (2017)
- Law and Collins (2016) Ch. 5
- Toms (2015) Ch. 3, pp. 41-59
- Rigol-Sanchez et al. (2015)
- Padmanabhan et al. (2014)
<table>
<thead>
<tr>
<th>Week 14</th>
<th>Topics</th>
<th>Readings and Assignments</th>
<th>Deliverables/Due Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/18</td>
<td><strong>Web Services</strong>&lt;br&gt;Overview of different data formats that are often used in geospatial Web services to transport geospatial feature information between Web services and clients.</td>
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<tr>
<td>Week 15</td>
<td><strong>Individual Projects</strong>&lt;br&gt;Students work on individual projects.&lt;br&gt;Complete individual spatial modeling project and report.</td>
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<td>4/23*</td>
<td><strong>Final Individual Presentations &amp; Reports</strong>&lt;br&gt;Students present individual projects.</td>
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<td>No Lab</td>
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<td>4/25</td>
<td>*Friday, 4/27 is last day of class</td>
<td></td>
<td>Complete by 4/25-4/26: Individual Project Presentations&lt;br&gt;Complete by 4/27: Individual Project Reports. All projects must be submitted no later than 5:00 PM PT on 4/27</td>
</tr>
</tbody>
</table>

**Exam Week**<br>5/2-5/9<br><br>**Final Examination**

<table>
<thead>
<tr>
<th>Final Examination</th>
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<tbody>
<tr>
<td>Final Examination: Friday, 5/4, 11 am-1 pm PT</td>
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</table>

**Statement on Academic Conduct and Support Systems**

**Academic Conduct**

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” [https://policy.usc.edu/scampus-part-b/](https://policy.usc.edu/scampus-part-b/). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, [http://policy.usc.edu/scientific-misconduct](http://policy.usc.edu/scientific-misconduct).
Support Systems

**Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call**
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. [https://engemannshc.usc.edu/counseling/](https://engemannshc.usc.edu/counseling/)

**National Suicide Prevention Lifeline - 1-800-273-8255**
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. [http://www.suicidepreventionlifeline.org](http://www.suicidepreventionlifeline.org)

**Relationship & Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call**
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. [https://engemannshc.usc.edu/rsvp/](https://engemannshc.usc.edu/rsvp/)

**Sexual Assault Resource Center**
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: [http://sarc.usc.edu/](http://sarc.usc.edu/)

**Office of Equity and Diversity (OED)/Title IX compliance – (213) 740-5086**
Works with faculty, staff, visitors, applicants, and students around issues of protected class. [https://equity.usc.edu/](https://equity.usc.edu/)

**Bias Assessment Response and Support**
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. [https://studentaffairs.usc.edu/bias-assessment-response-support/](https://studentaffairs.usc.edu/bias-assessment-response-support/)

**Student Support & Advocacy – (213) 821-4710**
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. [https://studentaffairs.usc.edu/ssa/](https://studentaffairs.usc.edu/ssa/)

**Diversity at USC – [https://diversity.usc.edu/](https://diversity.usc.edu/)**
Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students