Health Geographic Information Systems
Spring Semester 2019

Professor: Kristen Kurland kurland@cmu.edu, Office Hours by appointment, Margaret Morrison 415 and Hamburg Hall 2101C

Prerequisite: 90-728, Introduction to Database Management Systems, equivalent course, or permission of instructor.

TAs: (Office hours to be posted to Canvas)
- Clarissa Paz <clarissp@andrew.cmu.edu>
- Drew Simmons <asimmon1@andrew.cmu.edu>

Class website: https://www.cmu.edu/canvas/

Course Description:

A geographic information system (GIS) provides storage, retrieval, and visualization of geographically referenced data as well as design and analysis of spatial information. GIS provides unique analytical tools to investigate spatial relationships, patterns, and processes of cultural, biological, demographic, economic, social, environmental, health care, criminal, and other phenomena.

The course includes lectures, computer labs, and a project using the leading desktop GIS software, ArcGIS Pro, from Esri, Inc. Subject areas include:

- Geographic concepts (world coordinate systems, map scale/projections, sea level/elevation),
- Government-provided map infrastructure (TIGER maps, census data, satellite and aerial photo images, local government cadastral maps),
- Map design (cartographic principles, interactive maps, map animations, and Web-based GIS),
- Geodatabases (importing spatial and attribute data, geocodes, table joins, data aggregation, and map queries),
- Creation of new spatial data (digitizing, geocoding, and dissolving vector features),
- Spatial data processing (clipping, merging, appending, joining, dissolving),
- Spatial analysis (proximity analysis, risk surface, site suitability, spatial data mining),
- Macros (form-based tools, flowchart-based design, user interface),
- 3D GIS (3D surface modeling, draping/extruding features, fly throughs, line-of-sight analysis),
- Raster GIS (hill shade, kernel density estimation, risk index modeling, raster queries),
- Data mining and cluster analysis (grouping analysis using centroid models and k-means algorithm), and
- Network analysis (traveling salesman problem, multi-vehicle routing problem, Huff gravity model location of facilities).
Course Objectives:

1. Identify and structure the spatial characteristics of diverse application areas for spatial data visualization, design, and analysis.
2. Search for, access, and use the world’s quickly-growing geospatial data infrastructure.
3. Become a skillful user of leading GIS software.

Objectives are met and assessed through weekly homework assignments, a take-home case study, two Quizzes, and a project.

Required items:

- A thumb drive with at least 4 GB space available for using the computers in 2009 HBH. If using your own computer with ArcGIS Pro installed on it, you will not need a thumb drive.

Course Materials:

- Videos and readings provided on Canvas
- Power Point Slides: used in lectures for note taking (available from Canvas)
- ArcGIS Pro software: available from Heinz Computing Services or via Heinz VMWare
- GIS data copied from Canvas

Additional Learning Resources and Course Communication:

Clarification and discussion of GIS course materials are not limited just to lectures and lab sessions. Also provided are the instructor’s office and lab meetings, TA office hours, and a Canvas Discussion Board. Neither instructor nor the TAs will answer questions through email or text messages that would have benefit for the class, but instead will monitor the Canvas Discussion Board daily and respond to questions. Canvas Discussion Board questions are answered 9am-5pm Monday-Friday.

Grades:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework assignments</td>
<td>30%</td>
</tr>
<tr>
<td>Case Study</td>
<td>10%</td>
</tr>
<tr>
<td>Quiz 1</td>
<td>10%</td>
</tr>
<tr>
<td>Quiz 2</td>
<td>20%</td>
</tr>
<tr>
<td>Final project</td>
<td>30%</td>
</tr>
</tbody>
</table>

**NOTE:** I will curve grades and follow Heinz School guidelines that elective courses should have a mean grade of 3.5
**Class attendance:**

Students are expected to attend weekly lectures and lab sessions. Formal attendance will not be taken but you should alert me if you will miss due to interviews or other relevant excuse.

