94-802A
Geographic Information Systems, Fall 2024

Carnegie Mellon University, Heinz College

http:/www.cmu.edu/canvas

Teaching Staff

Instructor:

- Professor Kristen Kurland: kurland@andrew.cmu.edu

  Office hours by appointment

Teaching Assistants:

- TBA

Office hours TBA on 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, and other phenomena. The course includes lecture topics, computer tutorials, and a project using the leading desktop GIS software, ArcGIS Pro, ArcGIS Online, Story Maps, and selected apps, 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* (cartographics, interactive maps, map animations, and Web-based GIS),
- *Geodatabases* (importing spatial and attribute data, geocodes, table joins, data aggregation, and map queries),
- *Creation of 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),
- *Raster GIS* (hill shade, kernel density estimation, risk index modeling, raster queries),
- *Data mining and cluster analysis* (multivariate analysis using centroid models and k-means algorithm), and

- *Network analysis* (traveling salesman problem, multi-vehicle routing problem, Huff gravity model location of facilities).
- *Dashboards* (visual displays of data feeds in an easy-to-understand format, with a map as the center of focus)
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Learning 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.
4. Have an ability to use geospatial technologies to gain a significant advantage in architecture, urban design, engineering, computer science, information technology, public policy, and data analytics fields.

Objectives are met and assessed through weekly homework assignments, three quizzes, and a final project.

Course Materials:

- GIS Tutorial for ArcGIS Pro 3.1, Edition: by W.L. Gorr & K.S. Kurland, (2023), https://www.esri.com/en-us/esri-press/browse/gis-tutorial-for-arcgis-pro-3-1
- Video lectures provided on Canvas or via external links.
- Readings and external links provided as PDF files for selected topics.
- ArcGIS Pro software: **Version 3.3** - Available from Heinz Computing Services or via Virtual Andrew. It is strongly recommended that you install the software on your own computer.
- GIS data copied from Canvas.

Grade Allocation:

Homework (11 at 5% each)	55%
Quizzes (3@ 8% each)	24%
GIS Project	21%

Grade Interpretation Points, Credit Toward Graduation

A+	98% to 100%	Exceptional	4.33
A	93% to 97.99%	Excellent	4.00
A-	90% to 92.99%	Very Good	3.67
B+	87% to 89.99%	Good	3.33
B	83% to 86.99%	Acceptable	3.00
B-	80% to 82.99%	Fair	2.67
C+	77% to 79.99%	Poor	2.33
C	73% to 76.99%	Very Poor	2.00
C-	70% to 72.99%	Minimal Passing	1.67
R	less than 70%	Failing	0.00

NOTE: CIT graduate students are not eligible for A+ grades

Course Communication and Chapter Tutorials:

Clarification and discussion of GIS course materials are not limited just to lectures. Also provided are weekly office hours, and Canvas discussion boards. These discussion boards are for you to interact with others in the course, post questions about assignment clarifications, general comments, and notices of items of interest.

The teaching staff will check the discussion boards between **Monday-Friday 9AM to 5PM Eastern Standard Time**. Please plan your time accordingly so questions can be answered in a timely manner.

The teaching staff will NOT answer assignment and project questions through email or text messages that would have benefit for the class, but instead will monitor the Canvas discussion boards and respond to questions there.

Chapter tutorials in the required textbook are the main mode of learning the GIS software. Tutorial work is not graded unless otherwise indicated and is strictly for you to learn GIS. If the teaching staff determine that you have not worked through a tutorial before starting corresponding assignments, we will not answer assignment questions on basics covered in the tutorial.

Policy on Collaboration and Cheating:

This course follows the Heinz College policies on ethics and discipline as stated in student handbooks. A specific policy of this course is as follows:

Homework assignments—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 work.

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

Quizzes—Quizzes are online and completed as an honor system. You must complete quizzes on your own. Collaboration of any type is considered cheating and if discovered will result in academic actions.

Late Homework Policy:

- GIS assignments build upon each other, so it is important to be up to date on your assignments.
- All assignments are due at 5pm Eastern Standard Time unless otherwise noted. Please see the course calendar and syllabus for all due dates.
- Late assignments result in a score of zero points.
- However, you can turn in one assignment 48 hours late but must be done **with prior notification to professor and all Tas.**

Grading questions:

Assignment rubrics contain solutions as well as feedback and scores for your assignments. You will not receive these before assignments are due but will see your scores on Canvas once each assignment has been graded and grades are released.

If you believe that there was an error in grading an assignment, please contact the TAs to resolve the issue. If you cannot resolve the issue to your satisfaction with the TAs, then please send an email message to me with the issue.

Re-grading of an assignment must be required within 5 days after it was returned, otherwise we will not re-grade the assignment.

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 by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. 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.

