COLLEGE OF BUILT ENVIRONMENTS
UNIVERSITY of WASHINGTON

URBDP 422/522 Geospatial Analysis
Winter 2021

Lecture: Mondays and Wednesdays |8:30 - 9:20 am

Instructor : Marina Alberti, Professor., malberti@uw.edu

INTRODUCTION

Course Description

This course provides theoretical and practical skills for analyzing spatial patterns and phenomena in metropolitan areas. Students will explore the functionality of geographic information systems (GIS) as an effective tool for analyzing and modeling complex spatial relationships within urban environments. Emphasis is given to data integration and modeling through both raster and vector systems. Selected case studies will be used to highlight data limitations and methodological complexities. In addition to the theoretical and technical foundations of GIS, students will develop and hone problem solving and spatial thinking skills, both critical to success in this course of your academic and professional careers. Problem solving is basic to the scientific method and refers to the process you will use to understand and reach a conclusion about something unknown. Spatial thinking is the process of understanding and recognizing objects within space and recognizing the importance of the space surrounding those objects and the relationships that occur within the whole system. Skills developed in this class will conclude with a final application (project) emphasizing principles and methods of spatial analysis applied to urban problems in the central Puget Sound region.

Objectives

This course aims at the following four objectives:

1. Develop a deeper understanding of spatial data and principles of spatial analysis.
2. Develop a proficiency in the analysis and evaluation of spatial data.
3. Develop technical skills to structure spatial data analysis and modeling in planning.
4. Develop and improve spatial problem solving abilities through the application of GIS knowledge and spatial thinking skills.

Course Structure

This course is based on paired lectures and lab sessions. In addition, students are expected to work on a team or individual project to apply spatial analysis to selected research questions. Each team will be asked to produce summary materials (5-page paper and digital data folder) describing the research question, methodology, and findings. Project teams are expected to give a presentation at the end of the quarter. A mid-term designed to examine students' ability to master the spatial concepts and technical skills they have learned in the course will be administered.

You are expected to successfully complete the following activities:
1. All assigned readings prior to class (required readings are listed for each class in the syllabus).
2. Lab exercises during the lab sessions, using the appropriate software. 3. A team project including a project report and presentation.
4. Mid-term exam.

Assignments (a.k.a. Lab exercises)

Students will experiment with and deepen their computer skills through a set of lab exercises. Practical hands-on exercises are designed to help students learn GIS functions and explore their application for spatial analysis. A number of lab sessions will be used for team projects.
For a schedule of exercises and assignments, see the course schedule. Students are responsible for turning in assignments that accompany the lab exercises. Homework submittal format will usually be a Word document or pdf with embedded images unless otherwise specified. Homework assignments are usually worth 10 points.
Assignments are due by 11:45 pm on the day that they are due; you might have upload issues or have your internet fail, or something along these lines. Don't wait until the last minute. Assignments are to be turned in using the course Canvas page for the Assignment. Assignment files shall be titled as uwid_ex## (example: maspatte_ex02) Late policy: for each day after the due date that assignments are turned-in, 1 point will be deducted from your grade. Assignments will not be accepted more than 1 week late.

Team Projects

The team project will provide you with the opportunity to apply specific GIS functions to a selected planning problem. You are expected to form project teams, select a planning question which involves the analysis of spatial relationships in an urban or regional context, and formulate a GIS approach to the question. In defining the project, the team is expected to explore the available data sets and to interview two or three key people in agencies relevant to their project. Each team is expected to produce and present a final project report. Students are expected to develop a project scope, prepare data layers, conduct analysis, and synthesize findings. Students will submit findings via a presentation, project brief, and digital data folder. Teams will be asked to present the analysis within the context of the larger research question, however focusing their project on the spatial analysis component. Students having background in multi-regression and other multivariate statistical analysis are encouraged to explore the application of these techniques to analyze geospatial data.

Team Project Evaluation Breakdown

- Project Idea and Agency Interview 10%
- Draft Project Design and Revision 15%
- Status Report 10%
- Final Report 30%
- Presentation 20%
- Data Folder 15%

Consult the Project Guideline for more details.

Grades

Grades are calculated as follows:
Lab Exercises: 25%
Mid-term exam: 25%
Team Project: 50%

Readings

All required readings will be accessible via the course Canvas site.
You are expected to read the required readings before lecture on the assigned day.

Materials

You will need a 2G USB drive (preferably larger) to save your lab exercises and team project files. Files should NOT be saved on UDrive, on machines in 007 or the Digital Commons generally.

