94-802Z: Geographic Information Systems
Summer 2018

Instructor:
Professor Kristen Kurland <kurland@cmu.edu>

Teaching Assistant(s): (Office hours to be posted on Canvas)
TBA

Class Web Site:
http://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 Lecture topics, computer labs, 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 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. Develop an understanding of the world’s quickly-growing spatial data infrastructure and of how to put it to work for producing location-based information.
2. Identify the relevant spatial characteristics of diverse application areas enabling professionals to integrate spatial thinking and GIS analysis into their careers.
3. Have an ability to use geospatial technologies to gain a significant advantage in the information technology field.

Course Materials:

  http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=340&moduleID=0
- Video lectures provided on Canvas or via external links
- ArcGIS Pro software: available from Heinz Computing Services or via Heinz VMWare
- GIS data copied from Canvas or CMU Box

Grade Allocation:

- Homework Assignments (9 @ 5% each) 45%
- GIS Quizzes (3 @ 10% each) 30%
- Final Project 25%

Grade Interpretation Points

Credit Toward Graduation

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<tr>
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<td>Failing</td>
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Course Communication

Questions 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 TA and professor will be checking the discussion **Monday-Friday 9AM to 5PM Eastern Standard Time** and occasionally (usually once a day) on weekends. Please plan your time accordingly so questions can be answered in a timely manner.

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*—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.

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 (e.g. illness with medical excuse).

Re-grading Homework Assignments and Quizzes:

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 TA 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 as soon as possible after it was returned, otherwise we will not re-grade the assignment.
Class Schedule
Subject to change

**Week 1, Introduction to GIS**
5/21/2018

*Assignment #1 assigned, due 9:00 a.m. EST, Wednesday, 5/30/2018 (extended one day due to the Memorial Day holiday)*

**Lecture topics**
- GIS Overview
- GIS History GIS
- Industries using GIS
- GIS Example: Environmental Study

**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.

**Week 2, Map design**
5/28/2018

*Assignment #2 assigned, due 9:00 a.m. EST, Tuesday, 6/5/2018*

**Lecture topics**
- Cartography overview
- Map types
- Symbolizing maps
- Colors
- Numeric scales
- Feature labels
- Additional guidelines
- Contrast and changing colors in ArcGIS
**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, GIS outputs**
6/4/2018
*Assignment #3 assigned, due 9:00 a.m. EST, Tuesday, 6/12/2018*

**Lecture topics**
- Map layouts and story maps
- Visibility ranges

**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**
6/11/2018
*Assignment #4 assigned, due 9:00 a.m. EST, 6/19/2018*

**Lecture topics**
- Attribute tables
- Data table joins
- Spatial joins
- Geodatabases
- Calculating geometry

**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**  
6/18/2018  
*Quiz1 due 6/21/2018*  
*Assignment #5 assigned, due 9:00 a.m. EST, 6/26/2018*

**Lecture topics**
- Map projections
- Map coordinate systems (geographic/spherical versus rectangular, spheroids)
- Spatial data formats (XY event files, KML files, CAD drawings, Smart Data Compression, spatial data infrastructure)
- US Census geographic files
- US Census data tables
- Other Geospatial data sources

**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**  
6/25/2018  
*Assignment #6 assigned, due 9:00 a.m. EST, 7/5/2018 (note: one day extension due to July 4 holiday)*

**Lecture topics**
- Attribute proximity selections
- Geoprocessing overview
- Append and merge
- Union and Intersect
- Tabulate intersection

**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**
7/2/2018

*Assignment #7 assigned, (chapter 8), due 9:00 a.m. EST, 7/11/2018*

**Lecture topics**
• Geocoding overview
• Address matching
• Linear address matching
• Polygon address matching
• Address matching problems solutions
• Geocoding Sources

*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, Spatial analysis**
7/9/2018

*Quiz 2 due 7/12/2018*

*Assignment #8 assigned due 9:00 a.m. EST, 7/17/2018*

**Lecture topics**
• Proximity buffers
• Multiple ring buffers
• Data mining cluster analysis

*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 9, Raster GIS**
7/16/2018

*Assignment #9 assigned, due 9:00 a.m. EST, 7/24/2018*

**Lecture topics**
- 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: 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.

**Weeks 10-12, Work on Final Project**

*Quiz 3 due 7/31/2018*

GIS Project Proposal, due on 7/24/2018, midnight EST
Final Project, due 8/7/2018, 9:00am EST