

Environmental Spatial Data Analysis

NRE 543, Fall 2004

Meets: Tuesday 10-11 am Thursday 11 am to 12 p.m.
1006 Dana 3325 Dana (3rd Floor Computer Lab)

Instructor: Dr. Dan Brown, 3505 Dana, 763-5803

Contact: danbrown@umich.edu

Webpage: <http://www.umich.edu/~danbrown/nre543/>
<http://ctools.umich.edu>

Prerequisite: NRE 420 and NRE 438, or equivalents, and graduate standing, or permission.

Credits: 3

Description

Information about events and attributes that is referenced to locations can be complicated to handle, but can provides insight into social and environmental processes. By analyzing this information in ways that take advantage of the spatial dimension, we search for spatial patterns to generate and test hypotheses about the causes and effects of those patterns. This course deals with the processing and quantitative treatment of spatial data for use in ecological and environmental analysis and assessment. The first topics of the class will address spatial data representation and visualization that make use of geographic information systems (GIS) for spatial analysis. The topics include discussion of transformations among spatial feature types, scale and resolution issues, sampling and data visualization options. The remaining topics introduce multiple approaches to analysis of point and area data. We begin with point pattern analysis, to test for patterns of points (e.g., clustering), then discuss geostatistical methods for estimation when the points represent locations of attribute measurements. We will look at a specific set of analytical tools for describing landscape patterns, derived from the field of landscape ecology. Finally, we will look at methods for inferential analysis using area-based measurements. Assignments involve computer exercises using real social and physical environmental and data. Students are will complete a semester project that represents either original research with spatial data or a review of applications of particular methods on particular topics.

Readings

The readings will be drawn from two different texts and from published articles. We will read most of one text (Bailey and Gatrell) and parts of another (Turner et al.). The articles and selected chapters from Turner et al. are available through the science library.

Required Text:

Bailey, T.C. and Gatrell, A.C. 1995. *Interactive Spatial Data Analysis*. Addison Wesley Longman.
Available at Ulrich's, Michigan Union, and Michigan Book and Supply

Supplemental Text:

Turner, M.G., Gardner, R.H., and O'Neill, R.V. 2001. *Landscape Ecology in Theory and Practice: Pattern and Process*. New York: Springer.

Lab Assignments

Students will be required to finish weekly assignments on the computer and a 1 to 2 page write-up resulting from each assignment. Assignments will make use of ArcGIS, GeoDa, ClusterSeer, Fragstats and other software as appropriate. The packages are available in the Dana 2nd and 3rd floor computing labs. Your unickname gains you access to the NT machines in those labs. Data will be provided for the exercises.

Grading

Grades are based on the written lab assignments, project/paper/presentation, and a written take-home final exam.

Tentative Schedule of Events (Subject to Change)

Date	Topics	Readings	Labs
Sept 7-9	<i>Spatial data, spatial processes, statistical preliminaries</i> Representing space - stationarity, isotropy, continuity, contiguity, distance, boundaries Goals of SDA - description, inference, modeling	Bailey & Gatrell 1 Fotheringham & Brunsdon 2004	Review of ArcGIS
Sept 14-16 Sept 21-22	<i>GIS-based Representation & Visualization</i> GIS-based transformations of relevance to SDA Dynamic mapping for exploratory analysis	Bailey & Gatrell 2	ArcGIS - Spatial Analyst and GeoDa
Sept 28-30 Oct 5-7	<i>Point pattern Analysis</i> Describing patterns for a single species or event-type (e.g., tests for clustering) Spatial analysis of quadrats and transects	Bailey & Gatrell 3 & 4 Kelly & Meentemeyer 2002 Oyana & Lwebuga-Mukasa 2003	ClusterSeer
Oct 12-14 <i>Fall Break 10/19</i> <i>Brown Travelling 10/21</i> Oct 26-28	<i>Geostatistical Interpolation</i> Introduction to geostatistical concepts Correlograms, variograms Trend surface analysis Estimation through kriging and its extensions	Bailey & Gatrell 5 & 6 Feng et al. 2004 Goovaerts 2000	ArcGIS, Geostatistical Analyst
Nov 2-4 <i>Brown Travelling 11/4</i> Nov 9/11	<i>Landscape pattern metrics</i> Kernel-based approaches Patch-based approaches Fractal dimension Effects of grain, extent, and data quality	Turner et al. 2001, Ch. 1, 5 Riitters et al, 1995 Rempel and Csillag, 2003 <i>Reference:</i> McGarigal, Marks, 1995	Fragstats and vLate Gergel and Turner, 2002, Ch. 7 & 8
Nov 16-18-23 <i>T'giving 11/25</i> Nov 30	<i>Measuring association among spatial variables</i> Effects of spatial autocorrelation in regression Spatial lag regression and autoregression	Bailey & Gatrell 7 & 8 Anselin 2002 Jerrett et al. 2001	GeoDa
Dec 2-7-9-14	Student Presentations		
Dec 21	Final Exam (10:30 am -12:30 pm)		