Course Policies

Important policies to follow during lectures and labs:
No non-course computer work is permitted during lecture. Typing during a lecture can be very distracting to other students, and you are probably not getting much out of the session if you're working on a separate assignment or writing emails anyway.
It is the preference of the instructor that note taking be conducted on paper. Students are encouraged to take notes by hand during lectures. Research shows greater retention of material in students who make handwritten notes.
Turn your cell phone off. Period. Never answer calls or texts in class. If you have a situation where you absolutely cannot miss a phone call (medical emergencies, job interviews, etc), put your phone on vibrate, and please discuss it with the instructor and/or TA to let them know that you may answer a call and leave during class.
Keep extraneous talking to a bare minimum. During lab sessions it is acceptable and encouraged to ask your neighbor questions, or to provide assistance if you see someone struggling and know how to help. However, out of context discussion should be limited in duration and volume.

Schedule

Lectures can be found in the files section of the canvas site. Readings listed below are summarized, for the full title go to the readings section of the Syllabus. Readings in red are optional. While mostly firm, the schedule below will likely be subject to some change, based on availability of guest speakers, student learning curves, etc.

Date & Topic	Lecture	Reading	In-Class Lab	Lab Due
Week 01				
01/04/2021: Course Overview	Lecture 0	None		
01/06/2021: Principles of GIS	Lecture 1	De Smith et al., 2018, Ch.1. Drummond and French, 2008.	Lab. 1	

Week 02				
01/11/2021: Spatial Data Models and Structures	Lecture 2	De Smith et al., 2018, Ch. 2. Longley et al., 2015. Ch. 3. Topology in ArcGIS Topology Rules Poster	Lab. 2 & 3	
01/13/2021: Building a Geo Database	Lecture 3	De Smith et al., 2018, Ch. 3. Longley et al., 2015. Ch. 5. ESRI, Understanding Map Projections, Ch 1-3.	Lab. 4	Lab.1; Submission of Team Members' Names
Week 03				
01/18/2021: No Class				
01/20/2021: Classifying the Urban Landscape	Lecture 4	De Smith et al., 2018. Ch. 4.2.12 Powell et al., 2008. Alberti, et al., 2004.	Team Time I: team formation and topic selection Lab. 5	Lab. 2 & 3
Week 04				
01/25/2021: Describing the Urban Landscape	Lecture 5	Turner, 1989. Wu and David, 2002.	Lab. 6	Lab. 4
01/27/2021: Quantifying and Analyzing the Urban Landscape I: Vector Analysis	Lecture 6	De Smith et al., 2018. Ch. 4.2.9 Chrisman, 1997.	Lab. 7	Team Project Idea & Interview Write-up
Week 05				
02/01/2021:	Lecture 7	Read at least one of the	Team Time	Lab. 5

Urban Landscape Review		following articles: He et al., 2000. Galster et al., 2005. Torrens, 2008.	II: CM design	
02/03/2021: Quantifying and Analyzing the Urban Landscape II: Raster Analysis	Lecture 8	Grimm et al., 2005 Hargis et al., 1998	Project Review and Feedback Lab. 8 Lab. 8b (extra credit)	Lab. 6

Week 06				
02/08/2021: Conceptual Models	Lecture 9	Alberti et al., 2003	Team Time III: Team presentation and discussion of Conceptual Models	Lab. 7
02/10/2021: Network Analysis	Lecture 10	De Smith et al, 2018. Ch. 7.1; Ch. 7.3.4 Eckley and Curtin, 2013	Lab. 09 Team Time IV	Draft Project Design
Week 07				
02/15/2021: No class				
02/17/2021: Midterm Review	Review		Team Time V	Lab. 8, 8b & 9
Week 08				
02/22/2021: Midterm				
02/24/2021: Modeling Spatial Phenomena: Urban Landscapes and the Land Cover Change Model	Lecture 11	De Smith et al., 2018. Alberti, M, 1999. Waddell, 2001.	Team Time VI	Project Design Revisions
Week 09				

03/01/2021: Watershed Delineation and Characterization	Lecture 12	De Smith et al., 2018. Ch. 6.4 Miller et al., 2007.	Lab. 10	
03/03/2021: Surface Analysis and Interpolation	Lecture 13	De Smith et al., 2018. Ch. 6.6	Team Time VII	Project Status Report
Week 10				

03/08/2021: Exploring Complexity, Uncertainty, and Error in the Urban Landscape	Lecture 14	De Smith et al., 2018. Ch. 5.3.2	Lab. 11	Lab. 10
03/10/2021: Cost surfaces and distance analysis	Lecture 15	Burrough, 1998. Ch. 9. Longley et al., 2015. Ch. 6.	Team Time VIII	
Final Week				
03/15/2021: Final Project Presentation		- Please send presentation files by 11:59 PM, 3/14/2021 - Please take notes on any questions or constructive feedback you have for each team regarding their project.		Lab. 11
03/17/2021: Reports Due by midnight				Final Project Report

LECTURES

Lecture 1: Course Overview and Principles of GIS

Course description, participation, and requirements

Introduction to spatial data, spatial concepts, and spatial analysis in planning

Lecture 2: Spatial Data Models and Structures

Representing the geometry of spatial phenomena

Raster and Vector data structures

Topology

Lecture 3: Building a Geo-Database
Features. Spatial relationships. Projection in more detail.

