1999 Joint Statistical Meetings, Luncheon T–14: GIS and Statistics — Present and Future

Jürgen Symanzik

George Mason University, Center for Computational Statistics 4A7, Fairfax, VA 22030, USA
symanzik@galaxy.gmu.edu, http://www.galaxy.gmu.edu/~symanzik/

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Abstract

The discussion will address the close relationships between Geographic Information Systems (GIS) and statistical software packages. Questions to be discussed, among others, are: what are the advantages of linking this type of software, how can this be realized technically, which GIS/statistics packages are currently linked, and how may this evolve in the future, in particular with respect to the World Wide Web.

Conceptual framework for geographical representations in statistical graphics

- Monmonier (1988): key term *geographic brushing*

Software solutions for exploring multivariate spatially referenced data

- McDonald & Willis (1987): Grand tour linked to an image to assess the clustering of landscape types in the band space of a LandSat image
- Carr, Littlefield, Nicholson & Littlefield (1987) and Monmonier (1989): Scatterplot matrix linked to a map view
- Unwin, Wills & Haslett (1990): REGARD — software that links map views with histograms and scatterplots and provides diagnostic plots for assessing spatial dependence
- MacDougall (1992): Exploratory system that links histograms and scatterplots with latitude and longitude (and depth) coordinates
- Carr, Olsen & White (1992): (Bivariate) ray–glyph maps linked with scatterplots
- DiBiase, Reeves, MacEachren, von Wyss, Krygier, Sloan & Detweiler (1994): Overview on existing multivariate (statistical) displays for geographic data
- Dykes (1996): *cdv* (Cartographic Data Visualizer): variety of plots linked with geography
- Openshaw & Perrée (1996): *STAC/M* (Space–Time–Attribute Creature/Movie): search for patterns in GIS data bases under the control of a Genetic Algorithm
- Brunsdon & Charlton (1996): Exploratory spatial analysis system in XLisp–Stat

- Zhang & Griffith (1997): Spatial statistical analysis module implemented in ArcView using Avenue

Software links between GISs and (graphical) statistical packages

- ArcView/XGobi link: Cook, Majure, Symanzik & Cressie (1996), Cook, Symanzik, Majure & Cressie (1997), Symanzik, Majure, Cook & Megretskaia (1997), Symanzik, Majure & Cook (1995), Majure, Cook, Symanzik & Megretskaia (1996),
  Web: `http://www.public.iastate.edu/~arcview-xgobi/homepage.html`
- ArcView/XGobi/XploRe link: Symanzik, Kötter, Schmelzer, Klinke, Cook & Swayne (1998), Symanzik, Klinke, Schmelzer, Cook & Lewin (1997), Symanzik, Cook, Klinke & Lewin (1998)
- ARC/INFO–XGobi link: Cook, Cressie, Majure & Symanzik (1994), Symanzik, Majure, Cook & Cressie (1994)
- Williams, Limp & Briuer (1990): Joint usage of S and GRASS GIS for archaeological site classification and analysis
- Scott (1994): STATA linked with ArcView
- Anselin, Dodson & Hudak (1993): Spatial data analysis software SpaceStat linked with ARC/INFO
- Klein & Moreira (1994): Interface between the image program MTID and XGobi, used for the exploratory analysis of agricultural images
- Anselin & Bao (1996) and Anselin & Bao (1997): SpaceStat linked with ArcView
- Haining, Ma & Wise (1996): Designing of a software system for interactive exploration of spatial data by linking to ARC/INFO
- MathSoft (1996): S+GISLink, a bidirectional link between ARC/INFO and S–PLUS
- Bao (1997): S+Grassland link between S–PLUS and Grassland GIS
- Bao & Anselin (1997): Comparison of the operational issues of the SpaceStat/ArcView link and the S+Grassland link

Approaches for linking geographic packages with statistical packages

- Goodchild, Haining & Wise (1992): Introduction of terms *close coupling* and *loose coupling*
- Close Coupling: one package is calling other packages directly or this package is calling user–written routines using InterProcess Communication (IPC) facilities such as Remote Procedure Calls — examples: S+Grassland link, ArcView/XGobi/XploRe link
- Loose Coupling: multiple processes simultaneously access (read and write) the same file(s) or they simply pass data files (ASCII or binary) among each other — examples: link between ArcView and SpaceStat and the software system designed by Haining et al. (1996)
- Web–based approaches — examples: Burk & Lime (1998) (`http://www.gis.umn.edu/fornet`)

References

Anselin, L. & Bao, S. (1996), Exploratory Spatial Data Analysis Linking SpaceStat and ArcView, Technical Report 9618, West Virginia University, Morgantown, WV.

Anselin, L. & Bao, S. (1997), Exploratory Spatial Data Analysis Linking SpaceStat and ArcView, *in* M. M. Fischer & A. Getis, eds, 'Recent Developments in Spatial Analysis', Springer, Berlin, pp. 35–59.

