GEOG 493/593: Digital Terrain Analysis

(CRN: 11516/11538, 4 credits)

Course Webpage: http://web.pdx.edu/~jduh/courses/geog493f15/
(Or go to http://web.pdx.edu/~jduh/ and select "Courses-> GEOG 4/593 (F15)")

Instructors: Geoffrey Duh (jduh@pdx.edu),
Office: CH 424H Ph: 503-725-3159 Office hours: Tue, Thu 14:00-15:30
Course emailing list: digitalterrain@lists.pdx.edu
Lecture and Lab: Tue, Thu 12:00-13:50 at CH469
Pre-course survey: Click here to begin.

Course Objectives

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 including ArcGIS 3D Analyst, ESRI CityEngine, and ENVI.

Text and Readings

Required: No required textbook.
Articles: (pdf in I**:\Students\Instructors\Geoffrey_Duh\GEOG4593\Readings** folder.)
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 %
Midterm	15 %
Lab Assignments	40 %
Project	35 %

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. PLEASE DO NOT MISS CLASS. 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 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 put additional relevant materials you find on the internet or from other references that might help students understand the topic.

Exams (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 Component (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.

Project Component (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. Each project group must submit a final paper that describes the project in a publishable style/format (see guidelines here). 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 spatial and attribute databases you will use, and a conceptual description of the methods you will use. 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).

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.

Click here for the information on the requests for academic accommodation and the policy on academic honesty.

Student Discussion Topics

Week	Tuesday	Presenters
2 Oct 6	* Basic aerial photography geometry * Determining the scale of a vertical aerial photograph * Relief displacement * Image parallax	- - -
3 Oct 13	* 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 20	* Components of Airborne Laser Scanning (ALS) systems * Resolutions of ALS * Lidar laser beam "returns" and point cloud * Lidar data attributes and LAS file format	- - - -
5 Oct 27	* Hydro-flattening	-
6 Nov 3	No discussion topics	-
7 Nov 10	* Structure from Motion (SfM) * Unmanned Aerial Vehicle (UAV) / Unmanned Aircraft Systems (UAS) * UAV/UAS applications	-
8 Nov 17	* Filling depressions (sinks) in a DEM * Flow direction * Flow accumulation * Deriving runoff characteristics in ArcGIS (Hydrological Modeling Flowchart)	- - -
9 Nov 24	* Watershed delineation: Stream burning * Watershed delineation: Normalized excavation * Watershed delineation: AGREE	- - -

Course Schedule

Week	Tuesday	Thursday
1 Sep 29, Oct 1	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 by noon Oct 8)
2 Oct 6, Oct 8	Photogrammetry 1 (Lillesand, Kiefer, and Chipman. pp. 146-165 in 6th edition) Slides	Lab 2. Digital Photogrammetry: Image Registration & DEM Extraction (20 points - Due by noon Oct 22)
3 Oct 13, Oct 15	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 20, Oct 22	LiDAR (Gatziolis & Andersen 2008)	Lab 3a. LiDAR Data Processing Part I (10 points - Due by noon Oct 29)
5 Oct 27, Oct 29	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 by noon Nov 5)
6 Nov 3, Nov 5	Midterm Exam ESRI online course - Surface Interpolation (see D2L Week 6)	Lab 4. Surface Interpolation (10 points - Due by noon Nov 12)
7 Nov 10, Nov 12	Structure from Motion (SfM) & UAV/UAS-Based Photogrammetry ESRI online course: Derived surfaces and Viewsheds (see D2L week 7)	Lab 5. Terrain visualization (10 points - Due by noon Nov 19)
8 Nov 17, Nov 19	Watershed delineation methods (Jenson and Dominque 1988)	Lab 6. Watershed Delineation and Terrain Descriptions (20 points - Due **by noon December 3**)
9 Nov 24, Nov 26	Advanced Watershed delineation methods (Baker et al. 2006)	Thanksgiving - University Closed
10 Dec 1, Dec 3	ESRI online course - 3D Building Modeling (see D2L week 10) Final project assistance	Course summary/ Final project assistance Final presentation
Dec 10 (Thu)	Final Presentation & Project Deliverables Due Final presentation (**10:15 ~ 13:00 at CH469**)	

Readings:

The readings PDF files can be found at:
I:\Students\Instructors\Geoffrey_Duh\GEOG4593\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, 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. 2010. *U.S. Geological Survey National Geospatial Program Lidar Guidelines and Base Specification Version 13 - ILMF*. http://lidar.cr.usgs.gov/USGS-NGP Lidar Guidelines and Base Specification v13(ILMF).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: Modeling a City Using ESRI CityEngine (see D2L week 10 instructions)