HIRES – 2016 Syllabus

Instructors:

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Course Description

Remote Sensing: The remote sensing portion of the course will explore how satellites observe the environment in both the visible and thermal spectrum. The main project will be to devise an algorithm that will detect clouds both in day and night, and will classify the remaining surface into vegetated, urban, and water. Python programming will be used to read, analyze and display the satellite data.

Python: Python is a powerful and popular programming language that provides students with the tools needed for numerical computations, data analysis of experiments and sensor measurements, and graphical displays of spatial and temporal data. The material covered in this portion of the course will be blended with the concepts of remote sensing; introducing students to the programming techniques needed to read, display and eventually analyze satellite data.

GIS: Geographic Information Systems (GIS) is a computer-based tool that uses spatial data to analyze and solve real-world problems. This course is designed to introduce the student to the basic principles and techniques of GIS with as objective to develop an understanding of geographic space and how maps represent geographic space. A student will be able to read maps, as well as write about and discuss information gleamed from maps. By the end of the GIS module, students will be creating maps from sources both graphical and tabular data using ArcMap. Students will be able to use GIS to build maps using data they collected during program. Students will present and discuss their mapping work based on data collected from different sources using PowerPoint presentation.

Section 1: Remote Sensing (Dr. Brian Vant-Hull)

Scoring

Quizzes and/or classwork will occur each day. The session will conclude with a computer project done in class.

Quizzes*:* 5pts/twice weekly
Classwork: 5pts/twice weekly
Project: 10pts/one per section

Thursday July 7 – *Introduction to Remote Sensing*
- Intensity, reflectivity, transmission, absorption and scattering
- Descriptive optical depth
- Pixels and images
- Satellites and other sensors
- Using Python in Interactive mode

Classwork: radiation physics

Friday July 8 – Field Trip to Carry Institute (no class)

Monday July 11 – *Making images using visible light*
- Reflectivity and Color
- Images and arrays
- Array mathematics in Python: numpy
- Reading a text file with Python

Quiz: radiation physics

Tuesday July 12 – *Working with Images*
- Making an image in Python
- Writing functions in Python: reading a file, displaying an image
- Decision structures: If and Boolean algebra
- Loops: FOR and WHILE
- Contrast

Classwork: script to open and display multiple files in succession

Thursday July 14 – *Thermal radiation and clouds*
- Thermal Radiation
- Creating a thermal radiation function
- Histograms
- Thermal cloud selection and cloud fraction

Classwork: function to calculate brightness temperature from radiation
Quiz: arrays and color

Friday July 15 – Trip to National Weather Service (no class)

Monday July 18 – *Calculating Optical Depth*

- Optical Depth and Math
- Calculating Optical Depth of Clouds
- Scatter plots of cloud properties

Quiz: thermal radiation
Begin Project (see below)

Tuesday July 19 – *Project Day*

You will be placed in groups to help each other develop a script using your previously developed functions to do the following:

1. Loop through the landsat archive by date and for each one:
    a. Open the thermal radiation file and convert to temperature.
    b. Make a histogram of temperature, and let the user input where to place the temperature to select cloud, or indicate if there is no cloud present. If clouds are present, do the following:
        - Pick out the pixels that have clouds, calculate cloud fraction.
        - Calculate the optical depth of each cloudy pixel
        - Append the optical depths and temperatures for each pixel to their respective arrays
        - Make a scatter plot of cloud top temperature versus optical depth, and save it with the date and cloud fraction in the file name.
2. Based on the plots you have, write a brief analysis of how cloud optical depth and cloud top temperature are related.

EVERY member of the team will turn in their own script and module containing the functions that go with it. However, the team may divide up jobs to let different members investigate each component of the project and explain to the rest how to do it.

Section 2: Python (Ms. Hannah Aizenman)

Questions concerning technical issues, clarification of lessons & assignments, and anything else related to Python or the course material should be posted in the blackboard discussion forum for the course.

Python Environment
https://www.continuum.io/downloads

Grading
Students will be given two individual homework assignments and 1 group project.

Classwork: 10pts/twice weekly
Project: 10pts/one per section

All analysis and graphics **MUST** be done in Python. Submission of work created in anything else (including but not limited to excel & matlab) is automatic grounds for failure. You may submit either a document or an IPython notebook.

Grades will be posted to blackboard. You are responsible for having a working account. Notify me ASAP if this is not possible.

