GEOG 493/593: Digital Terrain Analysis

CRN: 11798/11820, 4 credits
Course Webpage: http://web.pdx.edu/~jduh/courses/geog493f17/
(Or go to http://web.pdx.edu/~jduh/ and select "Courses-> GEOG 4/593 (F17)")

Instructor: Geoffrey Duh (jduh@pdx.edu), phone: 503-725-3159
Office hours: Tue, Thu 2:00 - 3:30 pm at CH424H
Lecture and lab hours: Tue, Thu 12:00 - 13:50 at CH469
Class Google group: https://groups.google.com/a/pdx.edu/d/forum/course-geog-4593-group
(**email**: course-geog-4593-group@pdx.edu)
D2L Daylight! Online Modules: https://d2l.pdx.edu/

Course Objectives (see the syllabus in pdf format)
This course focuses on the theory and methods of the generation, compilation, analysis, and applications of digital elevation data. Specific topics include GIS terrain data models, photogrammetry and LiDAR DEM processing, terrain surface modeling, digital terrain analysis, 3-D terrain visualization and animation, and watershed modeling. The course includes computer exercises in the generation and processing of DEM using GIS and image processing software packages such as ArcGIS 3D Analyst, and ENVI.

Text and Readings
There is no required textbook. Journal articles are available in pdf format and can be found at I:\Students\Instructors\Geoffrey_Duh\GEOG4593-DTA\Readings. See the Readings section for a list of weekly readings.
Software documents: There are online software documents that will be used for both the theoretical and practical components of the course. The instructor will provide access instructions in class.

Grading
The instructor will grade graduate and undergraduate students based on separate distribution curves. The components of a student's grade are:

Class Participation (10%)
Attendance to this course is mandatory. If you miss more than two class periods then you will be penalized five percent of your final grade per absence. You are expected to take part in the discussions and if you are not in class then you cannot. If you are repeatedly late you will be given an absence. The labs are due by Thursday before class the week after they are assigned (see the course schedule for the exact due dates). You can hand them in class or put them in the instructor's mailbox at CH424.

All students are required to select a topic from a list provided by the instructor (see the "Student Discussion Topics" table below) and give a 10 minutes presentation on that topic to the class. You must prepare a powerpoint presentation, 4 discussion/quiz questions and their answers. Students who are responsible for the week's topics must email the questions to the course mailing list (course-geog-4593-group@pdx.edu) and the questions and their answers to the instructor by 5pm the day before the class (i.e., on Monday); provide the powerpoint file to

the instructor at least 30 minutes before the class begins. The presentation should be mainly based on the assigned readings. I strongly encourage you to include additional relevant materials you find on the internet or from other references that might help students understand the topic.

Midterm exam (15%)
There will be one in-class, closed-book mid-term exam and no final exam. Unscheduled in-class quizzes will be administered without notifications. Results of these quizzes will be counted toward class participation.

Lab Assignments (40%)
You will do practical exercises on the computers. If you do not finish the labs during the assigned time periods (usually every Thursday) the lab also has open hours. The practical exercises provide a way to acquire skills using GIS software packages and to apply the course concepts to real data. Lab exercises are due by the beginning of the next exercise. All exercises require a significant amount of time to finish. Make sure you pace your lab exercises appropriately to prevent from turning them in late. Please refer to the course schedule for specific due dates of the lab exercises.

Final Project (35%)
A term project is required for all students. Students could form project groups (maximum 2 members per group) to investigate a particular research problem using the software packages that we use in class. The project should involve some types of digital terrain analysis. The deliverable is a digital copy of Powerpoint presentation that student groups will present to the class at the end of the term and a 250 words project abstract that provides a comprehensive description of the project. See this wiki page or the journal articles we read this term for examples of how to write an effective abstract. There are two stages to the project (their due dates are listed on the course schedule):

* Project proposal: Each project group will submit a one page project proposal. It should include a project title, a research question, a list of the required spatial and attribute databases, and a conceptual description of your methods. Here is a collection of several community-based GIS projects that might fit the scope of this course. Talk to the instructor if you are interested in working on the project on the list. Please make appointments with the instructor to discuss your proposal if you have any questions. Here is a list of criteria for reviewing a proposal. You can use the list as a guideline for preparing your proposal.
* Oral presentation: Includes the essential information described in the proposal, data sets used, the analyses performed, and display the maps and tabular output derived from the analyses (see presentation rubric). At the end of the term, submit the Powerpoint file and a 250 words project abstract. The abstract should also include a title, author(s) and their affiliation and contact information, and 5 to 7 keywords.

