URPL-GP.4651: Advanced GIS: Topics in Spatial Analysis
Spring 2016 Syllabus

New York University
Wagner Graduate School of Public Service

Instructor
Sean Capperis
sean.capperis@nyu.edu
Office Hours: by appointment

Schedule
Waverly Building 668

Prerequisites
URPL-GP.2618, CUSP-GX.3007, or equivalent and Excel proficiency. Course prerequisites may be waived with instructor’s permission.

Course Description
Advanced spatial analysis methods allow geographic information systems (GIS) to model spatial data, processes, and relationships in more nuanced, realistic ways than core GIS methods, particularly when working at the scale of a city neighborhood. This course will cover several advanced GIS methods that have particular application to urban planning and policy, including network analysis (transportation), 3D analysis (built environment), interpolation (housing market), polygon apportionment (demographics), and pattern and cluster analysis (public safety). This course will also reinforce replication of methods and results through tools like ModelBuilder. Students will strengthen their spatial problem-solving abilities as well as their map portfolio through exercises and projects.

Goals
By the end of this course, students will demonstrate these abilities:

- Assess and break down a spatial problem into its component parts
- Translate a spatial algorithm into a method using geoprocessing tools
- Document and replicate spatial data processes
- Communicate complex GIS methods effectively to their peers

Class Format and Preparation
Each class will consist of a brief lecture followed by an instructor-led lab exercise. Lab exercises and out-of-class assignments will often build on past class sessions.

Prior to class, you are expected to familiarize yourselves with that week’s readings and/or pre-class assignments. After class, please also consult any additional online documentation necessary to complete an assignment or extend your understanding of a concept or tool.

Required Hardware and Software
Many NYU lab computers are equipped with ArcGIS. If you would like to install GIS software on your personal computer, students can receive a free educational license of ESRI ArcGIS from NYU Data Services. ESRI software only runs on Windows operating systems. When installing and using ArcGIS, be sure to request ArcGIS for Desktop Advanced and ensure that the
extensions 3D Analyst, Geostatistical Analyst, Network Analyst, and Spatial Analyst are installed.

Students will maintain a data library and will need to have it available for every class session. Students should either bring a USB drive (16 GB minimum and formatted as NTFS or exFAT) to every class or use a cloud-based storage application.

**Academic Integrity**

Unless otherwise specified, all assignment deliverables must be independent work. You are not permitted to share data or models that you create for assignments with your colleagues, use data created by your peers in an assignment, or turn in the work of someone else (including data, maps, and text) as your own. However, you are permitted (and encouraged!) to consult your peers, online resources, and the staff of NYU Data Services for advice using ArcGIS tools and data. If you have any questions about academic integrity as it applies to this course, please speak to the instructor. For more information, please refer to NYU Wagner’s [academic code](#).

**Grading**

Final grades will be weighted based on the following components:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Class Participation</td>
<td>5%</td>
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<tr>
<td>Assignment 1</td>
<td>20%</td>
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<tr>
<td>Assignment 2</td>
<td>20%</td>
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<tr>
<td>Final Project</td>
<td>50%</td>
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<tr>
<td>Final Presentation</td>
<td>5%</td>
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*Deadlines:* All assignments are due by the start of class on the specified deadline date. Except in case of emergency, *no late assignments will be accepted.*

*Class participation:* Because we do not rely on a standardized text, and it can be tricky to learn GIS software without the opportunity for guidance, it is critical that students come prepared to fully participate in class. Students who do so will receive full credit.

*Assignments:* Students are required to complete two of four assignments. Students may complete a third assignment to replace another assignment with a lower grade. Assignments typically require two display maps and a written deliverable. More information on assignments will be distributed in separate handouts.

*Final project:* Students will propose and complete a final project posing and answering an urban planning/policy question using spatial analysis techniques. Students will first submit a proposal to the instructor by the start of class on April 25. The final project itself will consist of a memo setting up the research question, describing the GIS methodology (including data sources, tools, and any other methods), and discussing the results in an urban planning/policy context. An appendix should include display maps, a table summarizing results, and a process diagram. Students will present their final projects during the final class session. Further final project specifications will be shared in class.
Grading criteria: All assignments will be graded on the following list of criteria and their respective weights. Each criterion receives a score of 0-4: advanced understanding of course objectives, 4; competent work, showing basic understanding of concepts, 3; inadequate, showing significant flaws or gaps in understanding of material, 2; incomplete or ungradable, 0. A score of 3 or higher indicates understanding of course objectives and expectations.

- Methods (50%): Use of methods and tools demonstrate understanding of the underlying concepts, principles, and application of tools to the situation. The student designed a process appropriate to the challenge or question, selected the right tool for the task, sequenced tools properly and efficiently, entered the correct parameters, selected the correct input data, and output the correct results (both spatial and numerical).
- Display map design (20%): The maps tell a clear story and present an appropriate amount of spatial context. The layers shown in the maps support the narrative in the written deliverable. Symbology, extent, draw order, and hierarchy are appropriate to the features in the map. Please refer to map style guide for expectations.
- Written content (20%): Written materials deliver a clear, coherent, well-structured argument, and directly address the question posed in the assignment prompt. The student uses appropriate evidence (visual and numerical) to support their conclusions. Methods are described clearly and accurately. The tone is appropriate for the audience.
- Conventions and quality (10%): Written material (in both memos/writeups and maps) adhere to the conventions of formal academic English. Memos and maps are properly formatted, use consistent style (typefaces, margins, etc.), and are free of spelling and grammar errors.