Diversity Statement

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Class Schedule
(subject to change)

Week 1, Introduction to GIS and ArcGIS Pro

Assignment #1 assigned, due 5PM EST, Monday, 9/2

Required Video Lectures

- GIS Overview
- Analytical Tools
- Software Course "Map"
- ArcGIS Pro Overview

Optional Video Lecture

- History of GIS

GIS Tutorial for ArcGIS Pro: Chapter 1

- *Get an introduction to ArcGIS.*

- *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 2D and 3D maps.*

Week 2, Map design

Assignment #2 assigned, due 5PM EST, Monday, 9/9

Required Video Lectures

- Cartography and map design principles
- Map types
- Symbolizing maps
- Colors
- Numeric scales
- Feature labels and additional guidelines

GIS Tutorial for ArcGIS Pro: Chapter 2

- *Symbolize maps using qualitative attributes and add labels.*
- *Use definition queries to create a subset of map features.*
- *Symbolize maps using quantitative attributes.*
- *Learn about 3D scenes.*
- *Symbolize maps using graduated and proportional point symbols.*
- *Create normalized maps with custom scales.*
- *Create dot density maps.*
- *Add visibility ranges for interactive map use.*

Week 3, Maps for end users

Assignment #3 assigned, due 5PM, EST, Monday, 9/16
Quiz 1, due 5PM EST, Monday 9/16
(covers lectures 1-3)

Required Video Lectures
- GIS Projects and traditional outputs
- Map layouts and story maps

GIS Tutorial for ArcGIS Pro: Chapter 3

- *Build map layouts and charts.*
- *Share maps in ArcGIS Online.*
- *Use Map Viewer in ArcGIS Online*
- *Use ArcGIS StoryMaps℠.*
- *Use ArcGIS Dashboards*

Week 4, File Geodatabases

Assignment #4 assigned, due 5PM, EST, Monday 9/23

Required Video Lectures
- Attribute tables and queries
- Table and spatial joins
- Geodatabases
- Calculating geometry

GIS Tutorial for ArcGIS Pro: 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

Assignment #5 assigned, due 5PM, EST, Monday 9/30

Required Video Lectures
- Map projections
- Map coordinate systems
- Spatial data formats
- US Census geographic files
- US Census data tables
- Other Geospatial data sources

GIS Tutorial for ArcGIS Pro: Chapter 5

- *Work with world map projections.*

- *Work with US map projections.*

- *Set a projected coordinate system.*

- *Work with vector data formats.*

- *Work with US Census Bureau spatial and tabular data.*

- *Explore sources of spatial data.*

Week 6, Geoprocessing

Assignment #6 assigned, due 5PM, EST, Monday 10/7
Quiz 2, due 5PM EST, Monday 10/7
(covers lectures 4-6)

Required Video Lectures
- Attribute proximity selections
- Geoprocessing overview
- Append and merge

- Union and Intersect
- Tabulate intersection

GIS Tutorial for ArcGIS Pro: 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

Assignment #7 assigned, due 5PM, EST, Friday, 10/11

Esri Map Viewer and Data Axle tutorial

Week 8, Geocoding

Assignment #8 assigned, due 5PM, EST, Monday, 10/28

Required Video Lectures

- Geocoding overview
- Address matching
- Linear address matching
- Polygon address matching
- Address matching problems solutions
- Geocoding Sources

GIS Tutorial for ArcGIS Pro: Chapter 8

- *Learn about the geocoding process.*
- *Geocode using zip codes.*
- *Geocode addresses using streets.*

Week 9, Spatial analysis

Assignment #9 assigned due 5PM, EST, Monday 11/4

Required Video Lectures
- Proximity buffers
- Multiple ring buffers
- Data mining cluster analysis

GIS Tutorial for ArcGIS Pro: Chapter 9

- *Use buffers for proximity analysis.*

- *Use multiple-ring buffers*

- *Create service areas to estimate a gravity model of demand versus distance from nearest facility.*

- *Optimally locate facilities using ArcGIS Network Analyst™.*

- *Perform cluster analysis to explore multidimensional data.*

Week 10, Raster GIS

Assignment #10 assigned, due 5PM, EST, Monday 11/11
Quiz 3, due 5PM EST, Tuesday 11/12
(covers lectures 8-10)

Required Video Lectures
- Extract and symbolize raster maps
- Create hillshade maps
- Smooth point spatial data with kernel density smoothing
- Build a raster-based risk index

GIS Tutorial for ArcGIS Pro: 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, Dashboards

Assignment #11 assigned, due 5PM, EST, Monday 11/18
GIS project proposal, due 5PM EST Monday 11/18

Weeks 12-14, Final Project

- ***Data cleaning process log,*** *due 5PM EST Friday, 11/29*

- ***GIS final project data, report, presentation slides, Story Map, and final process log,*** *due 5PM EST Friday, 12/6*