Course Evaluation
The university will process course evaluations on online. There will be no paper evaluation. Students will be notified via PSU email at the beginning of week 10. Those who do not respond receive reminder emails the following week and again the day before the evaluations close. Students must check their PSU email accounts to receive the link to online course evaluation.

Student Discussion Topics

Week	Tuesday	Presenters
2 Oct 3	* Basic aerial photography geometry * Determining the scale of a vertical aerial photograph * Relief displacement * Image parallax	- - - -
3 Oct 10	* Image resolution and scanning resolution * Coordinate systems in digital photogrammetry * GCP and tie points for performing aerial triangulation * Interior orientation and exterior orientation	- - - -
4 Oct 17	* Resolution of ALS * Lidar laser beam "returns" and point cloud * Lidar data attributes and LAS file format	- - - -
5 Oct 24	* Hydro-flattening	-
6 Oct 31	No discussion topics	
7 Nov 7	* Structure from Motion (SfM) * Unmanned Aerial Vehicle (UAV) / Unmanned Aircraft Systems (UAS)	- - -
8 Nov 14	* Filling depressions (sinks) in a DEM * Flow direction and flow accumulation * Deriving runoff characteristics in ArcGIS (Hydrological Modeling Flowchart)	- - -
9 Nov 21	* Watershed delineation: Stream burning * Watershed delineation: Normalized excavation * Watershed delineation: AGREE	- - -

Course Schedule

Week	Tuesday	Thursday
1 Sep 26, Sep 28	Course Overview & Digital Terrain Data Models (Weibel and Heller 1991) Slides * Naked Continent: See Antarctica De-Iced * 3D GIS - Making IT Work Harder than Ever	Lab 1. Digital Terrain Data Models (10 points - Due before class on Oct 5)
2 Oct 3, Oct 5	Photogrammetry 1 (Lillesand, Kiefer, and Chipman. pp. 146-165 in 6th edition) Slides	Lab 2. Digital Photogrammetry: Image Registration & DEM Extraction (20 points - Due before class on Oct 19)
3 Oct 10, Oct 12	Photogrammetry 2 (Lillesand, Kiefer, and Chipman. pp. 165-181 in 6th edition and ERDAS Field Guide pp 595-633) Slides	Continue Lab 2.
4 Oct 17, Oct 19	LiDAR (Gatziolis & Andersen 2008) Slides	Lab 3a. LiDAR Data Processing Part I (10 points - Due before class on Oct 26)
5 Oct 24, Oct 26	Project Proposal Due (email to instructor before class) LiDAR Applications (USGS 2010) Working with Lidar Data in ArcGIS (link)	Lab 3b. LiDAR Data Processing Part II (10 points - Due before class on Nov 2)
6 Oct 31, Nov 2	Midterm Exam ESRI online course - Surface Interpolation (see D2L Week 6)	Lab 4. Surface Interpolation (10 points - Due before class on Nov 9)
7 Nov 7, Nov 9	Structure from Motion (SfM) & UAV/UAS-Based Photogrammetry Slides ESRI online course: Derived surfaces and Viewsheds (see D2L week 7)	Class Mannequin Challenge Exercise (MannequinChallenge)
8 Nov 14, Nov 16	Watershed delineation methods (Jenson and Dominque 1988) Slides	Lab 5. Watershed Delineation and Terrain Descriptions (20 points - Due before class on **Nov 28**)
9 Nov 21	Advanced Watershed delineation methods (Baker et al. 2006) Slides	Thanksgiving - University Closed
10 Nov 28, Nov 30	ESRI online course - 3D Building Modeling (see D2L week 10) Final project assistance	Course summary/ Final project assistance Final presentation
Dec 7 (Thursday)	Final Presentation & Project Deliverables Due Final presentation (**10:15 ~ 13:00 at CH469**)	

Readings:

Week 1:
  * Weibel, R., and Heller, M. 1991. Chapter 19: Digital Terrain Modelling. In Goodchild, M. F. and Rhind, D., eds., *Geographic Information Systems, Principles and Applications*. New York: Taylor and Francis.

Week 2:
  * Lillesand, T., Kiefer, R. W., and Chipman, J. 2008. *Remote Sensing and Image Interpretation*. 6th Edition. New York: John Wiley and Sons, 123-146.
  * Lillesand, T., Kiefer, R. W., and Chipman, J. 2008. *Remote Sensing and Image Interpretation*. 6th Edition. New York: John Wiley and Sons, 146-165.

