GTECH 73300 – GeoComputation II
Wednesday 5:35 – 8:15 pm • Spring 2018
Room 1090B-1-Hunter North

Instructor: Gordon M. Green, PhD
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Prerequisites: GTECH 73100 and GTECH 73200.

Course Description
This course covers models and algorithms used for spatial and spatiotemporal modeling. It will approach spatial modeling concepts and techniques from an algorithmic perspective, building on the conceptual and practical foundations established in the prerequisite classes. Students will be expected to work independently on a substantial project, to participate in exploring different modeling approaches, and to read independently and share what they have learned with the class throughout the semester.

We will begin with an overview of taxonomies of GIS models and the data representations used to support them. We will then look at cartographic models in more detail, and the techniques for generating data layers that can be combined to create descriptive and prescriptive spatial models. We will then move on to using multivariate classification to create categorical maps, starting with decision trees based on remote sensing data, with a survey of other methods of developing both categorical and continuous maps using machine learning methods. This will include a discussion of the applicable methods of accuracy assessment.

The next section of the class will focus on dynamic simulation models, beginning with non-spatial systems-dynamics models that estimate change over time, which will allow us establish the key concepts of convergence, parameter selection, and model sensitivity. This will serve as a basis for exploring spatiotemporal models of landscape processes. An applied example will cover landscape simulation from remote sensing data. Agent-based dynamic models will then be introduced, including the concept of emergent behavior, and object-based models of independent actors in a landscape.

We will also consider the visualization of GIS models. The challenges of communicating model uncertainty will be discussed, along with a series of workshops covering the basics of data-driven web-based representations in JavaScript, and useful techniques such as interactive and three-dimensional visualization.

You will be expected to explore additional readings on the presented methodologies, and to discuss them in class. Over the course of the semester, you will be required to complete a modeling project on a class topic of your choosing, subject to the approval of the instructor. You will be expected to conduct a brief literature review and present your review and completed projects in class. The project presentation must be accompanied by a 5+ page paper following standard research paper format, including a suitable evaluation of the accuracy of your model.

Course Objective
The goal of the course is to expose you to a multiple approaches to modeling spatial data and spatial processes, and to provide a framework within which you can develop modeling expertise and learn about possible subjects for more in-depth future study. The goal of the project is to promote a deeper understanding of a subset of the covered methodologies, and the practical issues of working with real data. The readings and project are intended to advance your understanding of current trends and methods, and extend your understanding beyond the basics covered in the required readings.

Expected Learning Outcomes
You should come away from this class with an understanding of how to use and evaluate GIS modeling algorithms; how to design, implement, and evaluate the results of one of the covered methodologies; and how to select methodologies for future applications. You should be able to conceive of an appropriate solution to a given modeling problem, write Python code that implements a solution, and evaluate and visualize the results.

Required Text
This text will be used for several segments of the class:

Spatial Simulation: Exploring Pattern and Process by David O'Sullivan and George L. W. Perry, Wiley-Blackwell, 2013. ISBN-13: 978-1119970798, ISBN-10: 1119970792.

Additional Texts
These additional texts will be referenced. You will also be expected to research journal articles using the Hunter College or other CUNY library systems.

Assessing the Accuracy of Remotely Sensed Data: Principles and Practices, Second Edition by Russell G. Congalton and Kass Green CRC Press 2008. ISBN-13: 978-1138746756, ISBN-10, 1138746754.

GIS Algorithms, by Ningchuan Xiao, Sage Publications, 2016. ISBN-10: 1446274330; ISBN-13: 978-1446274330.

GIS and Cartographic Modeling, by C. Dana Tomlin, Esri Press, 2012. ISBN-10:158948309X, ISBN-13: 978-1589483095.

Interactive Data Visualization for the Web: An Introduction to Designing with D3, 2nd Edition by Scott Murray O'Reilly Media, 2017. ISBN-13: 978-1491921289; ISBN-10: 1491921285.

Mapping Species Distributions: Spatial Inference and Prediction, by Janet Franklin, Cambridge University Press, 2010. ISBN-10: 0521876354, ISBN-13: 978-0521876353.

The Truthful Art: Data, Charts, and Maps for Communication by Alberto Cairo, New Riders, 2016. ISBN-13: 978-0321934079, ISBN-10: 0321934075.

List of Software Tools
The following tools may be referenced in the implementation walk-throughs and projects: Python 2.7; Postgres 9.3 / PostGIS 2.1 spatial database; ArcPy or OGR/GDAL, Numpy, SciPy, SciKit image, Orange data mining toolbox; ThreeJS, Cesium and D3 JavaScript libraries.

Grading
Grading will be based on the final project (50%), the accompanying paper and literature review (20%), the lab/homeworks (20%), and class participation and attendance, which is required (10%).

