Advanced GIS Analysis (Geog409g)

COURSE SYLLABUS

Course instructor (developer): ***Dr. Yongxin Deng***
Department of Geography, Western Illinois University

HIGHLIGHTS

The course will:

- Train students, both undergraduates and graduates, to become qualified GIS analysts and modelers.
- Expose to students a complete range of GIS problem-solving and analytical issues.
- Guide students to develop GIS skills necessary for diverse applications.
- Provide substantial learning opportunities including (in-class and recorded) lectures, readings, labs, course project, exercises, (online) class discussions, student presentations, and GIS project reviews.

The course is:

- A core course of the WIU GIS curriculum, which leads to multiple graduate and undergraduate degrees (and certificate).
- Both an online and an irregular (on WIU QC campus) course with flexible schedules and options.
- Taught by an experienced GIS professor/researcher.

INSTRUCTOR INFORMATION

Yongxin Deng, Ph.D.
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Office Hours: Arranged
GIS teaching experience: 12 years
GIS research experience: 17 years
Google Scholar Profile: https://scholar.google.com/citations?user=nbK15WMAAAAJ&hl=en&oi=ao
Sample GEOG409 collaborative research: http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-15-0141.1

ROUGH OUTLINE AND KEY THEMES

- **Module I** (Weeks 1–3): Spatial concepts, GIS modeling overview, and evaluation of analysis cases;
- **Module II** (Weeks 4–10): GIS ontologies, complications in GIS representation, data evaluation, and data processing;
- **Module III** (Weeks 10–14): Common GIS analytical approaches, methods, tools, and complications;
- **Module IV** (Week 15): Justification of the GIS analytical procedure.

COURSE DESCRIPTION AND OBJECTIVES

This course provides an opportunity for students to develop a solid understanding of advanced theories and analytical methods in Geographic Information Science. Students are also expected to strengthen their GIS skills through hands-on labs, exercises, and course projects. Putting these two aspects together, students of this course should measure their accomplishments in terms of an overall growth and maturity in modeling/analytical skills and problem-solving abilities using GIS. Successful completion of this course should mean that you have become a qualified GIS analyst.

Students will participate in the following four groups of course activities.

- Complete reading assignments in a timely manner, which is particularly important for you to learn to use GIS correctly and efficiently, or to find the "*best available*" GIS solution. If you have trouble understanding a particular part of the readings, you should find extra, usually more basic reading materials (such as previous textbooks or other sources like the internet) to assist your understanding.
- Follow the progress of lectures and fully understand the lectures. The lectures will focus on interpretation and evaluation of key GIS issues, possibly using materials and ideas of extensive sources much beyond the textbook and other reading materials. Lectures do not necessarily repeat the reading assignments (or Powerpoint slides), but will expose various GIS analytical cases, problems, solutions, and experiences to students. Thus a key role of the GIS lectures is to "*open GIS windows one after another*" for students to look beyond. You need to review after each lecture and devise a proactive study plan to make satisfactory progresses.
- Complete all labs and other exercises independently. Given the fact that this is an upper-/graduate-level GIS course, the lab exercises will be assigned as a series of mini-projects, with minimum step-by-step instructions. It is important that you, as a future GIS specialist, learn quickly to control the GIS process, to handle regular GIS tasks, and to solve new GIS problems. This means you may have to figure out or identify a (correct) solution if no solution is ready for you to adopt. Instructor help is nonetheless ready for you.
- Complete a fairly sophisticated GIS project that can satisfy all four (equally weighted) evaluation criteria that correspond to four stages of project development: representation of a real-world problem, GIS data handling, GIS analysis, and GIS output production or presentation (e.g. map and project report production). You must report to the instructor the progress of your project over the above four stages. The four reports will be separately graded and the grades will contribute to the final course grade. You should also expect to present your course project and its progress to the class.

Please remember that the course materials are rather broad and sophisticated, so you must have successfully taken at least one intro-level GIS course (GEOG202 or GEOG509), or the equivalent, before taking this course. Additionally, any previous hands-on experience in GIS is also highly desired.

REQUIRED COURSE MATERIALS

- Michael J. de Smith, Michael F. Goodchild, Paul A. Longley. 2015. *Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools* (http://www.spatialanalysisonline.com/). This book is a compressive, in-depth handbook of GIS analytical tools and methods.
- Selected academic journal articles and book chapters in the GIS literature that present cutting edge ideas and methods in GIS. These materials will be made available for you by the instructor.
- A course website through WIU's Western Online system (with ECOM Login). Important components of this website include: (1) the course *SYLLABUS*; (2) the *LECTURES* folder where the outline and accompanying questions of each lecture, as well as weekly Audio/Video lectures themselves, are posted; (3) *CALENDAR* that marks important dates/news/events for the course and posts reading assignments; (4) *MAIL* that students should use to communicate with the instructor and with one another; (5) the *ASSIGNMENTS* folder where students receive and submit various assignments; (6) *DISCUSSIONS* for class open discussions and forums; and (7) *MY GRADE* for you to monitor your grades after each exam, lab, exercise, etc. I recommend that students frequently visit this website.
- ArcGIS software that will be provided by WIU.
- GIS software websites and help functions such as ArcGIS/ArcInfo (online) Help, other online GIS help, glossary, discussion forums, and so on. You must learn to be an expert of using these resources which is an important GIS skill by itself.
- Open-source GIS software packages or programs such as GRASS GIS, QGIS, etc.
- Convenient access to WIU libraries (especially online library resources and Interlibrary Loan).

