Geographic Information Systems, Summer 2021

http:/www.cmu.edu/canvas

Instructor:

- Professor Kristen Kurland kurland@andrew.cmu.edu
  Online office hours by appointment

Teaching Assistants:

- TBA
- Online office hours TBA

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),
- *3D GIS* (3D surface modeling, draping/extruding features, procedural rules, fly throughs, line-of-sight analysis),
- *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).

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.
4. Have an ability to use geospatial technologies to gain a significant advantage in the information technology field.

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

Course Materials:

- GIS Tutorial for ArcGIS Pro 2.8, Fourth Edition: by W.L. Gorr & K.S. Kurland, (2021), ISBN-13: 978-1589486805
- https://www.esri.com/en-us/esri-press/browse/gis-tutorial-for-arcgis-pro-2-8
- Video lectures provided on Canvas or via external links.
- Readings and external links provided as PDF files for selected topics.
- ArcGIS Pro software: **Version 2.8** - 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.

Grades:

Homework assignments (9@6% each)	54%
Quizzes (8 @3% each)	24%
Final project	22%

*I will automatically drop your lowest homework assignment and lowest quiz scores

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

Course Communication and Additional Learning Resources:

Clarification and discussion of GIS course materials are not limited just to lectures. Also provided are office hours, and a Canvas Discussion Board**. Questions about assignments or of general interest should be posted on the discussion board via the Canvas site**. This discussion board is for you to interact with others in the course. Post questions, comments, notices of items of interest on this discussion board. The TAs and professor will be checking the discussion boards

Monday-Friday 9AM to 5PM Eastern Standard Time

Please plan your time accordingly so questions can be answered in a timely manner.

We will not answer questions through email, text, or direct messages via Canvas
Questions benefit others in the class, and we will monitor the Canvas Discussion Board and respond to questions there.

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 TAs or I 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—Do not copy or modify homework solutions 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 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.
- No assignment will be accepted after the due date unless previously arranged with the professor and only due to extraordinary circumstances (for example, illness with medical excuse).

Grading questions:

Excel grade sheets contain solutions as well as feedback and scores for your assignments. You will not receive these before assignments are due but will get a grade sheet for each assignment once graded. 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. Please ask for any re-grading of an assignment as soon as possible 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.

Each of us is responsible for creating a safer, more inclusive environment.Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed.

Anyone can share these experiences using the following resources:

Center for Student Diversity and Inclusion: csdi@andrew.cmu.edu, (412) 268-2150
Report-It online anonymous reporting platform: reportit.net username: tartans password: plaid

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.

Class Schedule

(subject to change)

Week 1, Introduction to GIS and ArcGIS Pro

Assignment #1 assigned, due 9 AM EST, Monday, 5/23
Quiz 1, due 9 AM EST, Monday, 5/23

Video lectures

- GIS Overview
- Analytical Tools
- Software Course "Map"
- ArcGIS Pro Overview
- Optional lectures: History of GIS

GIS Tutorial for ArcGIS Pro: 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.*

Week 2, Map design

Assignment #2 assigned, due 9 AM EST, Monday, 5/30
Quiz 2, due 9 AM EST, Monday, 5/30

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 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, GIS outputs

Assignment #3 assigned, due 9 AM EST, Monday, 6/6
Quiz 3, due 9 AM EST, Monday, 6/6

Video lectures

- GIS Projects and traditional outputs
- Map layouts and story maps

GIS Tutorial for ArcGIS Pro: 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

Assignment #4 assigned, due 9 AM EST, Monday 6/13
Quiz 4, due 9 AM EST, Monday 6/13

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 9 AM EST, Monday 6/20
Quiz 5, due 9 AM EST, Monday 6/20

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.*
- *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

Assignment #6 assigned, due 9 AM EST, Monday 6/27
Quiz 6, due 9 AM EST, Monday 6/27

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, Spatial analysis

Assignment #7 assigned due 9 AM EST, Monday 7/4
Quiz 7, due 9 AM EST, Monday 7/4

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 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 8, Raster GIS

Assignment #8 assigned, due 9 AM EST, Monday 7/11
Quiz 8, due 9 AM EST, Monday 7/11

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 9, Dashboards and Operations Management

Assignment #9 assigned, due 9 AM EST, Monday 7/18

Operations Management Lectures

- Introduction to operations management systems
- Operations Management Overview
- Graffiti Case Study
- Dashboard, Models, Tasks, Steps

Weeks 10-12, Final Project

- ***GIS project proposal, due 9 AM EST Tuesday 7/19***
- ***Data cleaning process log, due 9 AM EST Tuesday 7/26***
- ***GIS final project data, report, presentation slides, Story Map, and final process log, due 9 AM EST Tuesday 8/2***