Soc 560/CRP 629.14ST
Cornell University

Analytic Mapping and Spatial Modeling
FALL 2006

Course description and objectives:

The goal of this course is to introduce students in the social sciences and related fields to geographic information systems (GIS) and spatial statistics. Spatial relationships have become increasingly recognized as vital to deal with in socioeconomic, political and demographic analysis. Planners and regional scientists have long accepted GIS as a critical tool. It has become a mainstay of commerce and governmental programs. Research and planning experiences over the past decade have demonstrated the importance of understanding spatial relationships, in addition to other, aspatial factors in accounting for similarities and differences between people and organizations. For example, it has been shown that employing spatial modeling and resolving spatial autocorrelation significantly increases our analytic and explanatory power over traditional, aspatial analyses. Accordingly, this course presents GIS and spatial statistics not just as stand alone analytic frameworks, but also as a complementary set of tools to traditional (non-spatial) statistical analysis methods.

This course strives to accomplish two main goals. The first goal is to introduce various ways in which spatial thinking and research can benefit our theorizing and research. For this goal we will spend a little time discussing what it means to think spatially and examine some examples of research where space and place were important ingredients for increasing our understanding. The second goal is to provide you with enough structured guidance in applying GIS procedures and techniques to various social science research problems that you gain sufficient confidence and skills to apply spatial analysis to your own research. For this goal, emphasis is on application and use of GIS for spatial analysis and display, not on GIS theory or geography per se. Along the way we will learn some basic principles of geography needed to understand the GIS techniques.

Extensive use will be made of existing, easily retrievable information, like Census data, UNESCO and World Bank facts. Most of the time we will be using pre-existing GIS data (polygons, lines, points). However, students will create some data sets through geocoding and on-screen digitizing. Students will also create new data sets via subsetting, merging and similar GIS operations.

The course is designed to accommodate students and researchers that have no prior experience with GIS. However, those who are proficient in GIS should benefit from the approach used in this course which emphasizes the integration of spatial display and statistical analysis. While the bulk of time and therefore emphasis is on GIS, some amount of time will be spent at the end of the semester on spatial statistics, namely measures of spatial relationships via variograms, correlograms and point cluster analyses.

In terms of sequencing of topics, the course breaks into roughly three parts. The first month is mainly (1) learning how to think spatially and bringing location into our research considerations, and (2) learning the basics of GIS—finding appropriate spatial datasets, performing simple GIS manipulations, classification of information, and display—including making simple maps. Fundamentals of displaying, organizing, symbolizing a variable and showing relationships between spatially distributed variables will be covered in this section. In the second month, approximately, we explore more advanced spatial processing techniques as well as working with other kinds of spatial data. Fundamentals of geoprocessing covered include clipping, merging, intersecting, buffers, distance analysis. During this section of the course we

learn more about working with raster data, georeferencing, geocoding and GPS. The final few weeks of the semester introduces concepts of spatial statistics. These include diagnostics of spatial autocorrelation in the data and methods of interpolation that take advantage of this correlation over space. The effects of having spatially autocorrelated data in regression and related linear modeling analysis will be discussed, and the methods available for dealing with it in regression and related techniques also will be covered.

In short, the first two thirds of the course (lectures and labs) will cover GIS concepts and procedures found to be most useful to social scientists in their endeavors. The second part of the course (3-4 lectures and labs) will cover spatial statistics.

Software:

ArcGIS 9.1 is the software that will be used throughout the course. In addition, for the section dealing with spatial statistics, S-Plus will be employed as well as more specialized software—GeoDa and CrimeStat—will be introduced to supplement ArcGIS.

Prerequisites:

Students should be proficient with the Window operating system and Microsoft office, notably Word and Excel. It is not expected that students have prior knowledge or experience with geographic information systems or spatial statistics. On the other hand, it is expected that students have completed a course in basic statistics within the past three years. Specifically, you will need to know how to evaluate variable distributions and correlations, construct hypotheses, interpret test results, and have some knowledge of simple regression models.