WEEKLY LECTURE TOPICS

Week of irregular offering	Week of online offering	Lecture Topics
1	1	Course introduction; fundamental GIS analysis concepts
	2	GIS spatial concepts; roles of GIS components
2	3	GIS modeling overview and GIS analysis examples
	4	Spatial registration; modes of geographic information
3	5	GIS representational issues and multiple representations
	6	GIS thematic mode; data model complications
4	7	Census data and density field computation
	8	Common GIS data problems and solutions (Midterm)
5	9	Vector and raster data handling and transformation
	10	Spatial data transfer; spatial is special
6	11	Spatial autocorrelation
	12	Spatial interpolation; PRISM climatic interpolation

7	13	Topology and network analysis
	14	Geovisualization; GIS classification methods
8	15	Justification and evaluation of GIS analytical methods
	16	Final exam

LAB ASSIGNMENTS

Lab number	Duration of lab (hours)	Lab topic
1	4	Basic data hunting, generation, and handling
2	4	Census-based vector analysis
3	6	Population mapping and census data evaluation
4	6	Spatial interpolation methods
5	4	Network analysis
6	6	GRASS GIS and visualization
7 (*Graduate credit*)	4	Geostatistical analysis or GeoVISTA use

PROJECT IMPLEMENTATION AND PRESENTATION

- Project idea development (1/8th of the semester);
- Project design (1/4th of the semester);
- Project data preparation (1/2nd of the semester);
- Project analysis (3/4th of the semester);
- Project final production (end of the semester).

CLASS EXERCISES

- (Paper-based) polygon neighborhood (moving window) computation;
- Evaluation of published maps;
- ArcTools summary;
- (Paper-based) inverse-distance weight (IDW) computation
- Evaluation of existing, especially completed, GIS projects (graduate credit).

READING ASSIGNMENTS AND REVIEW OF LECTURES

Reading assignments will be given weekly on Western Online. Students will also be required to submit 7-8 reading and lecture summaries across the semester.

ONLINE CLASS DISCUSSIONS

4-5 online (for online section) and classroom (for irregular section) class discussions, each lasting for 1-2 hours, will be organized immediately following the due dates of the course project (and its stages). Students will present their project progresses to the class, answer questions, and receive comments and suggestions from both the instructor and the classmates. Equally important, students are required to follow the progress of their classmates' projects, so that they can expand their GIS experiences. Students' understanding of their classmates' projects and related ideas will be tested in the exams.

MIDTERM AND FINAL EXAMS

Both midterm and final exams will be comprehensive ones testing all the course materials covered in the corresponding period, especially readings and lectures. The exams will be given online for both the irregular and online sections of this course, respectively in the middle and at the end of the course offering.

ADDITIONAL COURSE RESOURCES, EXPECTATIONS, AND OPPORTUNITIES

- Students may access the computer labs with updated GIS software on Macomb and QC campuses of WIU if they wish to, even though all required coursework can be completed on students' personal computers.
- There will be irregular lectures and class meetings on the QC campus of WIU. These meetings will be arranged out of regular work hours (e.g., on weekends or evenings). Online students, if they choose to do so, are welcomed to attend these class meetings. At the same time, all online materials will also be available for students of the irregular section.
- There will be 25-30 hours of lectures posted on the course website that students can download and study. These lectures will mostly take the format of (audio) recorded Powerpoint presentations. A key feature of these lectures is that the instructor will introduce numerous GIS analysis and application examples (with recorded teaching audio) to explain concepts and ideas presented on the Powerpoint slides.
- For the simultaneously offered irregular and online sections of this course, the instructor will arrange fixed office hours as well as fixed lab hours in both Macomb and QC. Information of all these arrangements will be made available to students of both sections, and students of any section can freely access the instructor during any of the arranged hours. Students can also make (limited) appointments to meet with the instructor individually in either Macomb or QC, if they cannot make it to any of the hours. While students are expected to grow into independent GIS workers, you must be proactive in reaching the instructor for help or advice, when it is needed, on the understanding of course materials, the completion of labs, and the development of course project.
- If you seek the instructor's help online (i.e., through email), you should typically hear the response within 24 hours.
- Online students may be interviewed over the phone for the progress (as well as assistance) of your course project.
- Your GEOG409g project should represent the highest-level GIS project of yours so far, if not the first "*real*" GIS project.
- Both irregular and online students should expect to give feedbacks to classmates' projects (across the four stages), as soon as they are presented to the class, and you should incorporate classmates' feedbacks into the project when appropriate.

- Students are encouraged to participate in the instructor's research to understand how GIS research works, and to get the instructor involved in their research to produce high-quality student research outputs. Some students may find it appealing to continue and extend their research in this course to a higher level, towards a graduate degree in GIS or a possible academic publication (or conference presentation). You will get full-hearted support from the instructor in such efforts.

GRADE DISTRIBUTION AND PERFORMANCE EVALUATION

Student performance in this course will be strictly evaluated based on (1) the mid-term (15%) and final (15%) exams, (2) lab exercises (30%), (3) the course project (20%), and (4) class exercises, reading/lecture reviews, and class (e.g. discussion) participation and/or attendance (20%). You must pass (with a grade better than 60%) all the first three parts above to earn an acceptable course grade. It is highly recommended that you identify a particular GIS specialty or application field through this course, which will be counted positively towards your course grade. Students taking this course for graduate credits will be evaluated with higher expectations.

CLASS POLICY

Students must complete the entire coursework independently, including its labs, project, exams, exercises, (written and oral) presentations (especially maps), and reading/lecture summaries. You can get help from others (including the instructor) for all the tasks other than the exams, but you must still "*do everything*" on your own. Any academic dishonesty will not be tolerated.