11:216:474 Undergraduate Advanced Remote Sensing Spring 2022
16:215:604 Graduate Special Topics

Class Meeting: T-TH 3:55-5:15 PM ENR 247 (CRSSA Teaching Lab)
Instructors: Rick Lathrop e-mail: lathrop@crssa.rutgers.edu
On Canvas https://rutgers.instructure.com/courses/7206

Course goals:
Given an open-ended problem, it is the course's goal that students will be expected to:

1) Identify components of a geospatial problem;
2) Propose a workflow that identifies appropriate analytical approaches, tools, data, etc. needed to address the geospatial problem;
3) Be able to execute an acceptable solution;
4) Be able to evaluate the results and assess how to improve the outcome in the future;
5) Be able to communicate the results to others.

Course objectives:

1) Learn the fundamentals of digital analysis, interpretation and application of satellite remotely sensed imagery;
2) Develop an understanding of digital image analysis techniques (including the basic data structures and algorithms involved);
3) Become proficient in the hands-on application of these techniques using various types of image analysis software, including graphical modeling tools and Java coding;
4) Learn not just how but also why and when to apply various digital image analysis techniques.

The course will employ several different image analysis software tools. ERDAS Imagine is workstation GUI-based while Google Earth Engine entails writing JAVA code on a cloud-based server. This does represent an extra challenge on your part to learn multiple tools but I think it is important that you experience both "Old School" and newer "cutting edge" approaches.

I am committed to your success but ultimately the responsibility is on you. You will need to keep up with various techniques as they are introduced and completion of the assignments to hone your hands-on skills. Students who are successful tend to seek out resources that enable them to excel academically, maintain their health and wellness, prepare for future careers, navigate college life and finances, and connect with the RU community. Beyond the course-specific resources listed later in this document, there are a host of other resources that can help you succeed and connect with the Rutgers community; these can be found at success.rutgers.edu, and nearly all services and resources that are typically provided in-person are now available remotely.

Students are expected to uphold Rutger's policies concerning Academic Integrity. Please consult https://nbprovost.rutgers.edu/academic-integrity-students

Week 1 Jan18-20

Class 1: INTRODUCTION TO SATELLITE IMAGE ANALYSIS (ARS Lecture 1)
Class 2: IMAGE DISPLAY AND ENHANCEMENT (ARS Lecture 2) in Media Gallery
Lab 1: Introduction to Google Earth Engine Explorer (tutorial)
Field Guide: Geographic Information; Raster and Vector Data Sources; Image Display;
Remote Sensing Applications article review assigned

Week 2 Jan 25-27

Class 3: INTRO to Google Earth Engine (ARS Lab 2 INTRO and JAVA Basics)
Lab 2: Display/Enhancing in GEE (ARS Lab 2 Parts 1 & 2)
Class 4: Geometric, Radiometric & Atmospheric Corrections (ARS Lecture 3)
Lab 3: Filtering/Masking in GEE (ARS Lab 3)
Field Guide: Math Topics Rectification; Radiometric/Spectral Enhancement

Week 3 Feb 1-3

Class 5: In-Class Work/Consulting Day: Coding in GEE Consulting
Class 6: Image Math ()
Lab 4: Raster Math (ARS Lab 4)
Field Guide: Math Topics

Week 4 Feb 8-10

Class 7: Intro to ERDAS IMAGINE (ARS Lab 5)
Class 8: ERDAS IMAGINE Spatial Modeler
Lab 5: Image Segmentation in EI (ARS Lab 6)
User Guide: Spatial Modeler Workflows
https://hexagongeospatial.fluidtopics.net/reader/fH0o7KrMKUViXGUeoilQuA/h7SUZLn5MudQBdLB811zQg

Week 5 Feb 15-17

Class 9: IMAGE RATIOING (ARS Lecture 4)
Lab 6: Ratioing in EI (ARS Lab 7)
Class 10:
Lab 7: Ratioing & Vegetation Indices in GEE (ARS Lab 8)

