**NRES 498/898: Python Programming in Remote Sensing of Natural and Water Resources**

3 credits/Spring 2019

**Classroom location:** East Campus. Hardin Hall 141 (Computer lab)

**Class Time:** 11:00 am – 1:50 pm on Thursdays

**Course Instructor:** Dr. Ayse Kilic

Professor in the School of Natural Resources and Dept. Civil Engineering

Office: 311 Hardin Hall. East Campus, UNL

Office Hours: MW from 1 pm to 3 pm, 311 Hardin Hall

**Phone:** (402) 417-2562 **Email:** akilic@unl.edu **Website**: http://snr.unl.edu/kilic/

**Additional Course Instructors:**

There will assistance from Mr. Philip Blankenau and Mr. Peter Revelle, SNR

**Textbook:** Geoprocessing with Python. Chris Garrard. 2016. ISBN 9781617292149 360 pages. $35 on Amazon.

**Pre-requisite:** NRES 312 or NRES 412 or NRES 418 or NRES 812 or NRES 818 or instructor permission.

**Course Description and Goals**

Introduction to programming in Python with applications in accessing, handling and processing satellite imagery for natural and water resources systems. Introduction to GDAL, OGR, numpy and other spatial libraries used with Python-based image processing and spatial data for stacking, mosaicking and processing images. Image sampling, statistical analyses and spatial and temporal aggregation with Python and GDAL using shapes and fields. Python/Javascript on Google Earth Engine and accessing Earth Engine from locally-based Python.

**Learning Outcomes**

Students will develop a working knowledge of programming in Python for image processing and developing scripts to access satellite imagery and supporting data from the web. Students will be familiarized with open-source spatial libraries on the web, including GDAL, and how to utilize these library tools for spatial processing. Students will learn where to find various types of satellite imagery from a variety of sources and how to automate their acquisition. Students will be introduced to Google Earth Engine and using Python/Javascript to perform cloud-based image and data processing.

**Outline of topics**

- Introduction to Programming in Python
- Folder and File handling and management
- Constructing Python scripts in ArcGIS (ArcPy) and conversion to Python
- Introduction to GDAL, OGR, numpy and similar spatial and science libraries on the web
- Basic principles of remote sensing including georegistration, coordinate systems, atmospheric correction, and biophysical parameters including vegetation indices
- Processing satellite images such as Landsat using GDAL and computer memory management
- Python scripting to acquire satellite images and products from national repositories (Landsat, VIIRS, MODIS, Sentinel 2, GOES, etc.)
- Using GDAL to stack, mosaic, and process images
- Image sampling, statistical analyses and spatial and temporal aggregation using shapes and fields
- Exploration of time series with Python and GDAL
- Python/Javascript on Google Earth Engine
- Accessing Earth Engine from locally-based Python
- Processing and use of thermal imagery
- Estimation and analysis of spatial evapotranspiration
- Cloud and shadow detection (from Landsat BQA bands, FMask, etc.);
- Buffering cloud masks

**Method of Evaluation**
Course grades will be based on a weighted average of results as follows:
1. Homework 60%
2. Class participation/interaction: 10%
3. Term Project: 30%

Letter grades will be assigned as follows:

A = 95 – 100%; A- = 90 – 95%

B+ = 87 – 90%; B = 83 – 87%; B- = 80 – 83%

C+ = 77 – 80%; C = 73 – 77%; C- = 70 – 73%; D = 60 – 70%; F < 60%

There will be no make-up or incomplete grades in this course. We reserve the right to drop an exercise with notice in advance.

**List of Assignments (70% of grade)**

- Basic Programming and Scripting in Python
- Folder and File handling and management
- Constructing Python scripts in ArcGIS (ArcPy) and conversion to Python
- Georegistration and coordinate systems for satellite imagery
- Accessing and Processing Landsat images using GDAL
- Using GDAL to stack, mosaic, and process images

- Basic Atmospheric correction and biophysical parameters
- Python scripting to acquire VIIRS, Sentinel 2 and MODIS satellite images and products from national repositories
- Image sampling, statistical analyses and spatial and temporal aggregation using shapes and fields
- Analysis and production of time series with Python and GDAL
- Python/Javascript on Google Earth Engine
- Basic Estimation and analysis of spatial evapotranspiration
- Cloud and shadow detection (from Landsat BQA bands, FMask, etc.) and Buffering cloud masks

**Final Exam- Term Project (30% of grade)**

The final exam is based on a term project. Term project has three parts (a) written python code, (b) written term paper report either pdf or word format, and (c) in-class presentation. The format and grading policy for your term project is based on (a) how well is code written (20%), (b) content of and presentation of materials in the term paper (5%), and (c) in class presentation (5%).

