90-834: Health Geographic Information Systems  
Spring Semester 2016

Professor:  
Kristen Kurland <kurland@cmu.edu>, CFA 206B and HBH 2102A, Office Hours by appointment

Prerequisite:  
90-728 (Introduction to Database Management Systems), 91-802 (Information Systems for Managers), or equivalent course or permission of instructor.

Teaching Assistants: (Office hours to be posted on Blackboard, 90-834)

<table>
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<tr>
<th>Yuan Li</th>
<th><a href="mailto:yuanl2@andrew.cmu.edu">yuanl2@andrew.cmu.edu</a></th>
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<tr>
<td>Elizabeth Caniano</td>
<td><a href="mailto:ecaniano@andrew.cmu.edu">ecaniano@andrew.cmu.edu</a></td>
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Course website: [http://www.cmu.edu/blackboard](http://www.cmu.edu/blackboard)

Course Description:

A geographic information system (GIS) provides an effective way to visualize, organize and manage a wide variety of information including administrative and medical data, social services, and patient data. Public health and medical research agencies are also using GIS to map health-related events, identify disease clusters, investigate environmental health problems, and understand the spread of communicable and infectious disease.

This course uses a unique approach for teaching GIS in health care. It imbeds learning how to use GIS software in the context of carrying out projects for visualizing and analyzing health-related data. Each week includes a lecture and computer lab that focuses on a health care issue using ArcGIS from Esri, Inc. to analyze data or solve a problem. Through weekly assignments and project case studies students will not only learn how to use GIS software but will also learn the many distinctive advantages of using GIS for health care policy making and planning.

By the end of the course, students will have sufficient background so that they can become expert users of GIS in health care organizations - building, managing, and using GIS maps and health related data.

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 and geocoding),
- **Spatial data processing** (clipping, merging, appending, joining, and dissolving features),
- **Spatial analysis** (proximity analysis, 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),
- **Transforming data using approximate methods** (basic and advanced apportionment)
- **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 health information.
2. Identify the relevant spatial characteristics of health application areas enabling professionals to integrate spatial thinking and GIS analysis into their health care careers.
3. Have an ability to use geospatial technologies to gain a significant advantage in the information technology field, describing the spatial relationships of topics such as cancer mortality rates, uninsured populations, infant mortality and life expectancy, elevated blood levels of lead in children, correlation of poverty and injuries, population variables for health service areas and clinics, and heart-attack fatalities outside.

**Course Materials:**

- Power Point Slides: used in lectures for note taking (available from Blackboard)
- Laptop computer configured to run ArcGIS software.
• GIS data copied from the Heinz bolt server
• Miscellaneous readings, PDFs provided on Blackboard

Grades:

<table>
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<th>Component</th>
<th>Percentage</th>
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<tr>
<td>Homework assignments (9 @ 5% each)</td>
<td>45%</td>
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<tr>
<td>GIS quizzes (3 @ 10% each)</td>
<td>30%</td>
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<td>Final project</td>
<td>20%</td>
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<tr>
<td>Classroom and Blackboard participation</td>
<td>5%</td>
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I will curve grades and follow Heinz School guidelines that elective courses should have a mean grade of 3.5

Communication

Clarification and discussion of GIS concepts and procedural knowledge are not limited just to lectures and lab sessions. Also provided are weekly lab sessions, TA office hours, a Blackboard Discussion Board, or appointments with the TAs or myself. Neither the TAs nor I will answer questions through email that would have benefit for the class, but instead will monitor the Blackboard Discussion Board daily (9am-5pm), Monday through Friday and respond to questions during these hours.

Policy on Collaboration and Cheating:

I will follow 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.

*Quizzes*—You are not permitted to have unauthorized access to quizzes, use of unauthorized material during a quiz, supplying or communicating unauthorized information for quizzes.
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 and due to extraordinary circumstances (e.g. illness with medical excuse).

Re-grading Homework Assignments and Quizzes:

Gradesheets 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.

I will review the solution to the exams during class. If you believe that there was an error in grading your quiz, please contact me and I will re-grade the quiz.

Class Schedule
Subject to Change

Week 1, Introducing GIS and health applications/ArcGIS Online
Assignment #1, due 12pm (noon), 01/21/2016—Note that I will post all assignments on Blackboard
[Reading: GIS Core Concepts, chapter 1]
01/12/2016—Lecture
- Course overview and policies
- GIS definition
- Geospatial data types (vector and raster map layers)
- History of GIS (video)
- Cloud GIS
- Web API’s
- Location based devices
- GIS example
01/14/2016—Lab session (GIS Tutorial for Health, chapter 1, supplemental ArcGIS Online tutorial)
- Exploring the ArcCatalog user interface
- Reviewing data source types
- Exploring the ArcMap user interface
- Using and exporting a map
- Learning about GIS websites
- Creating and sharing map layers
• Creating health maps using ArcGIS Online content
• Using maps on smart phones and tablets

**Week 2, Visualizing health data**

**Assignment #2 due 12pm, 01/28/2016**


01/19/2016—Lecture
• GIS data and layers (environmental health study)
• Attribute tables and queries
• Rater GIS example
• Map audiences and presenting GIS data
• Graphic design principles
• Definition queries

01/21/2016—Lab (*GIS Tutorial for Health*, chapter 2)
• Manipulating layers in a map document
• Zooming to and panning health features on a map
• Creating spatial bookmarks
• Identifying features
• Selecting map features
• Finding map features
• Using an attribute tables
• Creating a new layer of a subset of features
• Creating a point map based on a definition query
• Labeling features

