URBDP 422/522 Geospatial Analysis
Department of Urban Design and Planning
Winter 2019

Lectures: Monday & Wednesday 8:30 - 9:20 am; Gould 007F
Lab session: Monday & Wednesday 9:30 - 10:20 am; Gould 007F
Instructor: Tianzhe Wang
TA: Meen Chel Jung

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. All 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.

<table>
<thead>
<tr>
<th>Date &amp; Topic</th>
<th>Lecture</th>
<th>Reading</th>
<th>In-Class Lab</th>
<th>Lab Due</th>
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<tbody>
<tr>
<td>Week 01</td>
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<tr>
<td>01/07/2019:</td>
<td>Lecture 0</td>
<td>None</td>
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<tr>
<td>Course Overview</td>
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<tr>
<td>01/09/2019:</td>
<td>Lecture 1</td>
<td>De Smith et al., 2018, Ch.1.</td>
<td>Ex. 1</td>
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Week 02
<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Lecture</th>
<th>Reading</th>
<th>Ex.</th>
<th>Notes</th>
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<tbody>
<tr>
<td>01/14/2019:</td>
<td>Spatial Data Models and Structures</td>
<td>Lecture 2</td>
<td>De Smith et al., 2018, Ch. 2. Longley et al., 2015. Ch. 3. Topology in ArcGIS</td>
<td>Ex. 2 &amp; 3</td>
<td>Topology Rules Poster</td>
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<td></td>
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<td>De Smith et al., 2018, Ch. 3. Longley et al., 2015. Ch. 5. ESRI, Understanding Map</td>
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<td>1 Submission of Team Members' Names</td>
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<td>Projections, Ch 1-3.</td>
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<td>01/16/2019:</td>
<td>Building a Geo-Database</td>
<td>Lecture 3</td>
<td>De Smith et al., 2018, Ch. 3. Longley et al., 2015. Ch. 5. ESRI, Understanding Map</td>
<td>Ex. 4</td>
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<td>Projections, Ch 1-3.</td>
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<tr>
<td>01/16/2019:</td>
<td>Building a Geo-Database</td>
<td>Lecture 3</td>
<td>ESRI, Understanding Map Projections, Ch 1-3.</td>
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<tr>
<td>01/21/2019:</td>
<td>No Class</td>
<td>Lecture 4</td>
<td>De Smith et al., 2018. Ch. 4.2.12 Powel et al., 2008. Alberti, et al., 2004.</td>
<td>Team Time I: team formation and topic selection</td>
<td>Ex. 2 &amp; 3</td>
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<td>01/30/2019:</td>
<td>Quantifying and Analyzing the Urban Landscape I: Vector Analysis</td>
<td>Lecture 6</td>
<td>De Smith et al., 2018. Ch. 4.2.9 Chrisman, 1997.</td>
<td>Ex. 7</td>
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<td>02/04/2019:</td>
<td>Urban Landscape Review</td>
<td>Lecture 7</td>
<td>Read at least one of the following articles: He et al., 2000. Galster et al., 2005. Torrens, 2008.</td>
<td>Team Time II: CM design</td>
<td>Ex. 5</td>
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<td>02/06/2019:</td>
<td>Quantifying and Analyzing the Urban Landscape II: Raster Analysis</td>
<td>Lecture 8</td>
<td>Grimm et al., 2005 Hargis et al., 1998</td>
<td>Project Review and Feedback</td>
<td>Ex. 6</td>
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<td>Ex. 8b(extra credit)</td>
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<td>Date</td>
<td>Topic</td>
<td>Lectures</td>
<td>Reading Material</td>
<td>Team Time</td>
<td>Notes</td>
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<td>02/11/2019</td>
<td>Conceptual Models</td>
<td>Lecture 9</td>
<td>Alberti et al., 2003</td>
<td>Team Time III: Team presentation and discussion of Conceptual Models</td>
<td>Ex. 7</td>
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<tr>
<td>02/13/2019</td>
<td>Network Analysis</td>
<td>Lecture 10</td>
<td>De Smith et al., 2018. Ch. 7.1; Ch. 7.3.4</td>
<td>Ex. 09 Team Time IV</td>
<td>Draft Project Design</td>
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<tr>
<td>02/18/2019</td>
<td>No class</td>
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<tr>
<td>02/20/2019</td>
<td>Midterm Review</td>
<td>Review</td>
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<td>Team Time V</td>
<td>Ex. 8 &amp; 9</td>
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<td>02/25/2019</td>
<td>Midterm</td>
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<tr>
<td>03/04/2019</td>
<td>Watershed Delineation and Characterization</td>
<td>Lecture 12</td>
<td>De Smith et al., 2018. Ch. 6.4</td>
<td>Ex. 10</td>
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<tr>
<td>03/06/2019</td>
<td>Surface Analysis and Interpolation</td>
<td>Lecture 13</td>
<td>De Smith et al., 2018. Ch. 6.6</td>
<td>Team Time VII</td>
<td>Project Status Report</td>
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<tr>
<td>03/11/2019</td>
<td>Exploring Complexity, Uncertainty, and Error in the Urban Landscape</td>
<td>Lecture 14</td>
<td>De Smith et al., 2018. Ch. 5.3.2</td>
<td>Ex. 11</td>
<td>Ex. 10</td>
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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 and the LCCM
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 [Data gathering]
Objectives: Refresh memory about GIS usage.
• import files from various formats,
• learn some ArcMap functionality (table of contents, layout view, toolbars),
• use ArcCatalog to define a projection,
• create a simple jpeg of a map of your home

Exercise 2: Creating new maps with topology [Data gathering]
Objectives: Learn how to use the new ArcGIS 9 object oriented topology rules to create a topology feature dataset.
• To gain a better understanding of what topology is,
• Select new rules
• Inspect errors
• Fix errors

Exercise 3: Features, Feature Class, Coverages, Shapefiles, and Workspaces
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.
• use query
• export
• spatial join
• statistics

Exercise 5: Classifying Satellite Imagery [Data processing]
Objectives: Explore satellite bands, false color composites, areas of interest, reflectance graphs. Link aerial photography to images using IMAGINE. Create a signature file. Complete a supervised supervision.

Exercise 6. Using Fragstats to assess Landscape Metrics [Data Processing to Data Analysis]
Objectives: Reclassify landcover data set, familiarize with fragstats GUI, and Learn about landscape metrics.

Exercise 7: Buildable Land Inventory [Data Analysis]
Objectives: This exercise focuses on vector data analysis. Lessons include:
• Buffer
• Dissolve
• Union
• Join table

Exercise 8: Park Selection using Spatial Analyst [Data Analysis]
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**
Objective: 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.

**Readings**

**Week 1**  
01/09/2019  

**Week 2**  
01/14/2019  
3. ESRI 10.5 Help Files on Topology in ArcGIS.  
4. ESRI Topology Rules Poster  
01/16/2019  
3. ESRI, ArcGIS 10.5 Help Files. An overview of the Geodatabase (do not read tutorial)  

**Week 3**  
01/23/2019  
2. Powell, Cohen, Yang, Pierce, and Alberti (2008) Quantification of impervious surface in
the Snohomish Water Resources Inventory Area of Western Washington from 1972-2006.

Week 4
01/28/2019

01/30/2019

Week 5
02/04/2019
Read One:

02/06/2019

Week 6
02/11/2019

02/13/2019
Week 8
02/27/2019
4. Dozier and Gail (2009), The emerging science of environmental applications. The Fourth Paradigm, Chapter 4. (optional)

Week 9
03/04/2019

03/06/2019

Week 10
03/11/2019

03/13/2019