The purposes of the term project are:

1. To explore an aspect of development and use of Python programming for processing spatial data in natural and water resources that is of interest to you.
2. To provide experience in the formulation, execution and presentation of original research, including the proper documentation of a computer programming project.
3. To make an oral presentation during the last week of class and produce a report that will be informative to you and to your classmates. You need to submit your final examination report on the last day of the school.

**<u>Guidelines for Term Project</u>**

<u>Content of the programming code</u>

1. Correctness. Is the analysis and interpretation technically correct?
2. Is the code writing clear, concise and organized?
3. Substance. Is the analysis and interpretation sufficiently substantial that demonstrates some original thinking and application beyond what has been done in class exercises? The work done should be sufficient to address the objective or questions posed.
4. Understanding. Does the work presented show understanding of the problem being addressed and include an interpretation of what the results or outcomes mean in the context of the problem posed?

<u>Content of the term paper</u>

1. Writing. The report should include introduction, statement of objectives or problem, method, results, discussion, conclusion. These should be balanced, concise, and organized. The writing should be simple and direct, avoiding jargon to the extent possible.

2. Do not copy text directly from the web, help or a paper. That is plagiarism and is a serious academic offense. I want you to 'digest' the material and restate it in your own words. You can copy figures or equations from papers or the internet as long as you provide the citation for it (to give credit).
3. Use of spatial data. Does the work done use remote sensing and GIS for producing maps (nicely labeled and quantitatively annotated with scale, labeling and legend appropriate for the context), gathering and organizing the data and performing spatial analysis?
4. Visuals (Maps, Figures and Tables). Are the maps, figures and tables clearly presented with axes labeled, units given, and presented in the best way possible to support the analysis and interpretation?

<u>Presentation</u>

1. You will have **10 minutes** for your talk – 8 minutes for the presentation and 2 minute for answering questions. You must not go over time or you will be cut off
2. Don't spend too much time on the introduction, one or two slides is enough, and then get to the heart of what you want to say
3. Think of the **one concept** or image or idea that you want your audience to take away from your talk and arrange all your material around that
4. There is not time to say everything important, only what is **most important**
5. Use **pictures** and **diagrams** wherever possible, they are more effective than words on slides
6. For slides with just words on them
7. Have a maximum of **five** bulleted points per slide, four is better than five.
8. For each bulleted point, have a maximum of 10 words, preferably 5 or 6 words, **less is better** than more
9. Highlight in **color** the one or two key words in each bulleted phrase
10. Use large font size on all text and labels of graphics so that they can be viewed from the back of the class room.
11. Stay away from red fonts, symbols and lines, which do not project well, and especially reds and green colors that can not be distinguished by people with color blindness

**Remote Sensing Applications**

Applications will use the context of satellite-based image analysis for water resources systems and other natural resources systems and associated questions.

Contents and programming applications will include:

- land surface biophysical variables (vegetation indices, etc.)
- land use and vegetation classifications,
- processing and use of thermal imagery,
- estimation and analysis of spatial evapotranspiration,
- land surface energy balance budget and components (albedo, net radiation, ground heat flux, sensible heat flux),
- soil water content,
- vegetation phenologies,
- fusion of multiple satellite platforms
- approximate atmospheric corrections for when surface reflectance products are not available.

- Writing Python-GDAL scripts to
    - construct cloud and shadow masks (from the Landsat BQA bands, etc.);
    - buffer cloud masks;
    - identifying and correcting false positives;
    - construct composited images where cloud masked are filled from other acquisition dates.

**Course/Instructor Evaluation Plan**

Course/Instructor evaluation will be conducted according to the policies of university.

Students will receive an email with a link to the evaluation website. In addition, there is going to be a link to the evaluation website via blackboard.

I encourage students to speak to me on any problems related to the course during the semester.

**Students with Disabilities**

The University of Nebraska provides upon request appropriate adjustments for qualified students with disabilities. For more information, 132 Canfield Administration Building or contact the Office of the Dean of Students at 472-3787.

**Course Drop Policies**

Refer to university Course drop policies and dates at
http://law.unl.edu/academics/academic_calendar.shtml