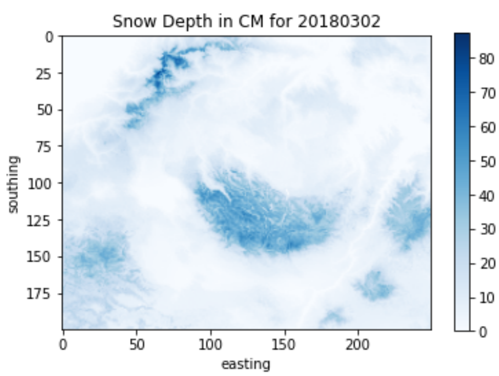
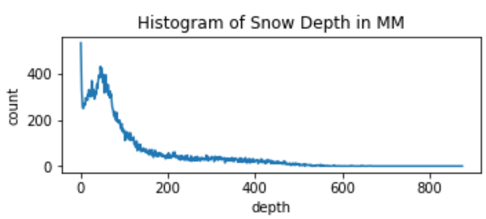
Geospatial Programming and Visualization with Python
Geog 4/591 - Spring 2018

Instructor: Dr. Nicholas Kohler (nicholas@uoregon.edu)
Lecture: Monday and Wednesday, 1 to 1:50 in 144 Hedco
Lab: Tuesdays, 9 to 10:50 or 11 to 1:50 in 445 McKenzie
Prerequisites: Geog 481 or Instructor's Consent.
No prior programming experience is required.

```
In [8]: ### now make a function to open the snowdepth for the date, filter no data values, a
        ### draws a plot of the snow depth, and a histogram of depth values
        def readsnow(dat_date):
            newtif = gdal.Open('us_ssmv11034tS__T0001TTNATS{}05HP001.bil'.format(dat_date))
            print('us_ssmv11034tS__T0001TTNATS{}05HP001.bil'.format(dat_date))

            tifArray = newtif.ReadAsArray()
            newMasked = np.ma.masked_where(tifArray == -9999, tifArray)
```





Course Description

This class introduces students to automated geospatial data collection, analysis, and visualization. Scripting languages and graphic modeling provide a means to efficiently collect and process geographic information, and have become crucial tools for scientists and businesses that use geospatial data.

This course explores the concepts underlying spatial data management, processing, and visualization using the open-source "Python" scripting language. The class will make students comfortable with basic concepts of geospatial data management and the automation of spatial analysis, and will teach them about the application of open-source tools for research and production purposes. Perhaps most important, the class is designed to foster the ability to continually learn, a necessary skill in the rapidly growing fields which are applying geospatial data science.

Learning Outcomes

The coursework should make students comfortable with geospatial data management, visualization, and processing, and confident in their ability to automate spatial analysis workflows.

In the class students will:

- Identify and manage appropriate data models to represent spatial features

- Analyse and visualize geospatial information
- gain experience writing Python scripts (to download, create, interact with and analyse geospatial data in ArcGIS and other software packages);
- understand the basic concepts behind object-oriented scripting and computing languages; and
- be able to create graphic models and custom tools for spatial analysis projects.

Course lectures cover the basic concepts behind modern scripting languages such as Python and R, introduce students to the paradigms of open-source software and reproducible science, and delve into the concepts underlying spatial data science. In class labs, students will gain hands-on familiarity with using Python to automate geospatial analysis tasks, using tools such as Arcpy, Geopandas, Numpy, and Matplotlib to process and visualize geospatial data.

Readings:

- ***Python Scripting for ArcGIS***, 2013. Paul A. Zandbergen
- ***Online readings*** linked in this syllabus, on Canvas, or in lecture notes and labs.

Student Engagement

How to learn in this class:

It is important that for this course that you 'learn how to learn' in the field of geospatial analysis, be able to solve and automate geographic problems, and critically evaluate the use of geospatial data and analysis techniques.

Do class assignments, including reading, on time, this will allow you to engage with your fellow students, the GE, and the lecturer. 'Active learning' is encouraged in the course in both lecture and lab session. 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 with each other. This helps to encourage the development of geospatial reasoning, the ability to interpret new information, to find and evaluate content, and to solve problems in the application of geospatial processing and spatial analysis.

