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GGS 650 DL1

Introduction to GIS Programming and Algorithms

1. General Information

Instructor:	Dr. Andreas Züfle
Where/When:	Online
Course Website:	Blackboard
Course Forum:	Blackboard
Credits:	3.0 Credits
Prerequisites:	None
Office:	Room 2215, Exploratory Hall
Email:	azufle@gmu.edu
Phone:	703-993-5866
Office Hours:	Thursday 4:30-6pm

2. Course Description

An algorithm formalizes a solution to a problem. In this course, we will look a variety of algorithms for different GIS problems, such as testing whether two line-segments intersect, testing whether a given point is inside a given polygon, and computing the convex hull of a set of points. Algorithms will be implemented using the programming language Python, for which an introduction will be given at the beginning of the course.
In the first part of the course, basic GIS algorithms will be taught and implemented. A midterm exam will require the understanding of basic algorithms and the ability of express basic algorithms in Python.
In the second part of the course, teams of students (supervised by the instructor) will work on implementing algorithms for more advanced problems, such as finding the shortest path in a spatial network, matching a trajectory to a spatial network, and efficiently finding the nearest neighbors of a point. Each group will implement their algorithm in Python, and present a demonstration of their algorithm and implementation.

3. Learning Outcomes

In this course you will learn to develop Python programs to solve geospatial problems. More specifically, you will:

- design and develop algorithms to solve spatial problems
- develop fundamental GIS programming skills
- apply programming techniques and algorithms in hypothetical and real world data processing tasks
- identify and use libraries for manipulating geospatial data
- employ Python to implement spatial computational solutions and applications
- use open source environments to implement geospatial solutions and applications

4. Format

The course will be taught as a combination of lectures and tutorials.

5. Textbooks

No required textbook.

Recommended textbook: [Ningchuan Xiao. GIS Algorithms. SAGE Advances in Geographic Information Science and Technology Series. ISBN-13: 978-1446274323]

Links to be used:

- Python Tutorial https://docs.python.org/3/tutorial/ (Python 3.7)
- Another Python Tutorial http://www.learnpython.org/
- Another Python Tutorial https://www.w3schools.com/python/
- Python Library https://docs.python.org/3/library/
- Shapely Package http://toblerity.org/shapely/index.html
- Python Shapefile Library http://code.google.com/p/pyshp/
- Numpy: www.numpy.org

6. Technology Requirements Hardware

You will need access to a Windows or Macintosh computer with at least 2 GB of RAM and to a fast, reliable broadband Internet connection (e.g., cable, DSL).

For the amount of computer hard disk space required to take an online course, consider and allow for the space needed to: 1) install the required and recommended software and, 2) save your course assignments.

Software

You will need:

- A Blackboard supported web browser (See Blackboard Support for supported web browsers)
- Blackboard Collaborate (Select Tools from the Blackboard Course Menu, then select "Blackboard Collaborate")
- Adobe Acrobat Reader (free download)
- PDF Creator - An open source PDF printer (free download)
- Open Source software and libraries including Python, GDAL/OGR, Mapnik, Shapely, QGIS

7. Course Format

The course will be taught as a combination of modules, topic/problem oriented discussion, and tutorials based on independent reading and class discussion.

Each module includes the material of one week. The course follows a weekly schedule:

- Thursday, 0:01am: Weekly module available
- Tuesday: (6-7pm) Collaborate session to discuss problems, issues (see link below)
- Wednesday (11:59pm): lab submission deadline
- All the time: Forum for questions, problems, discussions

8. Course outline (tentative)

In this course we will cover the following topics (please note that the topics and their order are subjected to change at the discretion of the instructor, any changes will be announced on Blackboard in time):