July 21st Developing a classifier:

- Review of image as array
- Filtering data via Boolean masking
- Computing statistics on selected regions
- Using statistics to build an NDVI classifier
- Creating classifiers for water, building, clouds

July 22nd Training a classifier:

- Comparing class statistics
- Updating classification rules based on findings.

Homework: Write a 1-2 page report (with graphs) summarizing:

- *The reasoning behind the criteria for each class*
- *The differences between the classes*
- *Why the classification is reliable*

July 25th Testing a classifier

- Factoring out classifier rules into function
- Applying to a new image
- Evaluating the results – confusion matrix, etc
- Updating the classifier

July 26th Expanding a classifier

- Incorporating Temperature & Optical Depth
- Adding classes & subclassing
- Comparing classes over time

Homework: Write a 1-2 page report (with graphs) summarizing:

- *How the classes have been improved*
- *Why the classification is reliable*

July 28th Project: Build Your Own Classifier

Develop a classifier for at least 1 surface type or weather phenomena not covered in class. The project must

- Explain the reasoning for the classification criteria
- Describe the training & testing of the classifier
- Evaluate the skill of the classifier
- Compare the class to:
    - Non-classifier data
    - Data in at least one complementary but opposing class (so NDVI vs. water)

Extra Credit: Repeat the project with a 2nd surface type/weather phenomena. You may compare this class to the 1st class you built for the project.

Plagiarism

In the case of multiple similar homework submissions, plagiarism on assignments is determined based on timestamps-the person who submitted first is assumed to be the originator and anyone else is assumed to have plagiarized. All students who submit similar exam answers are assumed to be cheating. Plagiarism will result in an automatic 0 for the assignment; two incidents will yield an automatic 0 for the course.

Plagiarism is copying solutions from pretty much anywhere, including friends, solution manuals, and random websites. Plagiarism can result in various academic repercussions as described in the CCNY integrity policy: http://www1.ccny.cuny.edu/current/integrity.cfm and any work suspected of being plagiarized will be dealt with per CCNY guidelines

Section 3: GIS (Dr. Tarendra Lakhankar)

Module Grading:

Group Project: 60%
Quiz: 25%
Class Participation: 15%

Assignment:

Students will be given assignments based on activities performed during the class. The examples of assignments includes: (1) importing data with latitude and longitude coordinates in GIS and creating maps, (2) Import excel or other data formats data in GIS and joining it Global or Local maps to create new maps using imported datasets. Students need to submit the assignment in 2 days of time. Since, these assignments are about creating maps, students will have 3 attempts to improve their maps and submit on the blackboard.

Group GIS Project:

Students are divided in several groups with 3-4 students in each group. In the GIS project, students are free to choose Earth System Science related topic, in consultation with the instructor. The project should have rich GIS elements. Students will be downloading data from various government website sources including: Census bureau, NOAA, NASA, USGS, DOL, World Bank, UN, and educational institutes, etc. The grading in GIS project is based quality of GIS maps produced, presentation skills, effort in data processing and preparation, and analysis of data. Students are encouraged to ask questions after presentations.

Mode of Presentation:

The PowerPoint slides will be used to class material on projector. Also, the computer and projector is used to show how to use ArcGIS software and their functionalities.

Communication:

Blackboard will be used for official communication outside the classroom. Students are expected to check their Blackboard account at least once a day.

Class 1 – Introduction to GIS

- An overview of GIS
- Concept of Vector and Raster
- Feature model and example of features
- How GIS data are captured, stored, retrieved, analyzed & displayed
- How to use ArcMap
- Introduction to shapefiles

Class 2 – Introduction to ArcMap

- Importing remote sensing data/images
- Importing and processing tabular data for GIS

Class 3 – Data analysis and mapping

- Editing data layers
- Analyzing GIS data
- Mapping the GIS data
- Selection of group GIS project
- Searching GIS data for project

Class 4 –Remote Sensing data and GIS

- Downloading the remote sensing (Glovis, NASA)
- Importing remote sensing data in ArcMap
- Supervised Classification of Remote Sensing (LandSat) data in GIS

Quiz: GIS Data type, data analysis

Class 5 – GIS project

- Creating/importing data
- Data plotting and analysis
- Analysis/plotting of GIS data
- Presentation of GIS Project

Project: students will independent project based on their area of interest. Instructor will help student in acquiring and processing data that will be imported in GIS framework.