GEOG 362: Image Analysis
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Syllabus

Geog 362: Image Analysis

This syllabus is divided into several sections. You can read it sequentially by scrolling down the length of the document or by clicking on any of the links below to “jump” to a specific section. That being said, it is essential that you read the entire document as well as material covered in the Orientation. Together, these serve the role of our course "contract."

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Course Overview

GEOG 362 - IMAGE ANALYSIS: Use of digital imagery and elevation data for visualization and analysis is a fundamental skill that must be mastered by today’s geospatial professional. This course assumes that the student has some familiarity with GIS concepts and is proficient with ArcGIS software at a basic level. Formal instruction is given in the production and use of digital imagery and elevation data from a variety of remote sensing sources. Students are taught to identify appropriate data for a variety of potential applications. They are also given experience discovering and using imagery and elevation data from a variety of federal, state, and local public domain sources. The culminating project presents students with the challenge of identifying data, visualization, and analysis methods in the context of a real-world scenario.

Prerequisites: Geog 160

Students will complete ten lessons with corresponding hands-on assignments, online discussions, and a final project. Each lesson consists of:

- reading assignments online, in the course textbook, or on library reserve
- a practice reading quiz to self-assess comprehension of the reading material and prepare for exams
- a practice crossword puzzle game to self-assess mastery of technical vocabulary
- an online discussion opportunity to interact with peers and instructors
- a hands-on lab activity to demonstrate and apply concepts from the lectures and reading
- students are encouraged to share questions and post comments at any time in the ANGEL Discussion Forums

Throughout the course, students confront realistic problem scenarios that incorporate such skills and concepts as definition of data needs, metadata content standards, data formats and types, and analysis methods.

Course Objectives

Students who excel in this course are able to:

- Describe the basic principles of image and elevation data acquisition.
- Summarize the basic operational characteristics of commercial remote sensing systems.
- Critically assess the strengths and weaknesses of remote sensing imaging instruments and
platforms for a broad range of application scenarios.

- Perform orthorectification of digital imagery
- Perform simple image enhancement, image interpretation, and automated analysis using digital optical imagery.
- Perform simple terrain analysis using digital elevation/terrain models.
- Describe the quantitative methods and industry standards for geometric accuracy assessment of imagery and elevation data products.
- Describe the qualitative methods and industry standards for quality assurance and quality control of imagery and elevation data products.
- Use acquired knowledge and critical thinking skills to create visualizations and perform analysis of imagery, elevation, and supplemental vector data in GIS.

Required Course Materials

Required Textbooks

There is one required textbook for this course.


Our library has also purchased a digital version of the textbook for this course. To access the eReserve:

- Access The CAT from the University Library web page.
- Choose Exact match for the Quick Search type
- Enter "Introduction to Remote Sensing" in the Search field, and choose "Title" in the keyword pick list
- Click Search. (If you get more than one match, you did not select "Exact" for the match type.)
- Click on the resulting link provided for Online Content.

Other Required Materials

Students must provide their own 16GB (minimum) USB flash drive to store their lab and project data. Attempting to use network drives will result in very slow performance. You will also likely run out of available space. Other forms of media that are compatible with lab computers can be substituted for the flash drive, but they must be read/write and of the same minimum storage capacity.

Supplemental References (No Purchase Necessary)

Additional readings may be provided electronically through the ANGEL course management system or Penn State library services. These readings may include, but are not limited to, the following sources.

**Required Software**

1. **ESRI, ArcGIS**
   ArcGIS will be installed on computers in GIS Laboratory. Students will also be provided with the installation package and a student edition license to install on their own computers. Using your own computer for this course is optional; it does not eliminate the requirement to attend the lab sessions. ArcGIS Desktop is certified for Windows platforms and can be run on an Apple computer using a virtual Windows OS. Be sure to read ESRI's System Requirements to see if it will work on your own system. **NOTE:** You need administrative rights on your computer in order to properly install the ArcGIS Student Edition.

2. **Excelis, ENVI**
   ENVI will be installed on computers in GIS Laboratory.

