# Advanced Geo-spatial Methods (URPL 6260)

**Draft Course Syllabus**

Instructor Austin Troy
Austin.troy@ucdenver.edu;
Office hours: by appointment on Zoom or in person until further notice; please email
Meets Tues 2-4:45

## Description:

This is an advanced GIS techniques course for students who already have a solid grounding in introductory GIS using ArcGIS Pro. While the methods learned apply to many fields and professions, this course has a particular emphasis on tools that are useful to urban planning. It consists of both lectures on theoretical topics in Geographic Information Science as well as a weekly computer lab covering GIS techniques. The course labs are divided into four thematic modules: 1) geoprocessing, 2) spatial statistics and pattern analysis, 3)automation, and 4) visualization. The first module builds on tools that students typically learn in their introductory GIS class; it teaches advanced methods for doing multi-layer analyses, including vector geoprocessing, raster overlay, viewshed, network analysis, and topology. The second addresses spatial statistics, including hotspot analysis, spatial clustering, sampling and regression. The third module teaches how to automate, simplify, and share complex and repetitive processes using model builder, iterators, and basic Python scripting. And the fourth module instructs students on topics including basic imagery classification, LiDAR processing and visualization, and 3D urban modeling with City Engine.

Throughout the semester students will also learn about theoretical topics in geo-spatial sciences, such as spatial reference systems. In addition to the weekly labs, students have a midterm exam and a final project that is meant to simulate a real-world GIS consulting report.

## Learning Objectives:

- Learn to integrate diverse geoprocessing skills to address complex geographic problems
- Learn introductory geo-statistical tools and concepts to look for statistically significant trends
- Learn how to save time and boost productivity by automating processes and models using Model Builder, including looping through processes using iterators, all while integrating diverse geoprocessing tools
- Learn how to increase workflow efficiencies using Python
- Learn how to turn LiDAR data sets into actionable information about built and natural landscapes.
- Learn basic functionality in City Engine to allow for development of simple urban models and do visualize of urban development scenarios.
- Learn the fundamentals of spatial references systems, including the meaning and integration of datums, spheroids, graticules, projections and plane coordinate systems to allow for skilled handling of raw data.
- Learn about key public data sources.

## Grading:

- Lab assignments: 50%
- Final project: 25% ( approx. 22% for paper, 2% for presentation, 1% for proposal)
- Exam: 22%

- Participation/ attendance: 3%

## Software, computers, storage and FAST consultants (new as of 2/2)

We will be using mainly ArcGIS Pro 3.4. Click here for download and installation instructions for Arc Pro. Note that older versions might be a little different. City Engine install instructions from last year are here. Check back for updates. Both of these programs have fairly robust hardware requirements, which you can check using the referenced documents. As for platforms, GIS software will not run on a Mac OS. If you own a Mac, you can still run ArcPro, however, by installing a dual Windows boot using platforms like BaseCamp, Parallels or VMWare Fusion. If you can't support ArcPro on your own computer, you'll have to remotely access one of the 42 FAST workstations available for Remote Desktop. This uses software called VMware Horizon, and more information on how to access this is available from the FAST consultants. Remote desktop instructions for PC are here and for Mac are here. The VMware troubleshooting guide is here.

You can email me at any time (please don't use Canvas Mail as it gets lost in my Clutter folder) with questions about the labs and I'll try to get back to you as soon as possible. Alternatively, you can also contact the consultants at the FAST who may be able to respond to you more quickly, although they may not know as much about the specific exercise. Any questions about software, hardware, ESRI licensing, and data storage should be directed to the FAST consultants at Fast@ucdenver.edu. They will write you back promptly. You can also schedule times with the consultants by going to this link: https://clas.ucdenver.edu/fast/geospatial-consultingLinks to an external site.. Feel free to reach out to either me or the consultants with questions about the assignments.

Each lab (see below) will require downloaded data available as zip files on Canvas. Some labs will have you download directly from the Internet.

As for storing your own files, the best approach is to save them to your personal hard drive if working on your own personal computer. If working on the FAST computers you can either save the data to a synced One Drive folder or to a thumb drive/ external hard drive. One Drive generally works, but the syncing can glitch once in a while. It is easier to work on a local drive with big data sets (later in the semester), so if you do decide not to use a synced One Drive folder when working on a FAST computer, I would suggest setting your working directory to something simple, like C:\Temp\lab1. When you're done for the day, then you can upload that to your One Drive account.

## Course Requirements

**Lab assignments:** these are weekly exercises conducted over the first 11 weeks. All are original and will be available as PDFs on Canvas. You may work alone on lab assignments or with a partner. However, if working with a partner, please try to ensure that each person participates in all steps of the lab. Lab data is available on the FAST data share drive, but assignment PDFs must be uploaded to Canvas (or published to ArcGIS Online if we can make that option work). They will be graded by our TA. All labs are due by the start of the following week's class unless otherwise noted on the syllabus. I will allow up to two late assignment submissions per semester with no credit taken away IF and ONLY IF you have a valid reason for not being able to turn in the assignment on time AND let me know you more than 48 hours before the due date. Typically I will allow late assignments to be turned in up to 5 days late. Keep in mind that there is a lab almost every week in this class, so if you turn in a lab late, it will make it that much more difficult to complete the lab the following week and the backlog can quickly cascade, so you

should avoid this option unless absolutely necessary. Homework assignments that are turned in late without a pre-arranged excuse will lose 0.5 points if turned in late but during the same calendar day and 1 additional point per day if turned in after that.

**Extra Credit assignments:** If you'd like to learn more and increase your homework score, the following extra credit assignments are available.

