Geography 579

GIS and Spatial Analysis

University of Wisconsin-Madison

Fall, 2012

Instructor: ***Last Update: Sept. 4, 2012***

Professor A-Xing Zhu
Department of Geography
Rm 255 Science Hall
Email: azhu@wisc.edu
Tel: 262-0272

Course Websites:

General Information: http://solim.geography.wisc.edu/axing/teaching/geog579/index.html
Lecture and lab materials: Learn@UW

Schedule and Location:

Lecture Hour:

Tuesdays	1:00 p.m. - 2:15 p.m.	444 Science Hall
Thursdays	1:00 p.m. - 2:15 p.m.	444 Science Hall

Lab Hour:

See Lab Syllabus

Office Hours:

Tuesdays:	2:30 p.m. - 3:30 p.m.
Thursdays:	11:00 a.m. - 12:00 noon

1. Course Description:

This is an advanced GIS course covering analytical methods used in GIS and spatial analysis. The course is intended to provide students with a firm understanding of the theoretical/conceptual side of algorithms found in GIS software. We are concerned with the assumptions and underlying mathematical basis for widely-used techniques, and the degree to which analytical capabilities are constrained by those assumptions. Among the topics covered are methods for neighbourhood operation, map transformation, spatial interpolation, terrain analysis, network analysis, and spatial overlay. Other advanced topics such as fuzzy sets, and neural networks will also be covered. The emphasis is on the usefulness and limitations of competing algorithms, as opposed to optimal implementation.

The objectives are:

1) To provide students with a proper understanding of the usefulness and the limitations of GIS analytical techniques with the hope that students will observe these limitations when using these GIS techniques.

2) To develop students' analytical ability so that they will naturally investigate the limitations of GIS techniques which are new to them and thereby avoid misuse or abuse.

2. Prerequisites:

Geog 377/CEE 357 or equivalents.

3. Evaluation and grading:

3.1 Components of Evaluation:

Exercises	40%
Exam 1	30%
Exam 2	30%

3.2 Grading policy:

Grades of exercises are based on:

1) the academic merit of your answers to the questions
2) clarity of answers, ***NO BEATING AROUND THE BUSH***
3) concise and logical presentation, no one wants to flip through a messy assignment report looking for answers. Here is a general format for your presentation:

Question:
Your answer and discussion
Your support documents (images, graphs, tables, etc.)

The grade for each of the exercises and examinations is reported as ***points_scored*** / ***total_points_of_exercise***. For example, an assignment has 20 points and your answer is worth 18 points then you should see ***18/20*** on your marked assignment.

Each assignment is worth of 20 points. ***5 of these 20*** points are for doing the computer work and ***15 of them*** for answering questions.

3.3 Due date and time:

Each of the assignments will have a due day clearly written underneath the title of the assignment. The due time is the beginning of the lab session on the due day. Any assignment that is turned after the due time on the due day is considered late.

3.4 Penalty for late assignments:

The penalty of a late assignment is based on the number of days late (***including weekends!***). If an assignment is late less than 24 hours, it is considered 1 day late. If an assignment is late less than 48 hours but more than 24 hours, it is considered 2 days late, and so on. If you have to turn in an assignment late during the working hours and the instructor is not in his office, you can put it in the instructor's mail box. However, the assignment will be considered to be turned in when the instructor takes it out of his mailbox.

Late assignments are penalized 10% per day. Here is the formula for calculating the points of a late assignment:

Points_get = Points_scored - 0.1*num_days_late*Points_scored

The minimum value of *Points_get* is 0. Assignments handed in after the instructor has returned the graded assignment to class (usually a week after the due date) will receive ***no points***.

4. Computer Environment and Software:

ARC/INFO and IDRISI will be used for the exercises.

5. Other Important Issues:

There may be a time that the class is full and there are people waiting to get into the class. Those of you who are registered for this class but later decide not to take the course, please let the instructor know as soon as possible so that he can add the people on the waiting list to the class list.

Only medical reasons may be taken as excuses for turning in an assignment late or missing a class. However, you must provide a written report from a medical doctor stating your inability to attend class and/or complete an assignment.

The instructor will certainly give you ample time for each assignment. There is no reason for him to be informed that the computer is down or the software is not working a day before the assignment is due. He will ***NOT*** take this as an excuse for a late assignment!

6. Course Materials:

6.1 Course text:

None. Relevant references will be given in class or at the lecture material website.

6.2 Key texts:

Burrough, P.A. and Rachael A. McDonnell, 1998. *Principles of Geographic Information Systems*. New York: Oxford University Press, 333 p.

Chang, K.T., 2002. *Introduction to Geographic Information Systems*. McGraw Hill, New York, 348 p.

Chrisman, Nicholas R., 2002. *Exploring Geographic Information Systems*, John Wiley & Sons, New York (Second Edition).

Fenna, D., 2007. Cartographic Science: A Compendium of Map Projections, with Derivations, CRC Press, Taylor & Francis Group,New York.

Isaaks, Edward, H. and R. Mohan Srivastava. 1989. An Introduction to Applied Geostatistics. Oxford University Press, New York, 561 p.