Course work:

Course work outside of class includes readings and work on the materials assigned in lab. You are expected to do work on labs outside of scheduled lab time - this can be done in the SSIL facilities, the library Reed Room, or on your own computer (talk to the GTF or instructor for more information on getting the software used in lab for yourself)

Estimated undergraduate engagement distribution over the term

Lecture:	20 hours (20 x 1 hour meetings)
Lecture assignments:	20 hours (average)
Readings and materials:	25 hours (@ 15-40 pages per week, average)
Lab Attendance:	20 hours (10 weeks X 2 hours per week)
Lab work - unsupervised:	35 hours (average)

Total 120 hours (40 required attendance, 80 average remaining)

Additional engagement for graduate credit

Group meetings outside class time:	2 hours
Method examples and demonstrations:	14 hours
Annotated bibliography for final project:	4 hours
Final project:	20 hours

Additional Total 40 hours

Grading

Geog 461 requirements:

45% Individual and Group Labs and Projects
45% Exams and Lecture Assignments (Take Home or In-Class)
10% Final Project and Presentation

Geog 561 requirements:

40% Individual and Group Labs and Projects
45% Exams and Lecture Assignments (Take Home or In-Class)
10% Final Project, annotated bibliography, and Presentation
5% Methods bibliography and presentation

Course Schedule and Assignments

Lecture notes, class handouts and information, and grades will be available through the Canvas system located on the web at "canvas.uoregon.edu".

Lecture	Reading	Lab Exercise / Work
Week 1 **Overview of Geoscripting and**	**Ch. 1** “Introducing Python”; “Putting it all together” (PSU) ; **Ch. 3** “Using the Python Window”; **Ch. 4** “Learning Python	**Lab 1** - Introduction to Python with Geospatial Data:

Modeling M: 4-2 Why use programming for geospatial analysis?	Language Fundamentals" What is Python? ; A quick tour of Python ;	due on Canvas by 1pm the day of your lab, Week 2 (20 points) - Ex. 3 - Using the Python window" - Ex. 4 -Learning Python language Fundamentals
W: 4-4 Scripting with Python Basics - Commenting and Pseudocode	**Ch. 5** "Geoprocessing in ArcGIS" What is the Python window? ; Using the Python window ; Executing tools in the Python window ; Setting environments in the Python window ; Saving, loading, and recalling your work in the Python window ; Creating workflows using the Python window	
Week 2 **Creating and executing analysis models** M: 4-9 ArcGIS Geoprocessing and Python	**Ch. 5** "Geoprocessing using Python" What is ArcPy? ; Writing Python scripts ; Creating a new Python script ; Executing and debugging Python ; Setting breakpoints using Python ; Finding additional Python examples	**Lab 2 - Geoprocessing and basic data visualization** due Week 3 on Canvas . - Ex. 5 "Geoprocessing using Python" - Geospatial visualization exercise
W: 4-11 GIS programming	Python and Geoprocessing Basics	
Week 3 - Controlling geoprocessing workflows M: 4-16 Geoprocessing Loops and iterations	**Ch. 6** "Exploring spatial data" Conditionals; Iteration ; Lists Learn Python - Loops	**Lab 3 - Accessing data geospatial properties and visualizing basic distributions** - Ex. 6 "Exploring Spatial Data" due Week 4
W: 4-18 loops and iterations continued.	Make Feature Layer (Data Management); Make Table View (Data Management); Copy Features (Data Management); Save To Layer File (Data Management); Select Layer By Attribute (Data Management); Get Count (Data Management);	
Week 4 **Working with geospatial datasets** M: 4-23	**Exam 1 - Python Basics for GIS**	**Lab 4 - Ex. 7 "Manipulating Spatial Data"** due by 1:30pm the day of your lab, Week 5
W: 4-26	**Ch. 7** "Manipulating Spatial Data" Functions and modules ; Reading and parsing text ; Writing geometries ; Automation with batch files and scheduled tasks ; Running any tool in the box ; Working with map documents ; Limitations of Python scripting with ArcGIS What is a Python add-in?	
Week 5 **Understanding vector geometries** M: 4-30	**Ch. 8** "Working with Geometries"	**Lab 5 - Ex. 8 "Working with geometries"** Due by 1:30 pm the day of your lab, Week 6
W: 5-2	Accessing and editing vector geometries	

