Geographic Information Systems
AL / ANTH 33201 / AL 53201 / CE 33100 (3 credits)
Location: Library 247 (Library classroom)
MW 3:30 PM – 4:45 PM

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Geographic Information Systems, Spring 2015
Course Syllabus

This course is aimed to provide a basic understanding of how Geographic Information Systems (GIS) and satellite imagery can be used to visualize and analyze spatial data. Students will learn basic techniques for analyzing, manipulating and creating geospatial data in both pixel-based (satellite imagery and digital terrain models) and vector-based (point, line and polygon representation of spatial data) formats. Students will also learn how acquire high-resolution satellite imagery and other GIS data from online data servers.

Each week, these techniques will be applied to both sample data and to data from a region of interest chosen by the student. Preferably, this will be someplace the student can visit at least once (e.g. state parks, large areas of land) though for students interested in inaccessible areas, different methods can be used. In addition to lab-based work, students will learn basic field techniques, including how to navigate and record using a Global Positioning System (GPS) handheld receiver, how to integrate field GPS data into a GIS database, and how to produce maps for fieldwork and publication.

A course in GIS is very computer intensive, so students should be familiar with the basics of using PCs and the Windows operating system. We will be using the ArcGIS 10.3 software package. ArcGIS is the industry standard GIS program, and it handles the integration of vector and raster data well (although its imagery analysis capacities are not as sophisticated as other packages). Most of our work will be done within the ArcMap component of the ArcGIS suite of programs. Some of you may have worked with ArcView in the past; ArcMap is similar in that it has a user-friendly graphic interface but it incorporates more of the capacities of the previously command line driven ArcInfo. Time willing, we will also briefly experiment with using ArcGIS Online as both a source of additional data and to make GIS datasets available to a broader audience.

Please note that this course requires a decent amount of time in addition to the scheduled meetings. If your schedule does not allow you to spend that kind of time on campus, you should reconsider taking the course. The course is structured to be incremental, so your ability to understand the material in one week will be contingent upon your completion of the lab from the previous week.

Course Structure

The course has three different kinds of meetings:

- A one-hour lecture / discussion, usually on Mondays that will present basic information on the week's topic. Students will be expected to have watched a video lecture in advance and be prepared to discuss assigned readings.
- A 1 hour demonstration (recitation), usually on Wednesday. This session will demonstrate the techniques that you will be using that week using sample data. Detailed instructions will be available each week on the course's Sakai site as will a video.
- Two 1-hour optional supervised lab periods where students will work to replicate the procedures learned in the demonstration session and complete weekly assignments. The timing on these will be decided during the first and second week. Rarely will this session be sufficient to complete the lab assignment, so you should be prepared to spend additional unsupervised time in the Center for Digital Scholarship GIS lab.

Course Requirements & Grading

The final grade for this class is made up of three components:

1). Weekly Lab Assignments (50 %): Each week students will complete a lab assignment based on the demonstrated techniques. Lab assignments should be posted to Sakai by the next class meeting. Each assignment will be graded out of 10 points. The lab assignments will be returned promptly. If errors are made, the student will have one opportunity to resubmit for additional points.

2). Final Paper (20 %): Students are expected to develop a proposal for using the techniques demonstrated in class to approach a topic of interest to them. A prospectus and literature review (worth 5 %) will be required by midterm. The final proposal must be at least 10 pages and will include pilot data and a detailed methodology of how GIS techniques can be used to address a specific question.

3). Final Presentation (15 %): Because GIS and spatial data are inherently visual, students will also be required to give a short (5 - 10 minute) presentation on their proposal using PowerPoint and including relevant maps and spatial data.

4). Participation (15 %): This will be more than just attendance and will include two short presentations of other research in your field.

Students are expected to be present promptly at the beginning of each class period, unless prevented by illness or by other compelling cause. In the event of such absence, students may request that faculty members be notified by the Office of Academic Services and Retention. Alternatively, you may also directly email the instructor. Students are responsible for completing course work missed through absences. All health-related absences or late assignments require documentation from a physician. Late assignments will lose 1 point for each week late. No incompletes will be given for the final grade.

In this course, you will have difficulties if you fall behind, since each step rests on the work that you accomplished the previous week. Moreover, 50% of your grade rests on your successful completion of the lab assignments. It is important not to miss either the demonstration session or your lab. If for some reason you cannot make these sessions, please let the instructor know as soon as possible so we can try to make some arrangements which will prevent you from falling behind. You should also expect to spend a significant amount of time in the computer lab outside of scheduled class times.

Academic honesty is extremely important in this, and all, university classes. You are expected to turn in work that is original and your own. You may help each other on lab assignments, but you are expected to submit a final product that is unique. For the final paper and presentation absolutely no instance of plagiarism will be tolerated. If you are unsure, just ask me.