Lecture 4: Classifying the Urban Landscape
Classifying satellite image into land cover classes with spectral pattern recognition,spatial pattern recognition, and accuracy assessment of a classified map.

Lecture 5: Describing the Urban Landscape
Characterizing the urban landscape by describing its spatial and attribute properties. Data sources
Function vs. structure
Boundary definition
Choosing a scale for analysis

Lecture 6: Quantifying and Analyzing the Urban Landscape I: Vector Analysis Vector spatial analysis
Buffering and proximity analysis
Polygon overlays
Spatial clusters
Spatial modeling

Lecture 7: Urban Landscape Review
Urban Sprawl

Lecture 8: Quantifying and Analyzing the Urban Landscape II: Raster Analysis Raster spatial analysis
Neighborhood functions, reclassification, spatial queries
Map algebra operations
Introduction to landscape pattern metrics

Lecture 9: Conceptual Models

Lecture 10: Network Analysis
Basics of network analysis and Network Analyst
Example of optimal routing
Tip and tricks

Midterm Review

Lecture 11: Modeling Spatial Phenomena: Urban Landscapes Logit model conversions
Hedonic model of single housing sites
Biocomplexity Conceptual model
UrbanSim
The Land Cover Change Model

Lecture 12: Watershed Delineation
Digital elevation models

Terrain visualization and analysis
Basin delineation
Splines, Inverse Distance Weighting, Kriging, Spatial Statistics

Lecture 13: Surface Analysis and Interpolation
Spatial Unit, Scale, Impact of Measurement
Determining an Optimal Scale of Analysis

Lecture 14: Exploring Complexity, Uncertainty, and Error in the Urban Landscape
Registration error
Classification error
Accuracy assessments
Course Review

Lecture 15: Cost Surfaces and Distance Analysis

EXERCISES

Exercise 1: REVISITING GIS
Objectives: Refresh memory about GIS usage.

Exercise 2: Creating new maps with topology
Objectives: Learn how to use the new ArcGIS 10.7 object oriented topology rules to create a topology feature dataset.

Exercise 3: Features, Feature Class, Coverages, Shapefiles, and Workspace
Objectives: To test your understanding of different concepts such as coverages, shapefiles, features, feature class, and feature dataset.

Exercise 4: Processing vector data [Data processing]
Objectives: Use ArcMap to perform simple analytical procedures.

Exercise 5: Classifying Satellite Imagery
Objectives: Explore satellite bands, false color composites, areas of interest, reflectance graphs. Create a signature file. Complete a supervised supervision.

Exercise 6. Using Fragstats to assess Landscape Metrics
Objectives: Reclassify land cover data set, familiarize with fragstats GUI, and Learn about landscape metrics.

Exercise 7: Buildable Land Inventory
Objectives: This exercise focuses on vector data analysis. Lessons include:

Exercise 8: Park Selection using Spatial Analyst
Objectives: Learn how to use Spatial Analyst to conduct raster analysis and conduct a

cost analysis for the best park location.

Exercise 8b (optional extra credit): Advanced raster analysis
Objectives: Provides you the opportunity to practice some more advanced raster analysis.

Exercise 09: Hydrology in the Urban Environment: Use DEM to analyze water flow within a sub-watershed.
Objectives: Use ArcMap to look at flow direction, sinks, splitting, fill. Use Spatial Analyst for raster calculator, hillshade and basin mapping.

Exercise 10: Network analysis
In this exercise you will become familiar with the network analysis extension.

Exercise 11: Accuracy Using Kappa
Objective: In this exercise you will compare an aerial photo to a classified image in order to conduct an accuracy assessment.

READING
Week 1
1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador. Chapter 1, thru 1.4.1
2. Drummond, W. J., & French, S. P. (2008). The future of GIS in planning: Converging technologies and diverging interests. Journal of the American Planning Association, 74(2), 161-174.