Week 6 **Classes and Functions / Raster properties and analysis** M: 5-7	**Ch. 9** “Working with Rasters”	**Lab 6 - Ex. 9 “Working with rasters”, Ex 12 “Creating Python functions and classes”** Due by 2:30 pm the day of your lab, Week 7
W: 5-9	**Ch. 12** “Creating Python functions and classes”	
Week 7 **Error handling and debugging** M: 5-14 Raster data	**Ch. 11.** “Debugging and Error Handling” *turn in project proposal*	**Lab 7 -Ex. 11 “Debugging and error handling”** Due by 1:30 pm the day of your lab, Week 8
W: 5-16 Creating functions		
Week 8 **Building custom tools** M: 5-21 Creating Tools	**Ch. 13** “Creating custom tools”; **Ch. 14** “Sharing tools”	**Final Project Begins** Final Project
W: 5-23	**Exam 2 in class**	
Week 9 **Project management** M: 5-28	***No Class - Memorial Day***	***Wednesday lab open to all students***
W: 5-30	project draft summaries due	
Week 10 **Moving forward with geospatial scripting** M: 6-4 Project presentations	Emerging trends in automated geospatial processing. Graduate presentations	**Final Project Draft Due**
W-6-6 Project presentations	Graduate presentations	Final Project
Week 11	**Take-Home Test and Final Project Due** 5pm Wednesday, June 13	**Final Project due**

Course Policies

Grading Rubric

A+ (98% and greater) Only used when a student's performance significantly exceeds all requirements and expectations for the class. Typically very few to no students receive this grade.
A (90% to <98%) Excellent grasp of material and strong performance across the board, or exceptional performance in one aspect of the course offsetting somewhat less strong performance in another. Typically no more than a quarter of the students in a class receive this grade, fewer in lower-division classes.
B (80% to <90%) Good grasp of material and good performance on most components of the course. Typically this is the most common grade.
C (70% to <80%) Satisfactory grasp of material and/or performance on significant aspects of the class.
D (60% to <70%) Subpar grasp of material and/or performance on significant aspects of the class.
F (<60%) Unacceptable grasp of material and/or performance on significant aspects of the class.

Late work

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

Expectations

Attendance is expected at all lectures and all the lab sessions (to which a student is assigned). Since the course is conducted with an emphasis on 'active learning', this requires that students be inclusive of other viewpoints, participate in group exercises inside and outside of class, and be considerate of different levels of knowledge or ways of learning.

Students are expected to follow the UO Student Conduct Code [link], particularly in regard to academic integrity, class attendance and participation, and in regards to plagiarism.

Do not plagiarize your work. Make sure that you give credit where credit is due.

Please visit the UO library guide on 'Citation and Plagiarism' for more details:
https://researchguides.uoregon.edu/citing-plagiarism/whycite

Accommodations

The University of Oregon provides individuals with disabilities reasonable accommodations to participate in educational programs, activities, and services. Students with disabilities requiring accommodations to participate in class activities or meet course requirements should first contact the Accessible Education Center (164 Oregon Hall, 346-1155), and then contact the instructor as soon as possible.

General Python Geospatial Resources:

- ***Suggested supporting materials:***
    - *A Python Primer for ArcGIS*, Jennings 2011
    - *GIS Tutorial for Python Scripting*, Allen 2014

Introductory programming with Python -
The Python Tutorial (2.7) ; The Python Tutorial (3) ; Python for non-programmers ; How to Think Like a Computer Scientist

GIS Programming and Automation Class - PSU
https://www.e-education.psu.edu/geog485/node/91 ; "Other Sources of Help"

Introduction to Python for Computational Science and Engineering
http://www.southampton.ac.uk/~fangohr/training/python/pdfs/Python-for-Computational-Science-and-Engineering.pdf

EU Python Course
https://www.python-course.eu/course.php

Other relevant books:

ArcPy and ArcGIS: Geospatial Analysis with Python 2015

Programming ArcGIS with Python Cookbook - Second Edition 2015