**Field Trips**

No field trips are scheduled at this time.

**Course Content**

Below you will find a summary of the learning activities for this course. The lesson calendar is available in ANGEL.

**Lesson 0: Orientation**

Objectives - After completing the orientation you should be able to:

- navigate between this course text and the ANGEL course management system
- articulate your expectations about how and what you will learn in this course
- understand how and what instructors expect you to learn in this course
- locate key information about the course, including assignments, due dates, technical information, and ways to get help
- understand course policies, including academic integrity
- communicate with instructors and fellow students

**Lesson 1: Introduction to Remote Sensing**
Objectives - After completing this lesson you should be able to:

- Describe key milestones in the historical development of remote sensing.
- Describe fundamental principles of electromagnetic radiation that are the basis for remote sensing.

Lesson 2: Platforms, Sensors, and Georeferencing

Objectives - After completing this lesson you should be able to:

- Describe various types of remote sensing instruments used to create base map imagery and elevation data, including film cameras, digital multispectral and hyperspectral sensors, lidar and radar.
- Describe common platforms for deployment of sensors, including fixed-wing and rotary-wing aircrafts, satellites, and ground-based vehicles.
- Identify appropriate sensor/platform combinations for a variety of geospatial applications.
- Describe technologies and methods used to georeference remotely sensed data.
- Explain the difference between a datum, coordinate system, and map projection.
- Identify primary coordinate systems used for imagery and elevation data in the conterminous United States.
- Identify metadata fields that describe georeferencing in a variety of image and elevation data sets acquired from public domain sources.
- Import imagery and elevation data into ArcGIS in the correct geographic location, identifying and compensating for missing or incorrect information in the provided metadata.

Lesson 3: Production of Digital Image Base Maps

Objectives - After completing this lesson you should be able to:

- Describe the basic photogrammetric concepts used in orthorectification of imagery.
- Explain the difference between simple georeferencing and rigorous orthorectification.
- Perform both simple georeferencing and rigorous orthorectification of both airborne and satellite imagery.
- Use web-based tools to locate and download remotely sensed imagery.
- Identify common image data formats and perform conversions from one format to another.
- Overlay imagery data with vector data layer to prepare for visualization and analysis.

Lesson 4: Production of Digital Terrain Models

Objectives - After completing this lesson you should be able to:

- Describe the basic photogrammetric concepts used in creation of digital elevation models.
- Explain the characteristics of, and processing methods used to produce, digital elevation models, digital terrain models, digital surface models, and topographic contours.
- Discuss the strengths and weaknesses of various types of terrain representation in GIS analysis and applications.
- Identify common artifacts and anomalies that occur in elevation data and methods used to correct them.
- Identify common elevation data formats and perform conversions from one format to
Overlay elevation data with imagery and vector data to prepare for visualization and analysis.

Lesson 5: Management of Imagery and Elevation Data

Objectives - After completing this lesson you should be able to:

- Describe methods used to store and manage large image data and terrain data sets for multiple, distributed users.
- Discover, download, and import a variety of imagery and elevation datasets from federal, state, and local public domain sources.
- Discuss the strengths and limitations of web services vs. local hosting for both imagery and elevation datasets.

Lesson 6: Validation of Imagery and Elevation Data

Objectives - After completing this lesson you should be able to:

- Describe and compare various federal and state standards for imagery and elevation data.
- Compute a quantitative accuracy assessment in accordance with FGDC standards.
- Perform visual quality assessment for both imagery and elevation data.

Lesson 7: Image Enhancement and Interpretation

Objectives - After completing this lesson you should be able to:

- Describe and perform image enhancement techniques to improve interpretability of imagery.
- Describe common image interpretation tasks.
- Describe eight elements of image interpretation.

Lesson 8: Image Analysis Classification

Objectives - After completing this lesson you should be able to:

- Explain the basic principles of pixel-based image classification.
- Explain the basic principles of object-oriented image classification.
- Perform pixel-based supervised and unsupervised classification.
- Compare and contrast applicability of pixel-based and object-oriented classification methods.