**Policy on Collaboration and Cheating:**

*Homework assignments*—Do not copy or modify homework solutions done by others for your homework solutions. Homework must be individual work unless otherwise stated. You may consult each other on clarification, technical and conceptual issues, but you must do individual problem solving and derive your own solutions, including your own computer work.

You are not permitted to be in possession of any assignments from another student or any other source either from the current semester or from past semesters whether they are in electronic or paper form. Possession of or sharing such files constitutes an infraction of the academic integrity policies of this course.

Plagiarism means using words, ideas, or arguments from another person or source without citation. Cite all sources consulted to any extent (including material from the internet), whether or not assigned and whether or not quoted directly. For quotations, four or more words used in sequence must be set off in quotation marks, with the source identified.

Any form of cheating on a homework assignment or the case study will result in the highest grade possible in the course being a “C” for the first offense and will drop a letter grade for each successive offense. Any form of cheating on the Quizzes or project will result in failing the course. As a matter of Heinz College policy, when you fail a course, the failing grade remains on your transcript permanently and you cannot replace the failing grade by retaking the course.

By remaining enrolled, you consent to this policy.

*Quizzes*—One page of notes (handwritten or typed, front and/or back) is permitted for each Quiz. Notes must be unique for each student and returned to the instructor with your name on the sheet at the end of each Quiz. No other material (for Quizple books, photocopied lectures, nor additional online materials) is allowed.

**Late Homework Policy:**

GIS assignments build upon each other, so it is important to be up to date on your assignments. **No assignment will be accepted after the due date** unless previously arranged with me due to extraordinary circumstances (e.g. illness, out of town).
Re-grading Policy:

Gradesheets, available after grading, contain solutions as well as feedback and scores for your assignments. If you believe that there was an error in grading an assignment, please contact the TA who graded it to resolve the issue. If you cannot resolve the issue to your satisfaction with the TA, then please send an email message to me with the issue. Please ask for any re-grading of an assignment within one week after it was returned, otherwise we will not re-grade the assignment.

If you believe that there was an error in grading your Quizzes, please contact me immediately.

University's policy on accommodations:

Accommodations, academic adjustments, and auxiliary aids and services (collectively “accommodations”) are provided to students with disabilities, as required by the Americans with Disabilities Act (ADA), the Rehabilitation Act of 1973, and other applicable federal, state and local laws. Please refer to CMU’s website for information.

Health and wellness

Carnegie Mellon University and I believe in hard work but a balanced lifestyle. Do your best to maintain a healthy lifestyle this semester. Should you need them there are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at http://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.
Class Schedule
(Subject to change)

Week 1, Introduction
1/15 and 1/17
Assignment #1, due 11:59 p.m., Tuesday, 1/22/2019 (See Canvas for assignment details)
- Course overview and policies
- GIS Definition
- Map layers and their properties
- Geospatial data types (vector, raster, networks, 3D)
- Project Quizzes

Video lectures (view on your own)
- ArcGIS Pro Overview (view on your own before 1/17)
- History of GIS

1/17/2019 - Lab: (GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 1)
- Get an introduction to the ArcGIS platform.
- Get an introduction to the ArcGIS Pro user interface.
- Learn to navigate maps.
- Work with tables of attribute data.
- Get an introduction to symbolizing and labeling maps.
- Work with side-by-side 2D and 3D maps.
- Publish a map in ArcGIS Online.
- Configure maps in ArcGIS Online.
- Use Explorer for ArcGIS on a mobile device.

Note:
Lab sessions will get you a good start on working through the assigned tutorial chapter, but normally you’ll have to finish tutorials on your own time, outside of class. Tutorial work is not graded, but is strictly for you to learn GIS. An option will be for you to work the tutorial on your own ahead of lab time and then use lab time for questions on the tutorial and for working on the week’s homework assignments.