Class schedule and Course Organization:

Classes take place on Wednesdays from 1:25 to 4:25 PM in B60 Warren Hall. Approximately 45-50 minutes will be devoted to lecture with the rest of the time committed to hands on laboratory exercises. A new lab will be started each week. Below is the anticipated schedule of lectures, associated labs and homework. All lectures, labs and relevant data will be downloadable from the D Soc 560 Blackboard course site www.blackboard.cornell.edu . You self enroll in order to use the course site.

Sequence of Lecture Topics and Lab Themes

August 30 **Lecture Topic 1**: Course Orientation & Spatial Thinking in the Social Sciences
Readings for Concepts and Principles:
Monmonier, *Preface* and Ch 1: *Words and Maps*
Goodchild & Janelle, Ch 1: *Thinking Spatially in the Social Sciences*
Bolstad, Ch 1: *An Introduction to GIS*
Longley, et al, Ch 2: *A Gallery of Applications*
Readings for Laboratory Exercises:
None this week
Laboratory Exercise:
Introduction to Spatial Thinking via Google Earth
Homework 1:

September 6 **Lecture Topic 2:** An Introduction to ArcGIS
Readings for Concepts and Principles:

Bolstad, Ch 1: *An Introduction to GIS*

Readings for Laboratory Exercises:

ESRI Document: *What is ArcGIS*, Ch. 1
ESRI Document: *Getting Started with ArcGIS*, Ch 1-3.
ESRI Document: *Using ArcMap*, Ch. 1, 3 & 15

Laboratory Exercise: (Old Lab 1)

ArcGIS Basics, Finding Spatial Data, Basic symbolization, Creating subsets, Basic map creating and publication.

Homework:

September 13 **Lecture Topic 3**: Collecting Spatial Data

Readings for Concepts and Principles:

Longley, et al., Ch. 9: *GIS Data Collection* & Ch 10: *Creating & Maintaining Geographic Databases*
DeMers, Ch 5: *GIS Data Input* & Ch 6: *Data Storage and Editing*
Monmonier, Ch. 5: *Cartographic Sources and Map Compilation*
Bolstad, Ch. 4: *Data Sources and Entry* & Ch 5: *The Global Positioning Systems*

Readings for Laboratory Exercises:

ESRI Document: *Using ArcCatalog*, Ch. 1
ESRI Document: *Using ArcMap*, Ch. 1, 4 & 10

Laboratory Exercise: (Old Lab 2)

Locating existing geo-databases, Joining data, Attribute editing, Mapping, Metadata.

Homework: Look for datasets, for your research.

September 20 **Lecture Topic 4:** Displaying Spatial Data I

Readings for Concepts and Principles:

Monmonier, Ch. 3: *Visual Variables and Cartographic Symbols*, Ch. 6: *Statistical Maps, Data Scaling and Data Presentation*, Ch. 7: *Mapping Movement, Change and Process*, Ch. 8: *Relational Maps and Integrative Cartography*.
Longley, et al., Ch. 12: *Visualization and User Interaction*
Slocum, et al., Ch. 4: *Principles of Symbolization* & Ch. 5: *Data Classification*
Brewer, *Designing better Maps*
Mitchell, Ch 2: *Mapping Where Things Are* & Ch 3: *Mapping the Most and Least*

Readings for Laboratory Exercises:

ESRI Document: *Using ArcMap*, Ch 6, 10 & 11

Laboratory Exercise: (Old Lab 3, part)

Exploratory statistics, missing data, classification,d visualization of relationships between variables.