Week 3:
  * Lillesand, T., Kiefer, R. W., and Chipman, J. 2008. *Remote Sensing and Image Interpretation*. 6th Edition. New York: John Wiley and Sons, 165-181.
  * ERDAS 2010. Photogrammetric Concepts. *ERDAS Field Guide*. 595-633.

Week 4:
  * Gatziolis, D. and Andersen, H-E. 2008. *Guide to LIDAR Data Acquisition and Processing for the Forests of the Pacific Northwest*. United States Department of Agriculture Forest Service Pacific Northwest Research Station General Technical Report PNW-GTR-768.

Week 5:
  * USGS. 2014. *U.S. Geological Survey National Geospatial Program Lidar Base Specification Version 1.2*. https://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf

Week 6:
  * ESRI Virtual Campus course: Introduction to Surface Modeling Using ArcGIS (see D2L week 6 instructions)

Week 7:
  * Liang, X., Wang, Y., Jaakkola, A., et al. 2015. Forest Data Collection Using Terrestrial Image-Based Point Clouds From a Handheld Camera Compared to Terrestrial and Personal Laser Scanning. IEEE Transactions on Geoscience and Remote Sensing, 53(9): 5117-5132.
  * Unmanned aerial vehicle on Wikipedia, https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle
  * ESRI Virtual Campus course: Deriving Rasters for Terrain Analysis Using ArcGIS (see D2L week 7 instructions)

Week 8:
  * Jenson, S. K. and Dominque, J. O. 1988. Extracting topographic structure from digital elevation data for geographic information system analysis. *Photogrammetric Engineering & Remote Sensing*, 54(11): 1593-1600.

Week 9:
  * Baker, M. E., Weller, D. E., and Jordan, T. E. 2006. Comparison of automated watershed delineations: Effects on land cover areas, percentages, and relationships to nutrient discharge. *Photogrammetric Engineering & Remote Sensing*, 72(2): 159-168.

Week 10:
  * ESRI Virtual Campus course (see D2L week 10 instructions)

http://web.pdx.edu/~jduh/courses/faq/Academic_Guidelines.htm

PSU values diversity and inclusion; we are committed to fostering mutual respect and full participation for all students. My goal is to create a learning environment that is safe, equitable, useable, inclusive, and welcoming.

Title IX Reporting Obligations
As an instructor, one of my responsibilities is to help create a safe learning environment for my students and for the campus as a whole. As a member of the university community, I have the responsibility to report any instances of sexual harassment, sexual violence and/or other forms of prohibited discrimination. If you would rather share information about sexual harassment, sexual violence or discrimination to a confidential employee who does not have this reporting responsibility, you can find a list of those individuals. For more information about Title IX please complete the required student module Creating a Safe Campus in your D2L.

Access and Inclusion for Students
If any aspects of instruction or course design result in barriers to your inclusion or learning, please notify me. The Disability Resource Center (DRC) provides reasonable accommodations for students who encounter barriers in the learning environment.

If you have, or think you may have, a disability that may affect your work in this class and feel you need accommodations, contact the Disability Resource Center to schedule an appointment and initiate a conversation about reasonable accommodations. The DRC is located in 116 Smith Memorial Student Union, 503-725-4150, drc@pdx.edu, https://www.pdx.edu/drc.

* If you already have accommodations, please contact me to make sure that I have received a faculty notification letter and discuss your accommodations.
* Students who need accommodations for tests and quizzes are expected to schedule their tests to overlap with the time the class is taking the test.
* Please be aware that the accessible tables or chairs in the room should remain available for students who find that standard classroom seating is not useable.
* For information about emergency preparedness, please go to the Fire and Life Safety webpage(https://www.pdx.edu/environmental-health-safety/fire-and-life-safety) for information.

Policy on Academic Honesty
Any type of academically and ethically dishonest work (plagiarism, copying someone else's work, etc.) may result in an automatic "F" for the assignment and, when appropriate, a report filed with the Office of Student Affairs. The PSU Bulletin includes the following statement on Academic Honesty: "The Student Conduct Code, which applies to all students, prohibits all forms of academic cheating, fraud, and dishonesty. These acts include, but are not limited to, plagiarism, buying and selling of course assignments and research papers, performing academic assignments including tests and examinations for other persons, unauthorized disclosure and receipt academic information, and other practices commonly understood to be academically dishonest." A digital copy of the PSU Bulletin is available at: https://www.pdx.edu/academic-affairs/psu-bulletin.