If the TAs or I determine that you have not worked through a tutorial before starting corresponding assignments, we’ll not answer assignment questions on basics covered in the tutorial.
Week 2, Map design
1/22 and 1/24
Assignment #2, due 11:59 p.m., Tuesday, 1/29/2019

1/22/2019 – Lecture
• Map design principles
• Map types
• Symbolizing maps
• Color (spectrum, hue, color wheel, saturation)

Video lectures, view on your own before 01/24
• 2.5 Numeric scales (uniform, clustering, geometric, quantiles)
• 2.6 Feature labels
• 2.7 Additional guidelines

1/24/2019 – Lab (GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 2)
• Symbolize maps using qualitative attributes and labels.
• Use definition queries to create a subset of map features.
• Symbolize maps using quantitative attributes.
• Learn about 3D maps.
• Symbolize maps using graduated and proportional point symbols.
• Create normalized maps with custom scales.
• Create density maps.
• Create group layers and layer packages.

Week 3, Map outputs for GIS projects
1/29 and 1/31
Assignment 3 due 11:59 p.m., Tuesday 2/5/2019

1/29/2019 – Lecture
• GIS Projects and traditional outputs
• Map layouts (maps, legend, text, scale bar)
• GIS Outputs
• Story Maps

Video lecture
• Esri’s Mapping story maps (optional)

1/31/2019 – Lab (GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 3)
• Learn about alternatives for sharing maps and information from GIS projects.
• Build map layouts.
• Add visibility ranges for interactive map use.
• Build story maps.
• Make professional-quality tables and charts in Microsoft Excel (optional).
**Week 4, Geodatabases**  
2/5 and 2/7  
*Assignment #4 due 11:59 p.m., Tuesday, 2/12/2019*

2/5/2019 – Lecture  
- Modifying tables and attributes  
- Table calculations  
- Joining tables  
- Attribute queries  
- Data aggregation with a spatial join

2/7/2019 – Lab (*GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 4*)  
- Import data into file geodatabases.  
- Modify attribute tables and fields.  
- Use Python expressions to calculate fields.  
- Join tables.  
- Get an introduction to SQL query criteria.  
- Carry out attribute queries.  
- Aggregate point data to polygon summary data.

**Week 5, Spatial Data**  
2/12 and 2/14  
*Assignment #5, due 11:59 p.m., Tuesday, 2/19/2019*

2/12/2019 – Lecture  
- Map projections (small and large scale, conformal versus equivalent projections, spatial reference data)  
- Projected coordinate systems (geographic/spherical versus rectangular, spheroids)  
- Basemap data sources (physical surface, environmental, political, populations, biology/ecology)  
- WGS Web Mercator Pro Demo  
- US Census map layers and tabular data

2/14/2019 – Lab (*GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 5*)  
- Work with world map projections.  
- Work with US map projections.  
- Work with projected coordinate systems (PCS).  
- Learn about vector data formats.  
- Download US Census map layers and tabular data.  
- Explore, download, and process data from Living Atlas of the World.  
- Explore sources of spatial data from government websites.  
- Explore maps from a university’s web services.
Week 6, Geoprocessing
2/19 and 2/21
Assignment #6, due 11:59 p.m., Tuesday, 2/26/2019

2/19/2019 – Lecture
- Attribute proximity selections
- Geoprocessing overview
- Append and merge
- Union and Intersect
- Tabulate intersection

2/21/2019 – Lab (GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 6)
- Dissolve block group polygons to create neighborhoods and fire battalions and divisions.
- Extract a neighborhood using attributes to form a study area.
- Extract features from other map layers using the study area.
- Merge water features to create a single water map.
- Append separate fire and police station layers to one layer.
- Intersect streets and fire companies to assign street segments to fire companies.
- Union neighborhood and land-use boundaries to create detailed polygons on neighborhood land-use characteristics.
- Apportion data between two polygon map layers whose boundaries do not align.

Week 7, Geocoding
2/26 and 2/28
Assignment #7, due midnight, Tuesday, 3/19/2019.
Turn in completed Chapter 8 Geocoding tutorials for grading; there are no separate assignment problems for this week. Copy the entire finished Chapter8YourName folder to your Assignments folder for grading.