Lo, C.P. and A.K.W. Yeung, 2002. *Concepts and Techniques of Geographic Information Systems*, Prentice Hall, Upper Saddle River, New Jersey, 492 p.

Longley P.A., M.F. Goodchild, D.J. Maguire, D.W. Rhind, 2005. *Geographic Information Systems and Science*. John Wiley and Sons, New Jersey, 517 p.

6.3 Other GIS texts:

Aronoff, Stan. 1989. *Geographic Information systems: A Management Perspective*, WDL Publications, Ottawa, 294pp.

Bernhardsen, Tor, 1992. *Geographic Information Systems*. Longum Park, Norway: Viak IT, 318 pp.

Burrough, P.A. 1986. *Principles of Geographic Information Systems for Land Resources Assessment*. Walton Street, Oxford OX26DP, Oxford University Press.

Clarke, Keith C. 1990. *Analytical and Computer Cartography*. New York City: John Wiley and Sons.

DeMers, M.N., 1997. *Fundamentals of Geographic Information Systems*. New York: John Wiley & Sons, 486 p.

Dent, Borden D. 1999. *Cartography: Thematic Map Design*. 5th Edition. Dubuque, IA: Wm. C. Brown Publishers.

Environmental Systems Research Institute, Inc., 1992. *Understanding GIS: The Arc/Info Method*, Environmental Systems Research Institute, Inc., Redlands, CA, USA.

Fotheringham, A.S, C. Brunsdon, M. Charlton, 2002. *Geographically Weighted Regression: the anaysis of spatially varying relationships*, New York: John Wiley & Sons, 269 p.

Fischer, M., H. Sholten, and D. Unwin, 1997. *Spatial Analytical Perspectives on GIS*, Taylor & Francis, Bristol, P.A., 224 p.

Goovaerts, Pierre. 1997. Geostatistics for Natural Resources Evaluation. Oxford University Press, New York, 483 p.

Maguire, D.J, M.F. Goodchild, and D.W. Rhind (eds.). 1991. *Geographic Information Systems: Principles and Applications*.

Monmonier, Mark S. 1982. *Computer Assisted Cartography: Principles and Prospects*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Star, Jeffry; and Estes, John. 1990. *Geographic Information Systems: An Introduction*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

7. Intended Topics and Schedule:

Lecture 01: (Sept. 4)

Introduction

Introduction to the course
Classificaiton of GIS Analytical Functions

Lecture 02: (Sept. 6)

Logic frameworks I

Fuzzy sets vs. Crisp sets: basic concepts

Lecture 03: (Sept. 11)

Logic frameworks

Fuzzy sets vs. Crisp sets: Operations and Applications

Lecture 04: (Sept. 13)

Filtering

Raster neighborhood operators (filtering)

Lecture 05: (Sept. 18)

Digital Terrain Analysis I

Basic operations on DEM

Lecture 06: (Sept. 20)

Digital Terrain Analysis II
Drainage network extraction
Slope partitioning

Lecture 07: (Sept. 25)

Map transformations I
Ellipsoids and Datum

Lecture 08: (Sept. 27)

Map transformations II
Affine Transformation

Lecture 09: (Oct. 2)

Map transformations III
Rubber sheeting

Lecture 10: (Oct. 4)

Spatial Autocorrelation I
Introduction: aspects of spatial autocorrelation

Lecture 11: (Oct. 9)

Spatial Autocorrelation II
Geary Index
Moran Coefficient

Lecture 12: (Oct. 11)

Spatial Autocorrelation III
Joint count statistics
For other types of features and attributes

Lecture 13: (Oct. 16)

Spatial Autocorrelation IV
Semivariogram

Review Session (Oct. 18)

Exam 1: (75 minutes) (Oct. 23)

Lecture 14: (Oct. 25)

Point patten analysis I
Introduction
Exploratory and descriptive methods

Lecture 15: (Oct. 30)

Point patten analysis II
Modeling approaches

Lecture 16: (Nov. 1)

Spatial interpolation I
Introduction: Process and Issue

Lecture 17: (Nov. 6)
Spatial interpolation II
Thiessen polygon (nearest neighbour)
Triangulation

Lecture 18: (Nov. 8)

Spatial interpolation III
Moving average
Inverse distance weighting

Lecture 19: (Nov. 13)

Spatial interpolation IV
Kriging

Lecture 20: (Nov. 15)

Spatial interpolation V
Spline

Lecture 21: (Nov. 20)

Spatial interpolation VI
Measures for evaluating spatial interpolation

Thanksgiving Recess (Nov 22-25)

Lecture 22: (Nov. 27)

Spatial Indices and Lanscape Measures I
Spatial centroids
Shape Analysis

Lecture 23: (Nov. 29)

Spatial Indices and Landscape Measures II
Measures of landscape structures

Lecture 24: (Dec. 4)

Network analysis
Pathfinding (Shortest path analysis)

Lecture 25: (Dec. 6)

Advanced Topics
Neural networks and Class review

Review Session (Dec. 11)
Exam 2: (75 minutes) (Dec. 13)