Assigned Articles

- Anselin, L. 2002. Under the hood: Issues in the specification and interpretation of spatial regression models. *Agricultural Economics*, 27: 247-267.
- Feng, Q., Liu, Y.S., and Mikami, M. 2004. Geostatistical analysis of soil moisture variability in grassland. *Journal of Arid Environments*, 58(3): 357-372.
- Fotheringham, A.S. and Brunson, C. 2004. Some thoughts on inference in the analysis of spatial data. *International Journal of Geographical Information Science*, 18(5): 447-457.
- Goovaerts, P. 2000. Geostatistical approaches for incorporating elevation into the spatial interpolation of rainfall. *Journal of Hydrology*, 228(1-2): 113-129.
- Jerrett, M., Burnett, R.T., Kanaroglou, P., Eyles, J., Finkelstein, N., Giovis, C., and Brook, J.R. 2001. A GIS-environmental justice analysis of particulate air pollution in Hamilton, Canada. *Environment and Planning A*, 33: 955-973.
- Kelly, M. and Meentemeyer, R.K. Landscape dynamics of the spread of sudden oak death. *Photogrammetric Engineering and Remote Sensing*, 68(10): 1001-1009.
- McGarigal, K. and Marks, B.J. 1995. *FRAGSTATS: spatial pattern analysis program for quantifying landscape structure*. PNW-GTR-351. Portland, OR: USDA Forest Service, Pacific Northwest Research Station, pp. 1-59. (http://www.fs.fed.us/pnw/pubs/gtr_351.pdf)
- Oyana T.J. & Lwebuga-Mukasa, J.S. 2003. Spatial relationships among asthma prevalence, healthcare utilization, and pollution sources in Buffalo neighborhoods, New York State. *Journal of Environmental Health* 66: 25-38.
- Rommel, T.K. and Csillag, F. 2003. When are two landscape pattern indices significantly different? *Journal of Geographical Systems*, 5:331-351.
- Riitters, K.H., O'Neill, R.V., Hunsaker, C.T., Wickham, J.D., Yankee, D.H., Timmons, S.P., Jones, K.B., and Jackson, B.L. 1995. A factor analysis of landscape pattern and structure metrics. *Land. Ecol.*: 10:23-40.

Other References

- Bonham-Carter, G.F. 1994. *Geographic Information Systems for Geoscientists: Modelling with GIS*. Elsevier Science, Inc.
- Cressie, N.A.C. 1991. *Statistics for Spatial Data*. John Wiley and Sons.
- Dale, M.R.T. 1999. *Spatial Pattern Analysis in Plant Ecology*. Cambridge University Press.
- Diggle, P.J. 1983. *Statistical Analysis of Spatial Point Patterns*. Academic Press.
- Fotheringham, S. Brunson, C. & Charlton, M. 2000. *Quantitative Geography: Perspectives on Spatial Analysis*. Sage.
- Gergel, S.E., and Turner, M.G., 2002. *Learning Landscape Ecology: A Practical Guide to Concepts and Techniques*. New York: Springer.
- Goovaerts, P. 1997. *Geostatistics for Natural Resources Evaluation*. Oxford University Press.
- Greig-Smith, P. 1983. *Quantitative Plant Ecology*, 3rd Edition. Berkeley: U of California.
- Griffith, D.A. and Layne, L.J. 1999. *A Casebook for Spatial Statistical Data Analysis*. Oxford University Press.
- Haining, R. 1990. *Spatial Data Analysis in the Social and Environmental Sciences*. Cambridge University Press.
- Legendre, L., and P. Legendre. 1998. *Numerical Ecology*. Elsevier
- O'Sullivan, D. and Unwin, D.J. 2003. *Geographic Information Analysis*. John Wiley and Sons.
- Ripley, B.D. 1981. *Spatial Statistics*. John Wiley and Sons.
- Upton, G.J.G., and Fingleton, B. 1985. *Spatial data analysis by example*. Volumes 1: Point pattern and quantitative data. Wiley.
- Upton, G.J.G., and Fingleton, B. 1989. *Spatial data analysis by example*. Volume 2: Categorical and directional data. Wiley.