Homework:

September 27 **Lecture Topic 5:** Displaying Spatial Data II

Readings for Concepts and Principles:

Mitchell, Ch 4: *Mapping Density* & Ch 7: *Mapping Change*
Monmonier, Ch 6: *Statistical Maps, Data Scaling and Data Classification* & Ch 7: *Mapping Movement, Change and Process*

Readings for Laboratory Exercises:
ESRI Document: *Using ArcMap,* Ch
(ESRI Documentation on Map Making)
Laboratory Exercise: (Old Lab 3, part)
Homework:

October 4 **Lecture Topic 6**: Representing Our World Spatially—Geographic Fundamentals, Data Models and Spatial Referencing
Readings for Concepts and Principles:
Longley, et al, Ch 3: *Representing Geography,* Ch. 4: *Nature of Geographic Data* & Ch. 9: *Geographic Data Modeling*
Monmonier, Ch. 2: *Scale, Perspective and Generalization*
*Bolstad, Ch 2: *Data Models* & Ch. 3: *Geodesy, Projections and Coordinate Systems.*
DeMers, Ch 2: *Spatial Analysis: The Foundation of Modern Geography* & Ch 3: *The Map as a Model of Geographic Data: The Language of Spatial Thinking* & Ch 4: *Cartographic and GIS Data Structures*
Mitchell, Ch 1: *Introducing GIS Analysis*
Readings for Laboratory Exercises:
ESRI Document: *Understanding Map Projections*, Ch 1, 2 & 4
Laboratory Exercise: (Old Lab 4, part)
Homework:

October 11 **Lecture Topic 7:** Spatial Data Processing I
Readings for Concepts and Principles:
Bolstad, Ch 9: *Basic Spatial Analysis*
DeMers, Ch 7: *Elementary Spatial Analysis* & Ch 8: *Measurement*
Mitchell, Vol. 1, Ch 5: *Finding What's Inside* & Ch 6:*Finding What's Nearby*
Readings for Laboratory Exercises:
ESRI Documents & Help Files
Laboratory Exercise: (Old Lab 4, part)
GIS operations to organize data.—query, buffers, distance, clip, merge, intersect
Homework:

October 18 **Lecture Topic 8:** Spatial Data Processing II—Georeferencing and Geocoding
Readings for Concepts and Principles:

Readings for Laboratory Exercises:
ESRI Document: *StreetMap Tutorial;*
ESRI Document: *Geocoding in ArcGIS*, Ch 1 & 3
Laboratory Exercise: (Old Lab 5)
Basemaps, Creation of new spatial datasets through on-screen digitizing and geocoding.
Homework:

October 25 **Lecture Topic 9:** Other Spatial Data Types: Rasters
Readings for Concepts and Principles:
Bolstad, Ch 6: *Aerial and Satellite Images* & Ch. 10: *Topics in Raster Analysis*

Readings for Laboratory Exercises:
ESRI Document: *Using ArcGIS Spatial Analyst*, Ch 3, 4, 5 & 7
Laboratory Exercise: (Old Lab 6)
Homework:

November 1 **Lecture Topic 10:** Other Spatial Data Types: Lines and Network Analysis
Readings for Concepts and Principles:

Readings for Laboratory Exercises:
ESRI Document: *ArcGIS Network Analyst Tutorial*
Laboratory Exercise: (Old Lab 7)
Network analysis using road networks and travel times to determine shortest routes, closest facilities and service areas.
Homework:

November 8 **Lecture Topic 11:** Exploratory Spatial Data Analysis
Readings for Concepts and Principles:
Mitchell, Vol 2, Ch 1: *Introducing Spatial Measurements and Statistics*
Mitchell, Vol 2, Ch 2: *Measuring Geographic Distributions*
Rogerson, Ch 8: *Spatial Patterns*
Bailey and Gatrell, Ch 1: *Spatial Data Analysis*
Readings for Laboratory Exercises:
Anselin's "*Introduction to EDA with GeoDa*"
Laboratory Exercise: (Old Lab 8)
Exploring spatial trends in datasets. Building prediction models.
Homework:

Novermber 15 **Lecture Topic 12:** Spatial Autocorrelation
Readings for Concepts and Principles:
Rogerson, Ch 8: *Spatial Patterns*