Course Schedule

Note: Schedule of topics and pre-class assignments are subject to change with advance notice from the instructor.

Session 1: March 28

Course Introduction; Introduction to Networks

We will use Network Analyst to create a network dataset of pedestrian streets and paths.

Complete required pre-class assignment

Required readings:

  - About the ArcGIS Network Analyst extension tutorial [Link]
  - Exercise 1: Creating a network dataset [Link]
  - Exercise 5: Calculating service areas and creating an OD cost matrix [Link]
  - Exercise 9: Choosing optimal store locations using location allocation [Link]

Optional readings:
• Esri. *ArcGIS Network Analyst Tutorial.*
  ○ Exercise 2: Creating a multimodal network dataset [Link]

In-class exercise:

• Application: Creating a pedestrian street network

**Session 2: April 4**

**Network Analysis**

Using the pedestrian transportation network we created in session 1, we will model the *walksheds* (service areas) of neighborhood amenities.

Required readings:

• Wellington, Ben. “Almost One Third of NYC is Not Patrolled by the Closest Precinct House.” *I Quant NY.* [link]

See readings for session 1.

In-class exercise:

• Application: Creating walksheds for City-operated parks in Brooklyn
• Tools: Generalize, Feature Vertices to Point

**Session 3: April 11**

**3D Analyst**

Through an analysis of building shadows, we will explore differences between spatial data in two and three dimensions (data types, applications, and tools).

Required readings:

• Esri. *3D Analyst.*
  ○ Essential 3D Analyst vocabulary [link]
  ○ Understanding feature-based heights in 3D [link]
  ○ Multipatches [link]
  ○ Using extrusion as 3D symbology [link] -- read all subtopics
  ○ 3D navigation tools [link] -- just skim this
  ○ Sun Shadow Volume [link]
  ○ Intersect 3D [link]
  ○ Multipatch Footprint [link]
Optional readings:

- City Planning Commission, City of New York. NYU Core Final Environmental Impact Statement. “Chapter 6 - Shadows.” 2012. [link]
- Esri. 3D Analyst.
  - 3D polygon features [link]

In-class exercise:

- Application: Building shadows over Central Park
- Tools: ArcScene, Sun Shadow Volume, Intersect 3D, Multipatch Footprint

Assignment 1 due (Network Analyst)

Session 4: April 18

Spatial Statistics and Geostatistics (Interpolation)

Spatial statistics are concerned with measuring the distribution of spatial data and testing it for statistical significance. A major application of spatial statistics is pattern and cluster analysis: testing for the existence of clustering and identifying where they appear (both in terms of location and attribute value). Geostatistics are a set of spatial interpolation techniques; that is, they predict attribute values from a set of input features to locations between or beyond the input features.

Required readings:

- Esri. ArcMap [documentation].
  - How Kernel Density works [link] -- note: Focus on “Kernel Density for point features” section
  - Kernel Density [link]
  - How Hot Spot Analysis (Getis-Ord Gi*) works [link] -- note: “Calculation” section is optional
  - How Cluster and Outlier Analysis (Anselin Local Moran’s I) works [link] -- note: “Calculation” section is optional
  - How Optimized Hot Spot Analysis works [link]
- Esri. Geostatistical Analyst [documentation].
  - Introduction to Geostatistical Analyst [link] -- see “What is geostatistics?” and “Essential vocabulary for Geostatistical Analyst” subsections
  - Choosing the Right Method [link] -- see “An introduction to interpolation methods” and “Classification trees of the interpolation methods offered in Geostatistical Analyst”
  - Creating Surfaces [link] -- see “Geostatistical Analyst example applications” and all subtopics of “Key concepts for all interpolation methods”
  - Evaluating Interpolation Results [link] -- see “Performing cross-validation and validation”
  - Visualizing and managing geostatistical layers [link] -- see “What is a geostatistical layer?” And “Data classification”
In-class exercises:

- Application 1: Heat and hot water complaints
- Application 2: Land value in Brooklyn
- Tools: Kernel Density, Cluster and Outlier Analysis, Hot Spot Analysis, Optimized Hot Spot Analysis

Assignment 2 due (3D Analyst)

**Session 5: April 25**

**Areal Interpolation/Polygon Apportionment**

Areal Interpolation techniques that estimate attributes for a set of target polygons from another set of (typically non-coterminous) source polygons. This is often useful when the original granularity of source data is not available (e.g., most Census data). Some GIS users call these techniques polygon apportionment (this should not be confused with legislative district apportionment).

Required readings (likely more TBA):

- NYU Furman Center. “Methods.” *State of New York City’s Housing and Neighborhoods in 2014.* [link] -- see “Housing Unit Weighting Formula” section, p. 190
- NYU Furman Center. “Focus on Density.” *State of New York City’s Housing and Neighborhoods in 2014.* [link] -- see the section “4. Population density in New York City is associated with certain positive neighborhood amenities and largely unrelated to many negative attributes,” pp. 18-20

In-class exercise:

- Application: Demographics of coastal evacuation zones

Assignment 3 due (Spatial Statistics)

Final project proposal due

**Session 6: May 2**

**Replication and Remote Data Collection**

More information forthcoming.

Readings/pre-class assignments: TBA

In-class exercises: TBA
Assignment 4 due (Areal Interpolation/Polygon Apportionment)

Session 7: May 9

Final Project Presentations

Final project due