ES 103 Spatial Analysis of Environmental and Social Systems

Spring 2005
Time: Tuesday, 8:30-10:00AM (lecture), Thursday 9-1 (open lab time)
Location: Tuesday, Maxwell Dworkin MD 223
Thursday, Maxwell Dworkin Computer Instruction Lab, B121

Instructor:

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Course URL*:* http://www.courses.fas.harvard.edu/~es103/

Office Hours: Tuesday, Thursday 10:00-12:00 and additionally as arranged

1.0 Course Objectives:

An introduction to the fundamental mathematical, statistical, and mapping tools needed for analysis of environmental and social systems. By the end of the course the student will be expected to have an:

- Understanding of the nature of spatial data and the principles of geographic information systems
- Be able to use different types of spatial data structures
- Define a problem in terms of its spatial analytical context
- Specify models and methodology for spatial analysis
- Compare and evaluate alternative spatial analytical methods
- Assess the accuracy of spatial data and locate sources of error
- Visualize and present the results of spatial analysis

2.0 Course Description:

The course is intended to be for both undergraduate and graduate students from any discipline with an interest in analysis that involves spatial data. As policy makers and planning agencies increasingly use spatial data and methods to aid in their decisions, this course is relevant to anyone interested in policy and planning issues. The course will include:

- Introduction to GIS theory, data and models
- Introduction to the concepts of spatial analysis
- Specific methods of spatial analysis including interpolation, buffer zone analysis, spatial statistics and suitability models

Students will acquire technical skills in both mapping and spatial analysis. The software packages used will include ArcGIS, GeoDa and Multispec. Students will be encouraged to use this course as a setting for their own research interests.

The course will meet two times a week for 90 minutes. Every week (except the first week – see course outline in section 7.0), the first session (Tuesdays, except weeks 1 and 2) will involve a lecture and discussion and the second session (Thursdays, except weeks 1 and 2) will meet in the

lab for hands-on computer exercises that will segue into an assignment that must be handed in the following week. The lab is available to the students during all hours that the Maxwell Dworkin Building is accessible. Additional time may be required beyond the 90 minutes of assigned lab time to complete exercises. The course will also require a project to be done independently by the student(s) (See section 4.0).

There will be guest lectures by researchers and practitioners who use GIS and spatial models in their work. The mathematics prerequisite for this course is an understanding of basic algebra, calculus, statistics and introductory matrix manipulations. However, the instructor welcomes students from a variety of disciplines. Please contact the instructor about any questions regarding prerequisites.

3.0 Grading:

The final course grade will be based on:

Lab exercises	25%
Mid term exam (take-home exam)	25%
Final project presentation and report	40%
Participation	10%

4.0 Final Project

The purpose of the final project is to provide additional experience in collecting, processing and analyzing spatial data and linking it to models. The project should be relevant to your field of study. Students must start thinking about project ideas early in the semester. You are expected to provide and present a project proposal by the date specified in the Course Outline summary table (April 14th 2005). The proposal should include the spatial and non-spatial data available, a proposed model and background research to indicate the need for such a project. At this point in the semester, the student is expected to have the data to implement the project in hand. The final project will require a formal in-class presentation (10% of the course grade) and project summary report (30% of the course grade). Group projects are encouraged but the products of group work will be expected to scale-up corresponding to the number of members in the group. All individual projects must include a final report of 8 pages (excluding maps, tables and other visuals). You are encouraged to submit your project for the Howard Fisher Prize. More information about the prize that is open to undergraduate and graduate students is available at: http://www.gsd.harvard.edu/academic/fellowships/prizes/gisprize/index.htm.

5.0 Required textbook:

Burrough, P.A. and McDonnell, R.A. 1998. Principles of Geographic Information Systems: Spatial Information Systems and Geostatistics. Oxford University Press.

Ormsby, T., Napoleon, E., Burke, R., Groessl, C., and L. Feaster. 2001. *Getting to Know ArcGIS Desktop*. Redlands, CA: ESRI Press; Book and CD-ROM edition.

Other supplementary readings will be provided every week based on the environmental application area and will be distributed in class. All readings and textbooks are also on reserve at the Gordon McKay Library of Engineering and Applied Sciences**,** Pierce Hall (3rd Floor).

5.1 Other readings include:

Bonham-Carter, G. 1994. Geographic Information Systems for Geoscientists. Pergamon. (Chapters 3, 4, 6, 7 and 9)

Fotheringham, A.S., Brundson, C., and M. Charlton. 2000. *Quantitative Geography: Perspectives on Spatial Data Analysis*. London: Sage Publications. (Chapters 2, 3, 4, 5 and 8)

Haining, R. 1990. *Spatial Data Analysis in the Social and Environmental Sciences*, Cambridge: Cambridge University Press. (Chapters 1 and 2)

Fotheringham, S. and P. Rogerson, editors. 1994. *Spatial Analysis and GIS*. London: Taylor and Francis. (Chapters 3 and 4)

Anselin, L. 2002. "Under the Hood: Issues in the Specification and Interpretation of Spatial Regression Models," *Agricultural Economics* 27 (3), 2002: 247-267.