Readings for Laboratory Exercises:
Anselin's "*Introduction to Spatial Autocorrelation Analysis with GeoDa*"
Bailey and Gatrell, Ch 7: *Introductory Methods for Area Data*
Laboratory Exercise: (Old Lab 9)
GeoDA: neighborhoods and weight matrices, univariate, bivariate and local Moran's I. Correlograms.
Homework:

November 29 **Lecture Topic 13:** Spatial Linear Regression
Readings for Concepts and Principles:
Rogerson, Ch 9: *Some Spatial Aspects of Regression Analysis*

Readings for Laboratory Exercises:
Anselin's "*GeoDa User's Guide*"
Laboratory Exercise: (Old Lab 10)
Incorporating Spatial Variables and Non-Spatial Variables into Linear Regression Effect of weight matrices. Classic regression, spatially lagged regression, spatial error models.
Homework:

December 6 **Lecture Topic 14:** Point Pattern Analysis

Readings for Concepts and Principles:

What

Readings for Laboratory Exercises:

Anselin's "*Intro to Point Pattern Analysis Using CrimeStat*"

Bailey and Gatrell, Ch 3: *Introductory Methods for Point Patterns* & Ch 4: *Further Methods for Point Patterns*

Laboratory Exercise: (Old Lab 13)

Statistical properties of point distributions, Nearest neighbor analysis, Ripley's K, K-means clustering.

Homework:

Laboratory Work:

Each week we will begin and complete a new lab. For the labs you will be provided with a worksheet guide, datasets and any auxiliary materials needed to complete the lab. Because we cannot store our files or project work on the hard drives in Warren B60, you will need to purchase a Zip disk (100 or 250Mb), CD, or USB "thumb drive" to store your work and bring it with you to class each week. We highly recommend USB drives to transport your data. If you want to use the printers in B60 you will need to establish a NetPrint account (via Bear Access).

Grading:

Grading options for this course are S/U or letter grade. Grades will be based on lab and homework assignments; no formal tests will be given. A lab will be due each week. Each lab will be worth 50 points. There will be several homework assignments during the semester. Homework assignments will be worth 25 points each, unless otherwise announced. Points will be deducted for parts not completed and assignments handed in after the due date. The final grade will be derived as follows: grades for each lab and assignment will be cumulated and divided by the total achievable points for all labs and assignments. A letter grade for the semester will be assigned as follows: A+ =97-100%; A = 93-96%; A- = 89-92%; B+ = 85-88%; B = 81-84%, B- = 77-80%; C+ = 73-76%; C = 69-72%; C- = 65-68%; D+ = 61-64%; D= 57-60%; D- = 53-56%; F = below 53%. For those taking the course under the S/U option, S = 73% or more and U = less than 73%.

All lab and homework assignments are to be handed in by the start of class on the date they are due. To keep everyone on pace, 12% (equivalent to one letter grade) will be deducted for each week the lab and/or assignment is handed in late. Due dates will be specified for each Lab and homework assignment.

Teaching Staff

Joe Francis	Scott Sanders	Kathleen Arthur
235 Warren Hall	115 Warren Hall	
jdf2@cornell.edu	srs73@cornell.edu	kla32@cornell.edu
255-1687		
Office Hours: TBA	Office Hours: TBA	Office Hours: TBA

References

Textbooks

2001 Brewer, Cynthia A. Mapping Census 2000: The Geography of U.S. Diversity, 2000. Washington, D. C.: U.S. Dept. of Commerce, Economics and Statistics Administration, U.S. Census Bureau.

1995 Bailey, Trevor C. and Anthony C. Gatrell, Interactive Spatial Data Analysis Pearson Education Ltd., Essex, England/ Prentice Hall, NY, NY.

2005 Bolstad, Paul. GIS Fundamentals: A First Text on Geographic Information Systems. Second Edition. White Bear Lake, Minn.: Elder Press.

2002 Chrisman, Nicholas. Exploring Geographic Information Systems. 2nd Edition. New York: John Wiley & Sons.

1997 DeMers, Michael, N., Fundamentals of Geographic Information Systems. New York: John Wiley & Sons.

2004 Goodchild, Michael F. and Donald G. Janelle, Spatially Integrated Social Science. New York: Oxford University Press.