2/26/2019 – Video Lectures (watch on your own)
- 8.1 Geocoding overview
- 8.2 Address matching
- 8.3 Linear address matching
- 8.4 Polygon geocoding and address matching
- 8.5 Address matching problems solutions
- 8.6 Geocoding Sources

2/28/2019: Quiz 1

2/28/2019 – Lab (GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 8)
- Get an overview of the geocoding process.
- Geocode using ZIP Codes.
- Geocode addresses using streets.
- Use alias tables for place-name geocoding.
Week 8, study “studio sessions”: work on case study in class both days
(Case Study), due 11:59 p.m., Thursday, 3/7
3/5 – Work on case study
3/7 – Work on case study

Spring Break, no class week of 3/11-14/2019

Week 9, Spatial Analysis
3/19 and 3/21
Assignment # 9, due 11:59 p.m., Tuesday, 3/26/2019

3/19/2019 – Lecture
• Buffers for proximity analysis
• Multiple-ring buffers
• Network Analyst
• Facility location
• Data clustering

3/21/2019 – Lab (GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 9)
• Use buffers for proximity analysis.
• Use multiple-ring buffers to estimate a gravity model of demand versus distance from nearest facility.
• Estimate service areas of facilities using ArcGIS® Network Analyst.
• Optimally locate facilities using Network Analyst.
• Carry out cluster analysis to explore multidimensional data.

Week 10, Raster GIS
3/26 and 3/28
Assignment # 10 due 11:59 p.m., Tuesday, 4/2/2019

3/26/2019 – Lecture
• Extract and symbolize raster maps
• Create hillshade maps
• Smooth point spatial data with kernel density smoothing
• Build a raster-based risk index

3/28/2019 – Lab (GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 10)
• Extract and symbolize raster maps.
• Create hillshade maps.
• Smooth point data with kernel density smoothing.
• Build a raster-based risk index.
• Build a model for automatically creating risk indices.
**Week 11, 3D GIS, Operations Management, Open Source GIS (GeoDa)**

4/2 and 4/4

*Assignment #11 due 11:59 p.m. Wednesday, 4/10/2019*

Turn in one of the completed chapters (11, 12, or 13) for credit

4/2/2019 – Lecture
- LiDAR overview
- Procedural rules and multipatch features
- 3D Application for City Planning
- GIS, Augmented Reality, Virtual Reality
- Introduction to operations management systems

- Explore global scenes.
- Learn how to navigate scenes.
- Create local scenes and TIN surfaces.
- Create Z-enabled features.
- Create 3D buildings and bridges from lidar data.
- Work with 3D features.
- Use procedural rules and multipatch models.
- Create an animation.

*(GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 12: Graffiti Mapping System)*
- Create tasks to prepare data for an operations management system.
- Build a ModelBuilder model to be used in a task.
- Create an ArcGIS Online map for use in an Operations Dashboard operation view.
- Create and use an Operations Dashboard operation view

*(GIS Tutorial for ArcGIS Pro: A Platform Workbook, Chapter 13: Graffiti Removal System)*
- Build ModelBuilder models to automate an operations management system.
- Use Network Analyst to optimize routes for carrying out service deliveries.
- Use Python expressions to calculate fields.
- Prepare data for use in the Collector for ArcGIS® app.
- Prepare a map in ArcGIS Online for use in Collector.
- Use the Collector app to update data using a mobile device.

**Week 12**

4/9/2019 – Quiz 2

4/10/2019 – Project proposal due 11:59 p.m. Wednesday, 4/10/2019

4/11/2019 – Classes cancelled – Spring Carnival
**Week 13**
4/16/2019 – Work on final projects
4/18/2019 – Work on final projects

**Week 14**
4/23/2019 – Work on final projects (Data cleaning and processing due 11:59 p.m.)
4/25/2019 – Work on final projects

**Week 15**
4/30/2019 – Work on final projects (GIS project analysis due 11:59 p.m.)
5/2/2019 – Work on final projects (GIS story maps and reports due 11:59 p.m.)