Urban, D. Geostatistical Data Analysis
http://www.env.duke.edu/landscape/classes/env352/autocorr.pdf

Levine, N. Distance Analysis and Cluster Analysis,
http://www.icpsr.umich.edu/NACJD/crimestat/

Anselin, Luc (2003). *GeoDa 0.9 User's Guide*. Spatial Analysis Laboratory, Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, IL.
http://sal.agecon.uiuc.edu/csiss/pdf/geoda093.pdf

D. Liverman, E. F. Moran, R. R. Rindfuss, and P. C. Stern, editors. *People and Pixels*. National Research Council, Washington, DC. (Chapters 1, 2 and 3)

6.0 Student Responsibilities for Meeting Course Objectives

1. Obtain and read the required textbook and supplemental material. Students will be evaluated on knowledge and skills obtained from lecture, discussion, the required textbook and supplemental reading materials. The mid term exam and lab exercises will be based on this material.
2. Be prepared for class discussions and participation. Volunteer to both discuss information and answer questions. Outcomes of this practice will be used by the instructor as a means to subjectively evaluate students at the end of the semester.
3. Follow the student honor code and ethical behavior standards. This code of conduct can be accessed over the web at
   http://www.registrar.fas.harvard.edu/handbooks/student/chapter4/index.html
4. Out-of-class assignment must be professionally prepared. This means the course project and exercises will have to be typed and free of spelling errors, and poor grammar. References must be cited properly. No late assignments or paper will be accepted under any circumstances.
5. If you need to communicate with the instructor, you may do so via e-mail, voice mail, or by making a personal appointment. It may take at least one workday for the instructor to

return a telephone or e-mail message. Plan accordingly. If you need more then 5-10 minutes of the instructor's time, it may be best to schedule an appointment

7.0 Course Outline and Readings (subject to change)

	Lecture Content (Meets Tuesdays unless specified otherwise)	**Lab Content**
Week 1 Feb 3	Introduction of GIS and Spatial Analysis Readings: Borrough and McDonnell, Ch 1; Ormsby, Ch 1 **** (Meets on Thursday)****	No Lab
Week 2 Feb 8, 10	**Guest lecture: Paul Cote, Graduate School of Design** GIS data types, models, and structures; Map Projections and Coordinate Systems Readings: Borrough and McDonnell, Ch 2, 3 (pp 35-50), 4; Bonham-Carter, Ch 4 **** (Meets on Thursday)****	Lab1: Introduction to ArcGIS Massachusetts GIS data Readings: Ormsby, Ch 2, 3, 5, 19 **** (Meets on Tuesday)****
Week 3 Feb 15, 17	More on spatial data structures: Raster and vector data. Readings: Borrough and McDonnell, Ch 3 (pp 51-73); Bonham-Carter, Ch 3	Lab 2: Databases Massachusetts GIS data Readings: Ormsby Ch 4, 8, 9, 13, 14
Week 4 Feb 22, 24	Spatial data transformations Readings: Bonham-Carter, Ch 6, Ch 7	Lab 3: Grid based analysis Massachusetts GIS data Readings: Ormsby Ch 5, 6, 7
Week 5 March 1, 3	Estimating surfaces and interpolation Readings: Borrough and McDonnell, Ch 5, 6	Lab 4: Spatial operations on vectors Massachusetts GIS data Readings: Ormsby, Ch 10, 11, 12
Week 6 March 8, 10	Introducing spatial data analysis. Readings: Fotheringham et al, Ch 3, 4; Haining Ch 1, 2	Lab 5: Interpolation Los Angeles air quality Readings: Ormsby, Ch. 5, 18, 19
Week 7 March 15, 17	More on spatial analysis (spatial statistics) **Guest lecture: Rima Izem, Department of Statistics, Harvard University** Readings: Fotheringham et al, Ch 5 (p 93-103) 8 (except 8.3.1); TBD	Lab 6: Introduction to GeoDa Readings: sal.agecon.uiuc.edu/csiss/pdf/quicktour.pdf Nepal health data set
Week 8 March 22, 24	Spatial analysis of discrete and continuous entities Readings: Borrough and McDonnell, Ch 7, 8	Mid term exam (Take home) Out: March 23rd In: March 24th
Spring Break (No classes)		

	Lecture Content	Lab Content
Week 9 April 5, 7	Multivariate spatial models **Guest lecture: Rob McDonald, Harvard Forest** Readings: Urban; Levine Ch 6; Borrough and McDonnell, Ch 11	Lab 7: Linking models and GIS Readings: Ormsby, Ch 20 Boston land use data
Week 10 April 12, 14	More on spatial models Readings: Bonham-Carter, Ch 9; Borrough and McDonnell, Ch 12; Fotheringham and Rogerson Ch 3, 4	Student proposals due Optional Lab 8: 3D Analyst Massachusetts GIS data
Week 11 April 19, 21	Integrating models **Guest Lecture: Joe Ferreira, MIT** Readings: TBD	Lab 9: Spatial regression in GeoDa Readings: sal.agecon.uiuc.edu/pdf/geodaGA.pdf Anselin, 2002 Boston MSA housing data
Week 12 April 26, 28	Remote sensing **Guest lecture: Robert Rose, Harvard Map Library** Readings: Liverman, Moran, Rindfuss, and Stern, Ch 1, 2, 3; TBD	Lab 10: Classifying Images using Multispec Massachusetts data
Week 13 May 3, 5	Presentation/Preparation of projects.	Presentation/Preparation of projects.
Project report due at the end of the reading period		