Course Calendar and Content

Week	Topic	Assignments and Readings
1/31	**Introduction** – model taxonomies – model selection – implementation – verification – calibration – validation – evaluation – visualization; software infrastructure; overview of data resources and relevant algorithms.	Introductory readings; initial project research.
2/7	**Cartographic modeling 1** – neighborhoods – map algebra – local, zonal, and global functions; descriptive and prescriptive models; methods of developing input features.	Tomlin Cartographic Modeling; additional readings TBD.
2/14	**Cartographic modeling 2** – examples and algorithms.	Discussion of readings; cartographic model; **project proposal due.**
2/21	**Mapping with classification and regression models 1** – decision trees and random forests – more on feature engineering – quantifying error – precision and recall – confusion matrices – kappa index of agreement – RMSE and others.	Franklin Spatial Inference; Congalton and Green Accuracy, others TBD.
2/28	**Mapping with classification and regression models 2 –** survey of additional methods; making a categorical map from point observations.	Discussion of readings; making a categorical map.
3/7	**Simulation 1**– Monte Carlo methods – sampling from empirical and theoretical distributions – sensitivity analysis – parameter selection	O'Sullivan and Perry Spatial Simulation; others TBD.
3/14	**Simulation 2** - Spatial Markov example (e.g., predicting landscape change with cellular automata).	Discussion of readings; spatial Markov example; **literature review due.**
3/21	**Agent-based models 1** – agents and object-oriented programming – non-spatial and spatial examples.	Simulation readings TBD.
3/28	**Agent-based models 2 –** spatial agent-based model implementation (e.g., model of agents in a simple ecosystem).	Discussion of readings; spatial simulation example; **project check-in/review.**
4/4	No class	
4/11	No class	

4/18	**Network models 1 –** brief survey of network modeling concepts and methods.	Network readings TBD
4/25	**Network models 2 –** implementation issues on network models.	Discussion of readings.
5/2	**Workshop 1**: visualization with data-driven documents.	Readings from Cairo the Truthful Art; Murray Visualization; others TBD.
5/9	**Workshop 2**: interactive visualization.	
5/16	**Workshop 3**: 3d visualization.	
5/23	**Final project presentation; final paper due.**	

Please refer to the Hunter College registrar's site for important dates and deadlines.

Hunter College Policy on Sexual Misconduct

In compliance with the CUNY Policy on Sexual Misconduct, Hunter College affirms the prohibition of any sexual misconduct, which includes sexual violence, sexual harassment, and gender-based harassment retaliation against students, employees, or visitors, as well as certain intimate relationship. Students who have experienced any form of sexual violence on or off campus (including CUNY-sponsored trips and events) are entitled to the rights outlined in the Bill of Rights for Hunter College.

a. Sexual Violence: Students are strongly encouraged to immediately report the incident by calling 911, contacting NYPD Special Victims Division Hotline (646-610-7272) or their local police precinct, on contacting the College's Public Safety Office (212-772-4444)

b. All Other Forms of Sexual Misconduct: Students are also encouraged to contact the College's Title IX Campus Coordinator, Dean John Rose (jtrose@hunter.cuny.edu or 212-650-3262) of Colleen Barry (colleen.barry@hunter.cuny.edu or 212-772-4534) and seek complimentary services through the Counseling and Wellness Services Office, Hunter East 1123.

CUNY Policy on Sexual Misconduct Link:
http://www.cuny.edu/about/administration/offices/la/Policy-onSexual-Misconduct-12-1-14-with-links.pdf

Essential Policy Information

- There is absolutely **no eating or drinking in the computer laboratory**, either during class or when working independently. You run the risk of having your departmental computer account suspended if you are caught eating or drinking in HN 1090B.
- Attendance/lateness policy – you are expected to arrive on time and to email me when classes will be missed.
- Work is due as indicated in the syllabus or as reviewed in class. Late assignments will be marked down a letter grade.
- Policy for extra credit – There is no extra credit.
- Policy on the use of instructional technologies – I will post class materials on Blackboard, and will make class announcements through the Blackboard announcement system.

Hunter College Policy on Academic Integrity
Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The College is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures.

ADA Policy
In compliance with the American Disability Act of 1990 (ADA) and with Section 504 of the Rehabilitation Act of 1973, Hunter College is committed to ensuring educational parity and accommodations for all students with documented disabilities and/or medical conditions. It is recommended that all students with documented disabilities (Emotional, Medical, Physical, and/or Learning) consult the Office of Accessibility, located in Room E1214B, to secure necessary academic accommodations. For further information and assistance, please call: (212) 772- 4857 or (212) 650-3230.

Syllabus Change Policy
This syllabus is a guide for the course and is subject to change with advance notice by email and/or class announcement.