Date	Week #	Topic	Assignment
8/30-09/05	1	Course Overview Introduction to Algorithms	
09/06-09/12	2	Programming, algorithms and GIS	Hello World
09/13-09/19	3	Control Flow and Functions Basic Geo Types and Spatial Calculations	Use of control flow and functions
09/20-09/26	4	Object Oriented Programming in Python	Working with Geo-Objects
09/27-10/03	5	Geometric Algorithms Part I	Line Intersection Tests, Point in Polygon Tests
10/04-10/10	6	Geometric Algorithms Part II	Sweep Line Algorithms, Convex Hull
10/11-10/17	7	Spatial Indexing	Quad Tree, R-Tree
10/18-10/24	8	Midterm, Project Introduction	
10/25-10/31	9	Project Assignment Geo Data formats - Shapefiles	Research Poster
11/01-11/07	10	(No material this week. Instructor out of town.)	Research Poster (cont.)
11/08-11/14	11	Project Discussions (cont.) Geospatial development Manipulating vector data	GIS Day!
11/15-11/20	12	Project Discussions (cont.) Spatial Query Processing	Research Project Paper
11/21-11/28		No class – Thanksgiving Recess	
11/28-12/05	13	Final Project Presentations	Research Project Paper (cont.)
12/12-12/19	14	Final Project Presentations (cont.)	

9. Course website - Online Communication

This course has a Blackboard website which will provide you a single portal to obtain lecture notes, retrieve assignment data, review links to additional materials and receive special announcements.

Blackboard will be the main nexus of communication and will contain all material relevant for this course. Any course-relevant information that I disclose outside of Blackboard (for example, questions about the midterm exam asked during my office hours), will be added to the Blackboard forum.

10. Grades

Each assignment and written exam will be given a numerical grade on a 0-100 scale. Some assignments may include bonus tasks. At the end of the term all the marks will be totaled as a weighted average according to the following weights:

Intermediate assignments	**30%**
Midterm Exam	**30%**
Final Project	**40%**

Final grades at the end of the course will be assigned using **ONLY absolute achievements** not considering relative standing in the class.

11. Exams

The course includes a mandatory written mid-term exam. The material covered in the exams will be announced in class. A student who cannot write a course examination or complete a course assignment because of an incapacitating illness, severe domestic affliction or other compelling reasons can apply for extension of time to complete an assignment.

12. Assignments:

The course will include several written assignments on selected topics from the material covered in class and in the assigned reading. Assignments may include the writing of algorithms, in a programming language of choice of the student. Choice of programming language is subject to permission of the instructor. Common high-level languages such as Java, Python and C++ will be permitted.

Assignments should be done **through the Blackboard course website**.

Please note: Assignments should be submitted only through the Assignment submission section of the Blackboard system - DO NOT email assignments directly to the instructor.

Late papers submission:

Papers submitted **after the due date will not be accepted**. Exceptions to this policy may be made given serious circumstances at the discretion of the Instructor.

Please note: Deferral of term work is a privilege and not a right; there is no guarantee that a deferral will be granted. Please make sure you notify the instructor as soon as you know a deferral is required.

General guidelines for ASSIGNMENT preparation and submission

a. Grades of assignments will be based on:

- **Academic merit** of your answers.
- **Conciseness** and **completeness** of your answers. Please write to the point and explicitly address the question or task. Avoid using unnecessary graphics (figures, tables, graphs etc.) unless they serve a specific purpose. Make sure to use captions and to refer to the graphics you include in your written answer. Graphics without any reference or accompanying explanation will be disregarded.
- **Organization** and **presentation**. Remember that your assignment report is a reflection of your thinking and learning process. Please organize your report in a logical fashion so that your answers could be easily identified. A general format for your presentation should, as a minimum, include the following components: (1) Question number, (2) Your written answer and/or description and discussion of your results, and (3) Visualization of your results, e.g. images, graphs, tables, as necessary.

b. Please remember that your assignment is a **professional document**, and should therefore be formatted and constructed accordingly. All assignments are to be typed. Hand-written assignments will not be accepted.

c. Submission of a hardcopy will be made in class; submission of a softcopy will be made through Blackboard.

d. The electronic submission of your assignment report has to be in **PDF format**.

e. If more than one file is submitted, you may submit a single **ZIP** file containing all the assignment files.

f. Each assignment submission should include a cover page with the following information: assignment title, assignment number, student name, and submission date.

g. Please make sure you have a backup of all the materials you submit.