2005 Longley, Paul A., Michael F. Goodchild, David J. Maguire, and David W. Rhind, Geographic Information Systems and Science. Chichester, England: John Wiley & Sons, Ltd.

1999 Mitchell, Andy. The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns & Relationships. Redlands, CA: Environmental Systems Research Institute, Inc.

2005 Mitchell, Andy. The ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements & Statistics. Redlands, CA: Environmental Systems Research Institute, Inc.

1996 Monmonier, Mark S., How to Lie with Maps. Chicago: University of Chicago Press.

1993 Monmonier, Mark S, Mapping It Out: Expository Cartography for the Humanities and Social Sciences. Chicago: University of Chicago Press.

2004 Rogerson, Peter A. Statistical Methods for Geography. Thousand Oaks, Calif.: Sage Publications

2005 Slocum, Terry A., Robert B. McMaster, Fritz C. Kessler and Hugh H. Howard, Thematic Cartography and Geographic Visualization. 2nd Edition. Upper Saddle River, N.J.: Prentice Hall.

ESRI ArcGIS 9.1 Documentation Library, ESRI, Inc. Redlands, CA

GeoDa Applications

Anselin, Luc. "An Introduction to EDA with GeoDa"
"An Introduction to Spatial Autocorrelation Analysis with GeoDa"
"GeoDa 9.3 User's Guide"

Bonet, Jaime. (2004) Descentralización fiscal y disparidades en el ingreso regional: la experiencia colombiana. Cartagena, Colombia: Centro de Estudios Económicos Regionales (Working Paper No. 49).

Chasco, C. and Morón, P. (2005), "Influencia sobre el crecimiento del precio de la vivienda provincial del entorno geográfico: convergencia, vecindad y pertenencia a las CCAA". In P. Morón (ed), "La Política de Vivienda en los Albores del Siglo XXI", Fundación General de la Universidad Autónoma de Madrid.

Gamarra V., José R. (2005). Desfalcos y regiones: un análisis de los procesos de responsabilidad fiiscal en Colombia. Cartagena, Colombia: Centro de Estudios Económicos Regionales (Working Paper No. 66).

Griffin, Terry, Glenn Fitzgerald, Dayton Lambert, J. Lowenberg-DeBoer, Edward M. Barnes, Robert Roth. 2005. Testing Appropriate On-Farm Trial Designs and Statistical Methods for Cotton Precision Farming. 2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005.

Guillain R., Le Gallo J., Boiteux-Orain C. (2006) Changes in spatial and sectoral patters of employment in Ile-de-France, 1978-1997, Urban Studies, forthcoming.

Javier Pérez V., Gerson. (2005). Dimensión espacial de la pobreza en Colombia. Cartagena, Colombia: Centro de Estudios Económicos Regionales (Working Paper No. 54).

López, F.A. And Chasco, C. (2004), "Space-time lags: Specification strategy in spatial regression models". Regional Economics Applications Laboratory, University of Illinois in Urbana-Champaign, REAL 04-T17.

López, F.A. and Chasco, C. (2005), "Space-time lags: Specification strategy in spatial regression models". In F. J. Trívez, J. Mur, A. Angulo, M.B. Kaabia and B. Catalá (eds), "Contributions in spatial econometrics", Copy Center Digital; pp. 125-149.

Mella, J.M. and Chasco, C. (2005), "Urban growth and territorial dynamics in Spain (1985-2001): A spatial econometric analysis". In F. J. Trívez, J. Mur, A. Angulo, M.B. Kaabia and B. Catalá (eds), "Contributions in spatial econometrics", Copy Center Digital; pp. 327-370.

Mella, J.M. and Chasco, C. (2006), "A spatial econometric analysis of urban growth and territorial dynamics: A case study on Spain". In P. Nijkamp and A. Reggiani (eds), "Spatial dynamics, networks and modelling", Edward Elgar; pp. 319-360.