Lesson 9: Terrain Modeling and Analysis

Objectives - After completing this lesson you should be able to:

- Use both imagery and terrain data to create 3D visualization.
- Perform a simple slope and aspect analysis.
- Perform a simple flood inundation analysis.
- Perform a simple line-of-sight analysis.

**Final Project: Problem Solving with Imagery and Elevation Data**

Students will be provided with a problem scenario, and will be asked to discover imagery, elevation data, and supplemental vector data for visualization and analysis related to the scenario. They may work in teams to complete the analysis, but each student will be required to submit their own original written report document project approach, methods, and results.

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**Assignments and Grading**

Students earn grades that reflect the extent to which they achieve the learning objectives listed above. Opportunities to demonstrate learning include:

- 10 online discussions, worth 5 points each, for a total of 50 points (10% of final grade)
- 10 lab activities, worth 30 points each, for a total of 300 points (60% of final grade)
- 2 midterm exams, worth 50 points each, for total of 100 points (20% of final grade)
- 1 final project, worth 50 points (10% of final grade)
- Extra credit opportunities may be announced by the instructor. Extra credit points will be applied to the student's point total for calculation of the final letter grade. Extra credit will ONLY be applied if the student has turned in ALL required assignments throughout the semester (discussions, labs, and exams).
- Due dates for assignments will be announced in class. Discussions and labs must be turned in by the due date to receive full credit. After the due date, 1 point per day will be deducted from discussion scores; 5 points per day will be deducted from lab scores. Exceptions to this rule for special circumstances must be approved prior to the due date, IN WRITING, by the instructor or TA. Late assignments will still count as "turned in" for application of extra credit at the end of the semester.

<table>
<thead>
<tr>
<th>Grading Scale</th>
<th>Points</th>
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<tbody>
<tr>
<td>A</td>
<td>Above 90%</td>
</tr>
<tr>
<td>A-</td>
<td>88.0 - 89.9%</td>
</tr>
<tr>
<td>B+</td>
<td>85.0 - 87.9%</td>
</tr>
<tr>
<td>B</td>
<td>80.0 - 84.9%</td>
</tr>
<tr>
<td>B-</td>
<td>78.0 - 79.9%</td>
</tr>
<tr>
<td>C+</td>
<td>75.0 - 77.9%</td>
</tr>
<tr>
<td>C</td>
<td>70.0 - 74.9%</td>
</tr>
<tr>
<td>D</td>
<td>60.0 - 69.9%</td>
</tr>
<tr>
<td>F</td>
<td>59.9% or below</td>
</tr>
</tbody>
</table>

Grades for all activities will be promptly posted in the ANGEL gradebook throughout the semester. Students should monitor the gradebook and report any discrepancies to the instructor.
or teaching assistant as soon as possible. To view the ANGEL gradebook:

- Click on the Report tab.
- Select the Grades button in the "Type" section of the "Reports Console" page.

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Expectations and Policies

- **Penn State E-mail Accounts**
  All official communications from the Penn State World Campus are sent to students' Penn State e-mail accounts. Be sure to check your Penn State account regularly, or forward your Penn State e-mail [15] to your preferred e-mail account, so you don't miss any important information.

- **Time Requirement**
  This course will require approximately 8-10 hours of student activity per week, including two 50-minute lectures and one 115-minute laboratory session.

- **Attendance**
  Attendance at lectures and laboratory sessions will be taken and is required. Students are allowed three lecture absences and 1 lab absence without penalty. Each additional absence will result in 5 course points (equivalent to one percentage point) deducted from the final grade. For example, a student with six lecture absences and two lab absences who had earned a total of 390 course points (78%) and a B- grade, would be penalized 20 course points (4 percentage points) and drop to 370 course points (74%) and a C grade.

  The applicable University Faculty Senate Policy is 42-27: Class Attendance [16]. The procedures for Senate Policy 42-27 are implemented as Academic Administrative Policy and Procedure E-11: Class Attendance [17].