13. Practice

In addition to graded assignment, the course further includes practice assignments, which are not to be delivered or graded. These practice assignments are optional and purely for fun. Some of these will be of higher difficulty, to keep students engaged that are already adept at programming in Python.
While not graded, I will give feedback on and discuss these assignments. The assignments may lead to potential programming projects in the second half of the course.

14. Project

The course includes a project addressing a GIS problem to be addressed with Python programming and the selected open source GIS tools.

The project's deliverable will consist of (i) a written report, (ii) a software demonstrator and (iii) an in e-class presentation of the project results incl. a live demonstration. The specific format and timing of the project will be discussed in class.

The project will be graded based on the following criteria.

- **Academic merit** of your project
- **Quality of the written report.** The project results need to be communicated in a written report. Please remember that your report is a professional document, and should therefore be formatted and constructed accordingly. A template will be made available. Submission of a hardcopy of the report will be made in class; submission of a softcopy (in PDF) will be made through Blackboard. A brief introduction to scientific writing in LaTeX will be given in class.
- **Quality of the demonstrator** as assessed by the instructor and fellow students during the presentation of the project.
- **Quality of the presentations** of the project results as assessed by the instructor and fellow students. Students will be required to present their results in-class. The presentation will include a demonstration of the developed system.

15. Student Expectations:

- **Academic Integrity:** Students must be responsible for their own work, and students and faculty must take on the responsibility of dealing explicitly with violations. The tenet must be a foundation of our university culture. [See http://academicintegrity.gmu.edu/distance].
- **Honor Code:** Students must adhere to the guidelines of the George Mason University Honor Code [See http://oai.gmu.edu/the-mason-honor-code/].
- **MasonLive/Email (GMU Email):** Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students solely through their Mason email account.
  [See https://masonlivelogin.gmu.edu].
- **Patriot Pass:** Once you sign up for your Patriot Pass, your passwords will be synchronized, and you will use your Patriot Pass username and password to log in to the following systems: Blackboard, University

Libraries, MasonLive, myMason, Patriot Web, Virtual Computing Lab, and WEMS. [See https://password.gmu.edu/index.jsp].

- **University Policies:** Students must follow the university policies. [See http://universitypolicy.gmu.edu].Responsible Use of Computing - Students must follow the university policy for Responsible Use of Computing. [See http://universitypolicy.gmu.edu/policies/responsible-use-of-computing].
- **University Calendar:** Details regarding the current Academic Calendar. [See http://registrar.gmu.edu/calendars/index.html].
- **Students with Disabilities:** Students with disabilities who seek accommodations in a course must be registered with the George Mason University Office of Disability Services (ODS) and inform their instructor, in writing, at the beginning of the semester [See http://ods.gmu.edu].
- Students are expected to follow courteous Internet etiquette at all times; see http://www.albion.com/netiquette/corerules.html for more information regarding these expectations.

2. Student Services:

- **University Libraries:** University Libraries provides resources for distance students. [See http://library.gmu.edu/distance and http://infoguides.gmu.edu/distance_students].
- **Writing Center:** The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing. [See http://writingcenter.gmu.edu]. You can now sign up for an Online Writing Lab (OWL) session just like you sign up for a face-to-face session in the Writing Center, which means YOU set the date and time of the appointment! Learn more about the Online Writing Lab (OWL).
- **Counseling and Psychological Services:** The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance [See http://caps.gmu.edu].
- **Family Educational Rights and Privacy Act (FERPA):** The Family Educational Rights and Privacy Act of 1974 (FERPA), also known as the "Buckley Amendment," is a federal law that gives protection to student educational records and provides students with certain rights. [See http://registrar.gmu.edu/privacy].

Disclaimer: Any typographical errors in this Course Outline are subject to change and will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported by the instructor.

Note: Recording of any kind (e.g., audio, video), reuse or remix of course materials, and further dissemination of the course content is not permitted unless prior written consent of the professor and George Mason University has been given or if recording is part of an approved accommodation plan.ecording is permitted only with the prior written consent of the professor or if recording is part of an approved accommodation plan.