Week 6 Feb 22-24

Class 11: In-Class Work/Consulting Day
Class 12: Principal Components Analysis (ARS Lecture 5)
Lab 8: PCA in EI (ARS Lab 9)
Field Guide: Wavelet, Component Analysis
Feb 15 Remote Sensing Applications article review due

Week 7 Mar 1-3

Class 13: SPATIAL ENHANCEMENT/FILTERING (ARS Lecture 6)
Lab 10: Spatial Enhancement in EI (ARS Lab 10)
Field Guide: Spatial Enhancement; Radar Imagery

Class 14: CHANGE DETECTION Web (ARS Lecture 7)
Lab 11: Change Detection in EI (ARS Lab 11)
Reading: Change Detection User Guide
https://hexagongeospatial.fluidtopics.net/reader/fH0o7KrMKUViXGUeoilQuA/YBeK2dcxkOjPrfMMVxZPsw
Take-home Exam Distributed. Due Thursday Mar 10 in class

Week 8 Mar 8-10
Class 15:
Lab 12: Change Detection In GEE (ARS Lab 12)
Class 16: **Take-home Exam Due Thursday Mar 10 (due midnight)**

Week 9 Mar 15-17 Spring Break

Week 10 Mar 22-24
Class 17: IMAGE CLASSIFICATION
(ARS Lecture 8)
Lab 13: Unsupervised Classification (ARS Lab 13)
Class 18: SUPERVISED CLASSIFICATION (ARS Lecture 9)
Lab 14: Supervised Classification (ARS Lab 14)
Field Guide: Classification

Week 11 Mar 29-31
Class 19:
Lab 15: GIS Rules-Based Classification (ARS Lab 15)
Class 20: In-Class Work Day/Consulting
Field Guide: Classification; User Guide: Classification Workflows
Grad students: Research paper/proposal due March 5

Week 12 Apr 5-7
Class 21: ACCURACY ASSESSMENT (ARS Lecture 10)
Lab 16: Accuracy Assessment (ARS Lab 16)
Class 22: Advanced Methods for Classification (ARS Lecture 11)
Field Guide: Evaluating Classification

Week 13 Apr 12-14
Class 23:
Lab 17: Unsupervised Classification in GEE (ARS Lab 17)
Class 24:
Lab 18: Supervised Classification in GEE (ARS Lab 18)

Week 14 Apr 19-21
Class 25: HYPERSPECTRAL REMOTE SENSING (ARS Lecture 12)
Class 26: In-Class Work Day/Consulting

Week 15 Apr 26-28

Class 27: Lecture: FUTURE DIRECTIONS (ARS Lecture 13)

Class 28: Lab: Classification Project Due. Project Synthesis.

Take-home final exam distributed April 28

Week 16 May 9 Final Take Home Exam Due 8am

COURSEWORK EXPECTATIONS:

Reading assignments are expected to be read prior to the class date that is listed in the syllabus above. Students are expected and encouraged to ask questions concerning the reading assignments and lecture material. **If you don't ask, I won't know you don't understand.** Graduate students will meet every other week after Tuesday lecture to discuss the readings.

Homework assignments have been designed to supplement the lecture material and give the student added preparation in some of the details. Homework will be distributed on Mondays and will be returned (completed) to Professor Lathrop the following Monday. Each homework assignment is generally worth 4 points: 0 - not completed; 1 - unsatisfactory; 2-3 - satisfactory; 4 - excellent. Late homework will be accepted for 1 week after the assigned return date, it will be downgraded by 1 point.

Lab assignments are hands-on exercises using the ERDAS image processing work stations. During lab periods, students will work in groups (of 2) to complete the exercises. Interaction between students and the professor is expected and encouraged. Students are encouraged to work in the CRSSA teaching lab, alone or with other class members, outside of normal class periods. Don't let your lab partner do everything - students are expected to develop the proficiency to work unassisted on the ERDAS systems. There will be six lab assignments (5 pts each) during the first half of the semester. Graduate students will have a major cumulative lab assignment during the second half (worth 50 points). Late labs will be accepted for 1 week after the assigned return date, it will be downgraded by 1 point.