Week 2
1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador. Chapter 2
2. Longley, Goodchild, Maguire, and Rhind (2015). Geographic Information Systems and Science, Chapter 3
3. ESRI 10.5 Help Files on Topology in ArcGIS.
4. ESRI Topology Rules Poster

1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador. Chapter 3, thru 3.3.5
2. Longley, Goodchild, Maguire, and Rhind (2015). Geographic Information Systems and Science, Chapter 5.
3. ESRI, ArcGIS 10.5 Help Files. An overview of the Geodatabase (do not read tutorial) 4. ESRI (2004). Understanding Map Projections. Chapters 1-3. (Optional)

Week 3
1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador. Chapter 4.2.12.
2. Powell, Cohen, Yang, Pierce, and Alberti (2008) Quantification of impervious surface in the Snohomish Water Resources Inventory Area of Wester Washington from 1972-2006. Remote Sensing of Environment (112): 1895-1908.
3. Alberti, M., Weeks, R. and Coe, S (2004). Urban land cover change analysis in the Central Puget Sound region. (optional)

Week 4

1. Turner, M. G. (1989). Landscape Ecology: The Effect of Pattern on Process. Annual Review Ecological Systems 20, 171-197.
2. Wu, J. and David, J. (2002) A spatially explicit hierarchical approach to modeling complex ecological systems: theory and applications. Ecological Modeling (153):7-26
3. Gustafson (1998) Quantifying landscape spatial pattern: What is the state of the art? Ecosystem 1(2): 143-156 (optional)
4. Hahs and McDonnell (2006) Selecting independent measures to quantify Melbourne's urban-rural gradient. Landscape and Urban Planning (78):435-448 (optional)

1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador. Chapter 4.2.9
2. Chrisman, N (1997). Exploring Geographic Information Systems. J. Wiley. Chapter 5.

Week 5

Read One:

1. Galster, Hanson, Ratcliffe, Wolman, Coleman, and Freihage (2001), Wrestling Sprawl to the Ground: Defining and measuring an elusive concept. Housing Policy Debate (12):681-717
2. Torrens (2008), A toolkit for measuring sprawl. Applied Statistical Analysis (1):5-36
3. He, H. S., DeZonia, B. E., & Mladenoff, D. J. (2000). An aggregation index (AI) to quantify spatial patterns of landscapes. Landscape ecology, 15(7), 591-601.

1. Grimm V, Revilla E, Berger U, Jeltsch F, Mooij WM, Railsback SF, Thulke H-H, Weiner J, Wiegand T, DeAngelis DL. (2005) Pattern-oriented modeling of agent-based complex systems: lessons from ecology. Science 310, 987-991.
2. Hargis, C. D., Bissonette, J. A. and J. L. David (1998). The Behavior of Landscape Metrics Commonly Used in the Study of Habitat Fragmentation. Landscape Ecology 13, 167-186. (optional)

Week 6

1. Alberti, M., Marzluff, J. M., Shulenberger, E., Bradley, G., Ryan, C., & Zumbrunnen, C. (2003). Integrating humans into ecology: opportunities and challenges for studying urban ecosystems. AIBS Bulletin, 53(12), 1169-1179.

1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador Chapter 7.1; 7.3.4
2. Eckley and Curtin (2013). Evaluating the spatiotemporal clustering of traffic incidents. Computers, Environment and Urban Systems. Vol 37, pp 70-81.

Week 8

1.Alberti, M.(1999) Modeling the urban ecosystem: a conceptual framework. Environment and Planning B: Planning and Design (26)605-630.
2. UrbanSim: Modeling Urban Development for Land Use, Transportation and Environmental Planning, Paul Waddell, September 2001.
3. Hepinstall et al., (2008) Predicting land cover change and avian community

responses in rapidly urbanizing environments. (optional)
4. Dozier and Gail (2009), The emerging science of environmental applications. The Fourth Paradigm, Chapter 4. (optional)
5. Beechie, Sear, Olden, Pess, Buffington, Moir, Roni, and Pollock (2010), Process-based principles for restoring river ecosystems. Bioscience (60:3):209-222 (optional)

Week 9
1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador Chapter 6.4
2. Miller, S. N., Semmens, D. J., Goodrich, D. C., Hernandez, M., Miller, R. C., Kepner, W. G., and Guertin, D. P. (2007) The Automated Geospatial Watershed Assessment tool. Environmental Modelling & Software.

1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador Chapter 6.6

Week 10
1. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis. Matador. Chapter 5.3.2.

1. Burrough, P.A. and R.A. McDonnell (1998). Chapter 9.
2. Longley, Goodchild, Maguire, and Rhind (2001). Geographic Information Systems and Science, Chapter 6. (optional)