- Business Analyst Online
- Suitability Modeler (requires lab 2)
- Location Allocation (requires lab 3)
- Similarity (requires lab 4)
- Building creation with LiDAR (requires lab 10)
- LiDAR analysis in QT Modeler (requires lab 10)
- City Engine extras (requires lab 11)
- NEW: Arc Urban
- NEW: Web app query interface for ArcGIS Online

**Final Project**: this is a chance to utilize your GIS skills to an applied problem. These can be done in groups of up to three people. You can work on your own project or on one of several topics that I will present in class for which extensive data sets are available. We have several potential real-world clients for these projects this semester that I will outline later. Detailed guidelines will be on Canvas.

**Exam:** The **exam** is in the middle of the term will cover most of the topics from lecture and readings up to that point. A review will be provided in advance

**Attendance:** Students are requirement to **attend** class and **participate.** If you can't make it to class, please let me know by email at least by the Friday before. The first two unexcused absences will result in you losing half a percentage point each on your attendance grade. The next four will be one point each. Students are expected to do the reading before class too and come prepared with questions.

**Class structure:** Each class will be divided into sections. In most cases that will be 1) intro and logistics, 2) presentation, questions and discussion, and 3)working independently or in groups of two on labs. You can leave during part 3 to work on your own, but then you won't have me in the room to ask questions with an immediate response.

**Required readings:**
(Available at bookstore)

- Bolstad, P. *GIS fundamentals* . White Bear Lake, Mn: Eider Press. Seventh Edition ONLY (otherwise page numbers won't correspond). On schedule below, readings marked PB= Paul Bolstad
- several short PDFs on Canvas (see schedule)

## Academic Integrity:

Students must adhere to UCD's code on academic honesty which can be found at http://catalog.ucdenver.edu/content.php?catoid=6&navoid=530 (Links to an external site.)Links to an external site. Please take care to cite references correctly, use quotations appropriately and avoid plagiarism in doing your final project. Clear cases of plagiarism in the project will result in a zero. During

the midterm exam you are expected to using only your memory and avoid consulting any written materials of any kind.

## Schedule

Subject to change: please consult the syllabus on Canvas for updates

| Date | Topic | Lecture and assignment links (due next Tues) | Reading (readings due on day given below) |
|---|---|---|---|
| Part 1: Geoprocessing | | | |
| 21-Jan | Lab and lecture: Review of vector skills: Select by location and a vector geoprocessing site selection analysis | • Lab 1<br>• Lecture 1<br>• Data set | |
| 28-Jan | Lab and Lecture: Review of raster GIS skills: raster overlay site selection, viewshed, zonal statistics, conditional function | • Lab 2<br>• Lecture 2<br>• Data set | PB pp. 51-60; 435-460 |
| 4-Feb | Lab : Network analysis, including shortest path, drive time service areas, origin-destination matrices, nearest facility<br><br>Lecture : topology and network analysis | • Lab 3<br>• Lab 3 data<br>• Lecture 3<br>• Extra Credit topology lab | PB pp. 46-49; 410-415 |
| Part 2. Statistics and pattern analysis | | | |
| 11-Feb | Lab and Lecture: Statistical hot spots, clustering, autocorrelation, and spatially stratified sampling | • Lab 4<br>• Lecture 4<br>• Lab 4 data | • US DOJ: Mapping Crime, Understanding Hot Spots<br>• ESRI cluster tool reading<br>• Fortin and Dale |
| 18-Feb | Lab and Lecture: spatially adjusted regression | • Lab 5<br>• Lecture 5<br>• Lab 5 data | no reading |
| Part 3: Automation | | | |
| 25-Feb | Lab: Automation with Model Builder<br>Lecture: live demo of model builder by Austin (no PowerPoint) | • Lab 6<br>• **Project proposal due** | PB Ch 13<br>ESRI help part 1 and part 2 |
| 4-Mar | Lab: Integrating Model Builder with Iterators and Python 1<br>Lecture: Datums/ spheroids | • Lab 7<br>• Lab7.zip<br>• Lecture 6 | PB Chap 3 (pp 89-115) |
| 11-Mar | Lab: Integrating Model Builder with Iterators and Python 1<br>Lecture: Projections and Plane Coordinate Systems<br>Study guide for midterm | • Lab 8 *<br>• Lecture 7 | PB Chap 3 (116-134) |
| * you will have three weeks to turn in labs 7 and 8. You can decide when to turn each in during that period<br><br>Part 4: Visualization, imagery and 3 D | | | |

| | | | |
|---|---|---|---|
| 18-March | Lecture: terrain analysis and remote sensing<br>Lab: continue previous<br>Study session | • Lecture 8 | Skim PB Chapter 6 |
| 25-Mar | **Spring Break** | | |
| 1-Apr | Exam<br>Lab : image classification and intro 3D analysis and rendering | • Lab 9<br>• Lab9 data | |
| 8-Apr | Lecture: LiDAR<br>Lab: Arc GIS LiDAR processing and classification functions | • Lab 10<br>• Lecture 9 | PB 288-290, NOAA Intro to LiDAR, pp1-12 and 18-24 |
| 15-Apr | Lecture and lab: Urban 3D visualization with City Engine and discussion of projects | • Lab 11 | |
| Part 5: Projects | | | |
| 22-Apr | Review project guidelines and best practices, projects or extra credit assignment help | | |
| 30-Apr | Projects or extra credit assignment help | | |
| 6-May | Projects or extra credit assignment help in class (plus you can sign up for extra help sessions outside of class) | | |
| 13-May | Finals week: Presentations | | |