There will be a take-home exam and a final exam. These exams will be on the material covered in lecture, lab and the reading. There will be a literature research paper due during the first half of the semester focussing on RS applications. There are a series of extra readings for graduate students; we will meet biweekly to discuss. Grad Students Reading Evaluation: write a two-three page paper critiquing and summarizing your 3 favorite papers and your 3 least favorite papers from the course.

There will be a final project incorporating hands-on image classification and/or change detection and/or RS/GIS integration, etc. The work to complete the project will be done

outside of normal class meeting times. Each student is expected to work independently. You can confer with other students on different approaches, techniques used, etc., but the final results and project write-up should be your own. A separate handout concerning the project will be distributed later in the semester.

Grad Students Reading Evaluation: write a two-three page paper critiquing and summarizing your 3 favorite papers and your 3 least favorite papers from the course. Due: Week 15.

The CRSSA teaching lab is open 5 days a week (Monday to Friday) from 8:30AM to 6PM. If there is a class in session, you can work on downstairs on an open workstation.

CRSSA Computer labs and workstations: No food; Drink is permitted only in spill-proof containers. Approved spill-proof containers include:

- Spill-proof mugs with secure lids
- Sports bottles with a drinking spout
- Drink in capped bottles

The CRSSA labs are for work associated with Environmental Geomatics (or other approved DEENR) courses. The Printer is only for use related to Environmental Geomatics courses.

GRADING:

Midterm Take-home Exam	90 points
Labs	80 points
Article Review/critique	20 points
Final Exam	100 points
Final Project (ugrad)	100 points
Graduate students only:	
Classification lab	40 points
Independent project	60 points
Total	400 points (ugrad) 500 points (grad)

Grading Scale is quite standard; though there may be some scaling, use the following as a guide.

A	90-100
B	80-89
C	70-79
D	60-69
F	Below 60

Online Supplemental resources:

Hexagon ERDAS Producer Field Guide available online at
https://hexagongeospatial.fluidtopics.net/reader/uOKHREQkd_XR9iPo9Y_Ijw/khBQoaH4ne8R6PVMWZ7Ubw
Hexagon ERDAS online Help
https://hexagongeospatial.fluidtopics.net/search/all?filters=HGD_Product~%2522ERDAS+IMAGINE%2522

Google Earth Engine

https://developers.google.com/earth-engine/

Google Earth Engine Beginner's Cookbook. https://developers.google.com/earth-engine/tutorials/community/beginners-cookbook

Get Started with Earth Engine https://developers.google.com/earth-engine/guides/getstarted

https://ecology.colostate.edu/google-earth-engine/

Beginner-level GEE Developers using JavaScript API.
1) How to use Basic JavaScript Syntax in GEE JavaScript API
Link: https://youtu.be/fnQmpErZhx0
2) Beginner's Course on Google earth Engine part:1
Link: https://youtu.be/Z0nGoOxq1eY
3) Beginner's Course on GEE; Client Vs Server Object. How You Get The Server to Execute Your Code?
Link: https://youtu.be/-JSxkQXXseQ
4)How to import Raster and Vector data and display it in GEE JavaScript API?
Link: https://youtu.be/JTNTV4CfhO8
5) Earth Engine public data catalog. How to Import, Filter, Reduce, Clip and Display data in GEE?
Link: https://youtu.be/5CLL_V_peIU
6) Filtering and Displaying Least Cloudy Landsat satellite Images
Link: https://youtu.be/M2Fw5Dk7Il4
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Java Scripting

JavaScript Glossary https://www.codecademy.com/articles/glossary-javascript

Check Resource Module on Canvas for more JavaScript Cheat Sheets