Lecture - 1:00-1:50 Monday and Wednesday in 300 Villard
Lab - 2-3:50 Monday or Wednesday in McKenzie 442 (SSIL)

Dr. Nicholas Kohler (nicholas@uoregon.edu) **Office Hours** - Th, 1-2:30pm in 107e Condon

GTF: Christina Appleby (cappleby@uoregon.edu) **Office Hours:** M, 11am-12pm in 105 Condon

Course Overview

Geog 4/585 is an introduction to remote sensing - the acquisition of data about the world from afar. Often this is in the form of digital imagery acquired by aircraft or satellites, but a variety of other types of remote sensing exist and are discussed in the class.

This course gives students an overview of the physical science used in remote sensing and of the instruments and platforms used to collect remote sensing data. Lectures also cover data acquisition and pre-processing, and introduce the main methods used for remote sensing analysis. The emphasis of the class is on raster spectral data (such as satellite imagery), but other types of remote sensing information - such as lidar, radar, and structure-from-motion (SfM) are also addressed in lectures and lab exercises.

Description

'Active learning' is encouraged in the course in both lecture and lab session. This is intended to encourage the development of spatial reasoning and the ability to interpret new information, to find and evaluate content, and to solve problems in the application of remote sensing concepts.

This requires the students to engage with each other and the course instructors while exploring the course topics through problem solving, group work, and interaction - to *learn how to learn* in the field of the mapping sciences.

Lab sessions focus on understanding how digital data can be translated into effective visualizations of the environment (image enhancement), on techniques for correcting problems with the imagery (image restoration), and on approaches for land cover mapping with remotely sensed imagery (image classification). Learning to navigate through the image processing

software and tools used for remote sensing will be an important part of each lab.

Both open-source (primarily QGIS, also GRASS 7.0 and Monteverdi 2) and commercial (ArcGIS Desktop) spatial analysis software is used in the course, reflecting the wide variety of tools available to process, analyse, and visualize remote sensing information.

Labs provide practical experience that is typical of what you will encounter on most any remote sensing project. Early labs focus on the basic structure of the software and characteristics of remote sensing data. Later labs introduce image enhancement and visualization techniques, techniques for adding geographical coordinates to images, data transformation approaches to extract specific types of information, and classification approaches for mapping land cover.

You are encouraged to collaborate on labs and help one another out, but do not copy each others' written answers. Lab questions and writeups are due electronically on Canvas, with your lab data stored in your SSIL userspace - if you are working with data stored elsewhere, let you lab instructor know.

Lectures cover the broad range of knowledge needed to understand and interpret remote sensing data including:

- the visual interpretation of remote sensing images;
- the electromagnetic spectrum and interactions between electromagnetic energy and matter (including atmospheric and surface effects);
- the varieties of remote sensing data and the basic concepts behind the devices used to record (and sometimes project) electromagnetic signals, and their respective advantages and disadvantages;
- the components of a digital image processing, including:
    - sources of image distortion, and techniques used for image restoration;
    - techniques for enhancing images to better visualize spectral signals and patterns;
    - the use of digital data for classification, mapping, and monitoring environmental processes and environmental change.
- sources of existing remote sensing imagery.

Workload and Grading

Tests and assignments are 50% of the grade, with three in-class quizzes and a take-home final. The test grade also includes group exercises during lecture time or individual take home exercises given out in lecture.

Labs make up the remaining 50% of the grade for undergraduates, and 45% of the grade for graduates. Laboratory sessions will be in SSIL, and usually some materials are due by the end of each lab. You are expected to attend all labs sessions - please make arrangements with your lab instructor if you cannot make a session. Labs must be turned by the time they are due for full credit.

Graduate students will produce a small final project with a short writeup or a research paper / annotated bibliography on a remote sensing topic that makes up 5% of their grade. The project is of the students own design, or the paper reviews research articles on a specific application topic (ideally related to the students graduate work), have at least 5 academic references, and follow standard formatting guidelines.

Course work outside of class includes readings and work on the materials assigned in lab, so you are expected to do work on labs outside of scheduled lab time.

Work load distribution over the term…

Lecture Attendance:	20 hours (20 x 1 hour meetings)
Lecture assignments:	25 hours (average)
Readings:	25 hours (@ 25-60 pages per week, average)
Lab Attendance:	20 hours (10 weeks X 2 hours per week)
Lab work - unsupervised:	30 hours (average)
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Total	120 hours (40 required attendance, 80 average remaining)

Late work policy

- Lecture and lab assignments: 10% off per day late
- In-class exams and assignments: make arrangements or zero if not taken on time.
- Final Exam and Final Lab 30% off per day late

Schedule and Readings

Text: *Introduction to Remote Sensing*, 5th Edition. Campbell and Wynne, 2011. Guilford.