- **Communication**
  You should get in the habit of checking course email and discussion forums in ANGEL on a daily basis. That's where students and instructors share comments, pose questions, and suggest answers. With only occasional exceptions, instructors check email and forums every day, and will try to respond to your questions and concerns within 24 hours.

- **Exams**
  There are two exams scheduled during the semester. Students who will miss an exam should present a class absence form [18] to the instructor as soon as possible and, except in unavoidable situations, at least one week in advance of the exam date. An alternative exam will be provided for you that asks for responses to approximately 10 short essay questions. This is a different format than the in-class exams.

- **Deferred Grades**
  If you are prevented from completing this course within the prescribed amount of time, it is possible to have the grade deferred with the concurrence of the instructor. To seek a deferred grade, you must submit a written request (by e-mail or U.S. post) to your instructor describing the reason(s) for the request. It is up to your instructor to determine whether or not you will be permitted to receive a deferred grade. If, for any reason, the course work for the deferred grade is not complete by the assigned time, a grade of "F" will be automatically entered on your transcript.

- **Academic Integrity**
  This course follows the guidelines for academic integrity of Penn State's College of Earth
and Mineral Sciences. Penn State defines academic integrity as "the pursuit of scholarly project in an open, honest and responsible manner." Academic integrity includes "a commitment not to engage in or tolerate acts of falsification, misrepresentation, or deception." In particular, the University defines plagiarism as "the fabrication of information and citations; submitting other's work from professional journals, books, articles, and papers; submission of other student's papers, lab results or project reports and representing the work as one's own." Penalties for violations of academic integrity may include course failure. To learn more, see Penn State's "Plagiarism Tutorial for Students."

I cannot overemphasize the importance of academic integrity. **DO NOT copy and paste from unreferenced sources. Without exception: if you use a direct quote from any source, as part of any submitted assignment, the quote must be clearly noted and properly referenced.** (In-line references are fine.)

- **Citation and Reference Style**
  Academic Integrity and Citation Style Guide

- **Accommodating Disabilities**
  Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Office for Disability Services (ODS) Web site provides contact information for every Penn State campus: [http://equity.psu.edu/ods/dcl](http://equity.psu.edu/ods/dcl). For further information, please visit the Office for Disability Services Web site: [http://equity.psu.edu/ods](http://equity.psu.edu/ods).

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: [http://equity.psu.edu/ods/guidelines](http://equity.psu.edu/ods/guidelines). If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

- **Military Personnel**
  Veterans and currently serving military personnel and/or spouses with unique circumstances (e.g., upcoming deployments, drill/duty requirements, disabilities, VA appointments, etc.) are welcome and encouraged to communicate these, in advance if possible, to the instructor in the case that special arrangements need to be made.

- **Inclement Weather**
  In case of weather-related delays at the University, this online course will proceed as planned. Your instructor will inform you if there are any extenuating circumstances regarding content or activity due dates in the course due to weather delays. If you are affected by a weather-related emergency, please contact your instructor at the earliest possible time to make special arrangements.

- **Netiquette**
  The term "Netiquette" refers to the etiquette guidelines for electronic communications, such as e-mail and bulletin board postings. Netiquette covers not only rules to maintain civility in discussions, but also special guidelines unique to the electronic nature of forum messages. Please review Virginia Shea's "The Core Rules of Netiquette" for general guidelines that should be followed when communicating in this course.

- **Connect Online with Caution**
  Penn State is committed to educational access for all. Our students come from all walks of life and have diverse life experiences. As with any other online community, the lack of
physical interaction in an online classroom can create a false sense of anonymity and security. While one can make new friends online, digital relationships can also be misleading. Good judgment and decision making are critical when choosing to disclose personal information with others whom you do not know.

Disclaimer

Please note that the specifics of this Course Syllabus can be changed at any time, and you will be responsible for abiding by any such changes. Changes will be posted to the course discussion forum.
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Please send comments to the editor.

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Links:
[1] https://www.e-education.psu.edu/geog362/node/15/%23professor
[8] https://www.e-education.psu.edu/geog362/node/15/%23coursepolicies
[9] https://www.e-education.psu.edu/geog362/node/15/%23disclaimer