Mella, J.M., López, A. and Chasco, C. "Crecimiento económico y convergencia urbana en España". Colección Investigaciones. Instituto de Estudios Fiscales, Madrid.

Mobley, Lee R., Elisabeth Root, Luc Anselin, Nancy L. Gracia and Julia Koschinsky. (2006). "Spatial analysis of elderly access to primary care services. Journal: International Journal of Health Geographics.

Parker, Karen F., Brian J. Stults, Erin Lane [all University of Florida] and Geoffrey Alpert, University of South Carolina. "A Spatial and Contextual Analysis of Racial Profiling: A Theoretical Investigation into Racial Profiling at the Local Level" Ongoing research project.

Public Health Intelligence. (2005). *Identifying Schools for the "Fruit in Schools" Programme.* Wellington, New Zeand: Ministry of Health.

Public Health Intelligence. (2005). *Spatial Epidemiological Investigation of Legionellosis Cases in Christchurch.* Wellington, New Zeand: Ministry of Health.

Sharma, Ravi K. (2005). *Exploratory Spatial Data Analysis Using GeoDa: An Introduction.* AMCHP Annual Conference (Using Geographic Information System (GIS) to Analyze MCH EPI Data), December 5-6, 2005, The Wyndham Miami Beach Resort Hotel, Miami, Florida.

Voss, Paul. (forthcoming). "Highways and Population Change" Journal of Rural Sociology.

Voss, Paul. (forthcoming). "County Child Poverty Rates in the U.S." Journal of Population Research and Policy Review.

Voss, Paul. (forthcoming). "Explorations in Spatial Demography," in William Kandel and David L. Brown (eds.), The Population of Rural America: Demographic Research for a New Century. Kluwer Academic, 2006.

Xu, Steve S. W. (2005) “Spatial analysis of burglary crime in the City of San Antonio, Texas.” Unpublished research paper, The University of Waterloo.

Census Materials

U.S. Bureau of the Census. *Geographic Areas Reference Manual* (online @ www.census.gov/geo/www/garm.html and of particular use is www.census.gov/geo/www/tiger/glossary.html#glossary
U.S. Bureau of the Census Census 2000 TIGER/Line Files Technical Documentation. (online @ www.census.gov/geo/www/tiger/tiger2k/tiger2k.pdf

Web References

General GIS Websites containing maps and data:

ESRI www.esri.com
Geography Network: www.geographynetwork.com
GIS Data Depot www.gisdatadepot.com
Cornell University Geospatial Information Repository: http://cugir.mannlib.cornell.edu/
GeoData: www.geodata.gov
GIS Monitor www.gismonitor.com
GIS Portal www.gisportal.com
GIS Lounge www.gislounge.com
University of California, Berkeley http://sunsite.berkeley.edu/cgi-bin/nph-search?query=GIS&t=titles

Federal and State Websites

Federal Geographic Data Committee clearinghouse: http://clearinghouse1.fgdc.gov
National Map Atlas: http://nationalatlas.gov
U.S. Bureau of Transportation Statistics: www.geocomm.com/links/linksdata.html
U.S. EPA Envirofacts Data Warehouse: www.epa.gov/enviro/

GIS Websites with Social Science Data:

Center for Spatially Integrated Social Science www.csiss.org
University of Virginia http://fisher.lib.virginia.edu/
U.S. Census Bureau's American Fact Finder http://factfinder.census.gov
World Bank http://www.worldbank.org//
U.S. Department of Labor: http://stats.bls.gov/
Bureau of Economic Analysis: http://www.bea.doc.gov/bea/dn1.htm
U.S. Department of Agriculture: http://www.nass.usda.gov/census/
Center for Disease Control and Prevention: http://www.cdc.gov/

Useful Listserv (You will want to subscribe)

Cornell GIS listserv: gis-l@cornell.edu
Open Source Spatial Analysis Tools including GeoDa: https://www.geoda.uiuc.edu/support.php