**Week 3, Designing maps for a health study**

**Assignment #3 due 12pm (noon), 02/04/2016**


01/26/2016—Lecture
• Symbolizing maps (qualitative and quantitative maps)
• Colors
• Map layouts
• Exporting maps
• Other outputs

01/28/2016—Lab (*GIS Tutorial for Health*, chapter 3)
• Creating a choropleth map
• Creating a point map
• Making a scatterplot comparing populations
• Working with layer files
• Creating print layouts for a health-care study
• Creating custom map layouts for multiple maps
• Exporting maps
• Creating multiple output pages

**Week 4, GIS Quiz 1 and Intro to ArcGIS Pro**
02/02/2016—Quiz1
02/04/2016—Introduction to ArcGIS Pro

**Week 5, Projecting, downloading, and using spatial data**
Assignment #4, due 12pm (noon), 02/18/2016
02/09/2016—Lecture
• Map projections
• Map scales
• Geographic coordinate system (GCS)
• Rectangular coordinates
• Spatial-data formats
• Calculating geometry
• Geospatial data sources
02/11/2016—Lab (GIS Tutorial for Health, chapter 4)
• Exploring map projections for a world AIDS study
• Symbolizing area maps using size-graduated point markers
• Creating a prevalence map using point markers
• Country-level data and continental projections
• Downloading international HIV/AIDS data
• Exploring map projections for a US lung cancer study
• Local-level spatial data
• Adding and symbolizing existing map layers
• Working with spatial-data formats
• Creating points from x,y coordinates
• Downloading USGS raster maps
**Week 6, Downloading and preparing spatial and tabular data**

*Assignment #5, due 12pm (noon), 02/25/2016*

[Reading: *GIS Core Concepts*, chapters 3 coordinates and 5 infrastructure]

02/16/2016—Lecture
- Attribute tables
- Data table joins
- Spatial joins
- US Census geographic files
- US Census data files

02/18/2016—Lab (*GIS Tutorial for Health*, chapter 5)
- Downloading spatial data from the US Census Bureau
- Downloading tabular data from American FactFinder
- Processing tabular data
- Using ArcCatalog utilities
- Joining tables
- Building comparison maps

**Week 7, Geocoding tabular data**

*Assignment #6, due 12pm (noon), 03/03/2016*

02/23/2016—Lecture
- Geocoding overview
- Polygon geocoding
- Linear (street) geocoding
- Problems and solutions
- Geocoding layer sources
- Geocoding in ArcGIS

02/25/2016—Lab (*GIS Tutorial for Health*, chapter 6)
- Polygon address matching
- Geocoding patients to ZIP Codes
- Spatially joining patient and ZIP Code layers
- Creating a choropleth map showing patient counts by ZIP Code
- Linear address matching
- Geocoding hospital addresses to streets for competitive analysis
- Rematching addresses
- Creating a final comparison map

**Week 8, GIS Quiz 2 and Network Analyst**

03/01/2016—Quiz 2

03/03/2016 – Network Analyst lecture and lab

[Reading: *Accuracy of Prehospital Transport Time Estimation, Academic Emergency Medicine Journal]*]

- Creating a network
- Travel time polygons
- Traveling salesman problem
- Multiple vehicle routing problem
**Week 9, Processing and analyzing spatial data**

*Assignment #7 due 12pm (noon), 03/24/2016*

03/15/2016—Lecture
- Attribute extraction
- Feature location extraction
- Location proximities
- Proximity buffers
- Geoprocessing tools
- Digitizing

03/17/2016—Lab (*GIS Tutorial for Health*, chapter 7)
- Preparing a study region
- Making additional table and map preparations
- Investigating the correlation between poverty and injuries
- Investigating injuries near parks

**Week 10, Transforming data using approximate methods**

*Assignment #8 due 12pm (noon), 03/31/2016*

03/22/2016—Lecture
- Basic apportionment
- Apportionment model
- Advanced apportionment
- Cluster Analysis

03/24/2016—Lab (*GIS Tutorial for Health*, chapter 8)
- Aggregating block data for the elderly population to health referral regions
- Apportioning poverty data to emergency medical service zones
- Automating processes using models

**Week 11, Using ArcGIS Spatial Analyst for demand estimation**

*Assignment #9 due 12pm (noon), 04/07/2016*

03/29/2016— Lecture
- Raster maps
- Processing raster layers using Spatial Analyst
- Kernel density smoothing
- Raster based site suitability study
- Poverty risk model
- Spatial regression

03/31/2016—Lab (*GIS Tutorial for Health*, chapter 9)
- Out-of-hospital cardiac-arrest study
- Processing raster-map layers
- Creating a hillshade raster layer
- Making a kernel-density map
- Extracting raster-value points
- Conducting a raster-based site-suitability study
- Using ArcGIS ModelBuilder to create a poverty risk index
**Week 12, GIS Quiz 3 and 3D Analyst**
04/05/2016—Quiz 2
04/07/2016 – 3D Analyst lecture/lab

**Week 13, Project**
04/12/2016—Lab, work on project
04/14/2016—Lab, work on project

**Week 14, Project**
04/19/2016—Lab, work on project
04/21/2016—Lab, work on project

**Week 15, Project**
04/26/2016—Lab, work on project
04/28/2016—Lab, work on project