Supplementary materials are linked to in lecture notes and lab materials.

readings are expected to be done by the day they are listed next to.

Day	Lecture (1-1:50)	Reading	Lab (2-3:50)
Week 1 M, Jan 4	**Meet in Villard, then walk to lab.** SSIL introduction; course introductory survey;	Remote Sensing Interactives	1. Introduction to SSIL; Remote Sensing Software and Data: Examples from Lane County, Oregon. *Lab introductory questions due by the end of lab.* *Writeup due by 1pm noon, Monday Jan 11 or Wednesday Jan 13.*
W, Jan 6	Visual interpretation; The RS 'system'; Introduction to EMR Bands; Exercise	Ch.1 - *History and Scope of Remote Sensing* *Ch. 5. Image Interpretation*	
Week 2 M, Jan 11	Electromagnetic Radiation / Interactions with the Atmosphere and surface	Ch.2 - *Electromagnetic Radiation*	2. Image type comparison, interpretation/display issues (Lane County, Oregon. Redmond, OR. Madison, Wi,) - *Lab introductory questions due by the end of lab.* *Writeup due by 1 pm, Monday Jan 25 or Wednesday Jan 27*
W, Jan 13	Mapping Cameras / Electro-optical scanning Digital Imagery;	Ch.4 - *Digital Imagery*	
Week 3 M, Jan 18	**Martin Luther King Day - No Class**		**No Lab**
W, Jan 20	**Quiz 1 - Remote Sensing Principles and Raster Digital Data**		*Optional lab*: work on lab 2 (M and W lab students welcome)
Week 4 M, Jan 25	Land Observation Satellites	Ch.6 - *Land Observation Satellites* (Ch.3 - *Mapping Cameras)* Get USGS username and password.	3. Spatial subsetting / Mosaicking /Filters and Indices (Dundee Hills, OR) *Lab question due by the end of lab.* *Writeup due by 1 pm, Monday Feb 1 or Wednesday Feb 3*
W, Jan 27	Image enhancements, Resolution,	Ch. 10 - *Image Resolution* Ch.11 - *Preprocessing (up to page 320)*	
Week 5 M, Feb 1	Digital Image Processing;	Ch.11 - *Preprocessing*	4. Image Interpretation and Enhancement (Sensor Comparison

	Geometric errors and corrections		- Thermal - Lidar?) - volcano ALI Lab question due by the end of lab. *Writeup due by 1 pm, Monday Feb 8 or Wednesday Feb 10*
W, Feb 3	Atmospheric corrections Spectral preprocessing	*Ch. 9 - Thermal Imagery*	
Week 6 M, Feb 8	Image Classification Introduction	Ch.12 - *Image Classification*	5. Image Classification (WA?) - unsupervised *Writeup due by 1 pm, Monday Feb 15 or Wednesday Feb 17*
W, Feb 10	Image classification	Ch.12 continued	
Week 7 M, Feb 15	**Quiz 2 - Image preprocessing and imaging platforms**		6. Image Classification (WA?) - supervised *Writeup due by 1 pm, Monday Feb 22 or Wednesday Feb 24*
W, Feb 17	Accuracy Assessment	*Ch. 13 - Field Data* *Ch. 14 - Accuracy Assessment*	
Week 8 M, Feb 22	Indices and spectral transformations	*Student choice from Ch. 17, 18, 19*	7. Change Detection (Bend area?) Landsat, Vegetation indices, PCA, & the Tasseled-Cap Transform *Writeup due by 1 pm, Monday Mar 9 or Wednesday Mar 9*
W, Feb 24	Change Detections	Ch. 16 - *Change Detection*	
Week 9 M, Feb 29	Active (and Fun!) Remote Sensing	*Ch. 8 - Lidar Data* *(Ch. 7 - Active Microwave)*	8. Lidar and other emerging RS. ***last lab due Fr, March 11!***
W, Mar 2	Student presentations from Ch. 17/18/19 and Lab 7		
Week 10 M, Mar 7	Student Presentations, Graduate Presentations		***Finish lab 7 and 8***
W, Mar 9	**Quiz 3 - Image classification and analysis (indices and transformations; change); Lidar...**		
Week 11 Tuesday, Mar 15	**Final Take-Home Due** 5pm Tuesday, March 15		

Software Used:

[OSGeo4W package (32-bit)]

- **QGIS 2.12.1 Lyon** (and raster analysis plug-ins)
    - Orfeo Toolbox; PKTools; Profile Tool; Temporal/Spatial Profile Tool; Semi-Automatic Classification Plugin
- **GRASS 7.0.2**

- **OpenEV**

Monteverdi 2 0.8 / Orfeo Toolbox

ArcGIS Desktop 10.3.1

- Image Analysis Window; Spatial Analyst Extension