Students enrolled in this course are expected to abide by the University Notre Dame Honor Code. The purpose of the Honor Code is to protect the academic integrity of the University by encouraging consistent ethical behavior in assigned coursework by students. To fully understand your expectations as a student in this class, please visit this site: http://www.nd.edu/~hnrcode/docs/handbook.htm

Readings and Assigned Texts:

The majority of the practical “hands-on” material for the class will be come from the instructor's demo notes. These will be provided weekly to the students. However, students should also consider purchasing ESRI's *Getting to know ArcGIS* (at the bookstore or online). This is not only an excellent introductory exposure to ArcGIS, but also comes with a free trial version of the software, which can be useful for field or off campus work.

Other useful texts:

Erdas Field Guide. Technically, this is the manual for ERDAS Imagine (a GIS software suite designed for the in-depth analysis of raster imagery). However, over the years it has grown into a highly detailed presentation of the theories and techniques behind the analysis of raster data. It is available free as a pdf and the link is posted on Sakai.

Introduction to Geospatial Technologies Bradley A. Shellito. This is an excellent overview of many of the key GIS topics we will discuss throughout the class.

Course Schedule:

Week 1: January 13
General overview of syllabus and expectations

Week 2: January 18 & 20
Introduction to the course, software and the Raster Data Model

Lecture: GIS defined, data types, the nature of raster (pixel-based) data.
Demonstration: Displaying and manipulating scanned maps, aerial photographs and satellite imagery, and digital elevation models (DEMs).
Lab: Display various raster images in ArcGIS; manipulate image histograms.

Week 3: January 25 & 27
Vector Data Types

Lecture: The nature of vector data.
Demonstration: Representing, displaying and manipulating data in the form of vector geometries: points, lines and polygons.
Lab: Create maps of sample sites and regions using vector data in ArcMap; integrate vector data with raster imagery

Week 4: February 1 & 3
Projections and Transformations

Lecture: Projections and Transformations
Demonstration: Georeferencing maps in ArcMap; mosaicking georeferenced imagery, converting between projections
Lab: Georeference sample map; georeference map of your region

Week 5: February 8 & 10
Satellite Imagery* and *Aerial Photographs

Lecture: Multispectral Imagery and the Electromagnetic Spectrum; Enhancing Imagery
Demonstration: Spectral Enhancement; downloading and using multspectral satellite imagery; Filtering and Principal Components Analysis.
Lab: Experiment with filtering imagery of your area. Explain what results may mean.

Week 6: February 15 & 17
Creating and Manipulating Vector Data

Lecture: Creating Vector data
Demonstration: Creating vector data from digitized maps, georeferenced imagery, GPS readings and field observations
Lab: Create vector data from your georeferenced maps; georeference and digitize your survey maps; digitize features from your georeferenced imagery

Week 7: February 22 & 24
Tables and Databases: Making a spatial database

Lecture: Integrating spatial and attribute data.
Demonstration: Joining and relating tabular data to vector features; querying spatial databases
Lab: Join, relate and query tables from provided sample data.

Week 8: February 29 & March 2
Digital Terrain Models and Interpolation: Representing Topography

Lecture: Digital methods of representing topography; Interpolation; DEM-based analytical methods: viewsheds and least-cost paths.
Demonstration: Creating DEM and TIN terrain data from vector data; generating contour lines of continuous phenomena; generating viewsheds and least-cost paths.
Lab: Create various digital terrain models from spot heights and digitized contour lines; download and manipulate SRTM DEMs; derive slope and aspect; create hillshades; interpolate density of non-elevation data.

SPRING BREAK

Week 9: March 15 & 16
Basic Spatial Analysis

Lecture: Spatial analysis of discrete phenomena.
Demonstration: Basic spatial analyses; calculating area and length; calculating distance; theissen polygons, predictive modeling
Lab: Perform various analyses on sample data from sample data and on your dataset. Create a simple predictive model by weighting attributes.

Week 10: March 21 & 23
Hydrological Modeling

Lecture: Principles of hydrological modeling and its applications.
Demonstration: Creating hydrological models; defining watersheds and basins
Lab: Model the hydrology for your survey area.

Week 11: March 30 (No class on Easter Monday)
Three-Dimensional Analysis and Visualization

Lecture: Case studies in 3D analysis and visualization of landscapes.
Demonstration: Calculating volumes; producing profiles; viewshed analysis; visualizing landscapes in ArcScene; producing 3D images of 2D georeferenced imagery.
Lab: Produce profiles through your survey area; create viewsheds from discrete locations; drape georeferenced imagery over your terrain data.

Week 12: April 4 & 6
Time and temporal data

Lecture: How time can be represented on digital and paper maps
Demonstration: Using the time tools in ArcGIS with both raster and vector data.
Lab: Creating a time lapse video of sample data..

Week 13: April 11 & 13
Cartography and Presentation of Results

Lecture: This lecture period will be for discussion of the final proposal.
Demo: Making good maps; effectively presenting spatial data.
Lab: Create several finished maps of your study area.

Week 14: April 18 & 20
Other uses of GIS techniques

Lecture: Case studies in using landscape level analysis on very small phenomenon.
Demo: No demo or lab; students will work on their proposals

Week 15: April 25 & 27
Student Presentations

Final Exam: Final Papers Due