Advanced GIS: Geospatial Data Wrangling(with Python)
Geog 4/591 - Fall 2019

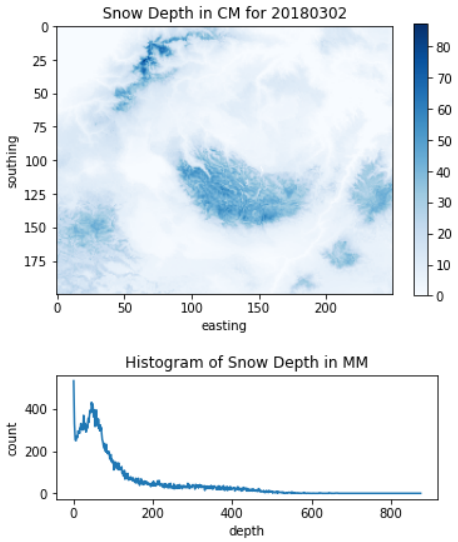
Lecture: 9:00 to 9:50, Tuesday and Thursday in 206 Condon **Lab:** Thursday, 12 to 1:50 in 442 McKenzie

Instructor: Dr. Nicholas Kohler (nicholas@uoregon.edu)
Office Hours: 10-11am Wednesdays in 106e Condon, or by appointment
GE: Riley Anderson (roa@uoregon.edu)
Office Hours: 1-2 pm Tuesdays in SSIL 445

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 both proprietary and 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:

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

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"

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

Grading

Geog 461 requirements:
40% Individual and Group Labs and Projects
45% Exams and Lecture Assignments (Take Home or In-Class)
15% Final Project and Presentation

Geog 561 requirements:

40% Individual and Group Labs and Projects
40% Exams and Lecture Assignments (Take Home or In-Class), Methods bibliography and presentation
20% Final Project (includes proposal, annotated bibliography or write-up, python script, and Presentation)

Course Schedule and Assignments - draft

Lecture	Reading	Lab Exercise / Work
Week 1 - Overview of Geospatial scripting and Modeling		
Tu - 10/1 Why use programming for geospatial analysis?		**Lab 1** - Introduction to Python with Geospatial Data: (20 points) - Ex. 3 - Using the Python window" - Ex. 4 -Learning Python language Fundamentals
Th - 10/3 Python Basics - Controlling geoprocessing workflows	What is Python? ; A quick tour of Python 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 Python and Geoprocessing Basics A quick tour of advanced techniques in ModelBuilder Conditionals; Iteration ; Lists Learn Python - Loops	
Week 2 - Creating and executing geospatial analysis models / Geospatial Data		
Tu - 10/8 Writing Scripts / Commenting and Pseudocode	What is ArcPy? ; Writing Python scripts ; Creating a new Python script ; Finding additional Python examples [Running any tool in the box ; Limitations of Python scripting with ArcGIS ; Automation with batch files and scheduled tasks]	**Lab 2 - Geoprocessing and basic data visualization** - Ex. 5 "Geoprocessing using Python" - Ex. 6 "Exploring Spatial Data" - Geopandas introduction due Week 3 on Canvas.
Th - 10/10 GIS programming	Tabular and Vector Data Structures: Introduction to PANDAS and GEOPANDAS What is a Python add-in? ; Types of Python Add-Ins Extending geoprocessing through Python modules Error handling with Python "Putting it all together" (PSU) ;Troubleshooting and getting help	
Week 3 - Working with geospatial datasets / Error Handling		
Tu - 10/15 Geoprocessing Loops and iterations	Describing data http://desktop.arcgis.com/en/arcmap/10.5/analyze/python/describing-data.htm Listing data http://desktop.arcgis.com/en/arcmap/10.5/analyze/python/listing-data.htm	**Lab 3 - Accessing geospatial properties and manipulating spatial data** - Ex. 7 "Manipulating

	Looking for data http://desktop.arcgis.com/en/arcmap/10.5/analyze/python/checking-for-existence.htm Using fields and indexes http://desktop.arcgis.com/en/arcmap/10.5/analyze/python/fields-and-indexes.htm "Manipulating Spatial Data" Accessing, Editing, Analysing Vector Attribute Tables Specifying a query in Python http://desktop.arcgis.com/en/arcmap/10.5/analyze/python/specifying-a-query.htm Accessing data using cursors http://desktop.arcgis.com/en/arcmap/10.5/analyze/python/data-access-using-cursors.htm	Spatial Data" -Ex. 11 "Debugging and error handling" - Geopandas and vector data
Th - 10/17	**Exam 1 - Python Basics and Geospatial Data**	
Week 4 - Vector Data Geometries		
Tu - 10/22	Accessing and editing vector geometries - **Ch. 8** "Working with Geometries" **Online Reading TBA** Writing geometries ; Reading and parsing text	**Lab 4 - Vector Geometries** - Ex. 8 "Working with geometries - Geopandas geometries
Th - 10/24 Mapping and Visualization Options	Grad Methods Presentations; "Working with Rasters" **Online Reading TBA**	
Week 5 - Raster Data		
Tu - 10/29		**Lab 5 - Raster Analysis** - Ex. 9 "Working with rasters" - GDAL and Rasterio exercise Due Week 6
Th - 10/31**: Raster properties and analysis**	Grad Methods Presentations	
Week 6 - Classes and Functions		
Tu - 11/5	**Online Reading TBA**	**Lab 6 - Functions and Classes** - Ex 12 "Creating Python functions and Classes"
Th - 11/7	Grad Methods Presentations Creating workflows using the Python window Functions and modules	

Week 7 - Data Visualization - ArcPy and Open Source		
Tu - 11/12	**Online Reading TBA** Mapping with ArcPy Working with map documents ;	**Lab 7 - Geospatial Data Visualization**
Th - 11/14	Grad Methods Presentations **Online Reading TBA**	
Week 8 - Network Analysis		
Tu - 11/19	Network Analysis Graphs - http://greenteapress.com/complexity/html/thinkcomplexity003.html	**Lab 8 - Final Project** Final Project
Th - 11/21	Grad Methods presentations, Test Review	
Week 9		
Tu - 11/26	**Exam 2 in class**	
Th - 11/28	***Thanksgiving Day - No Class***	
Week 10 - Moving forward with geospatial scripting		
Tu - 12/3 Project presentations	Emerging trends in automated geospatial processing. Graduate presentations	**Final Project Work**
Th - 12/5 Project presentations	Undergraduate / Graduate presentations	
Week 11	**Take-Home Test and Final Project Due** 8:00 Wednesday, December 11	**Final Project due**