Anselin, L., Dodson, R. F. & Hudak, S. (1993), 'Linking GIS and Spatial Data Analysis in Practice', *Geographical Systems* **1**(1), 3–23.

Bao, S. (1997), *User's Reference for the S+Grassland Link*, Mathsoft, Inc., Seattle, WA.

Bao, S. & Anselin, L. (1997), Linking Spatial Statistics with GIS: Operational Issues in the SpaceStat–ArcView Link and the S+Grassland Link, *in* '1997 Proceedings of the Section on Statistical Graphics', American Statistical Association, Alexandria, VA, pp. 61–66.

Brunsdon, C. & Charlton, M. (1996), Developing an Exploratory Spatial Analysis System in XLisp–Stat, *in* D. Parker, ed., 'Innovations in GIS 3', Taylor & Francis, London, U.K., pp. 135–145.

Burk, T. E. & Lime, S. D. (1998), 'Advanced Internet Tools for Communicating Spatial Data', *Computing Science and Statistics* **30**, 37–41.

Carr, D. B., Littlefield, R. J., Nicholson, W. L. & Littlefield, J. S. (1987), 'Scatterplot Matrix Techniques for Large N', *Journal of the American Statistical Association* **82**(398), 424–436.

Carr, D. B., Olsen, A. R. & White, D. (1992), 'Hexagon Mosaic Maps for Displays of Univariate and Bivariate Geographical Data', *Cartography and Geographic Information Systems* **19**(4), 228–236, 271.

Cook, D., Cressie, N., Majure, J. & Symanzik, J. (1994), Some Dynamic Graphics for Spatial Data (with Multiple Attributes) in a GIS, *in* R. Dutter & W. Grossmann, eds, 'COMPSTAT 1994: Proceedings in Computational Statistics', Physica–Verlag, Heidelberg, pp. 105–119.

Cook, D., Majure, J. J., Symanzik, J. & Cressie, N. (1996), 'Dynamic Graphics in a GIS: Exploring and Analyzing Multivariate Spatial Data Using Linked Software', *Computational Statistics: Special Issue on Computeraided Analysis of Spatial Data* **11**(4), 467–480.

Cook, D., Symanzik, J., Majure, J. J. & Cressie, N. (1997), 'Dynamic Graphics in a GIS: More Examples Using Linked Software', *Computers and Geosciences: Special Issue on Exploratory Cartographic Visualization* **23**(4), 371–385. Paper, CD, and `http://www.elsevier.nl/locate/cgvis`.

DiBiase, D., Reeves, C., MacEachren, A. M., von Wyss, M., Krygier, J. B., Sloan, J. L. & Detweiler, M. C. (1994), Multivariate Display of Geographic Data: Applications in Earth System Science, *in* A. M. MacEachren & D. R. F. Taylor, eds, 'Visualization in Modern Cartography', Pergamon (Elsevier), Oxford, U.K., pp. 287–312.

Dykes, J. (1996), Dynamic Maps for Spatial Science: A Unified Approach to Cartographic Visualization, *in* D. Parker, ed., 'Innovations in GIS 3', Taylor & Francis, London, U.K., pp. 177–187.

Goodchild, M. F., Haining, R. P. & Wise, S. (1992), 'Integrating GIS and Spatial Data Analysis: Problems and Possibilities', *International Journal of Geographical Information Systems* **6**(5), 407–423.

Haining, R., Ma, J. & Wise, S. (1996), 'Design of a Software System for Interactive Spatial Statistical Analysis Linked to a GIS', *Computational Statistics: Special Issue on Computeraided Analysis of Spatial Data* **11**(4), 449–466.

Klein, R. & Moreira, R. I. (1994), Exploratory Analysis of Agricultural Images via Dynamic Graphics, Technical Report 9/94, Laboratório Nacional de Computação Científica, Rio de Janeiro, Brazil.

MacDougall, E. B. (1992), 'Exploratory Analysis, Dynamic Statistical Visualization, and Geographic Information Systems', *Cartography and Geographic Information Systems* **19**(4), 237–246.

Majure, J. J., Cook, D., Symanzik, J. & Megretskaia, I. (1996), 'An Interactive Environment for the Graphical Analysis of Spatial Data', ASA Statistical Graphics Video Lending Library (contact: dfs@research.att.com).

MathSoft (1996), *S+GISLink*, MathSoft, Inc., Seattle, WA.

McDonald, J. A. & Willis, S. (1987), 'Use of the Grand Tour in Remote Sensing', ASA Statistical Graphics Video Lending Library (contact: dfs@research.att.com).

Monmonier, M. (1988), Geographical Representations in Statistical Graphics: A Conceptual Framework, *in* '1988 Proceedings of the Section on Statistical Graphics', American Statistical Association, Alexandria, VA, pp. 1–10.

Monmonier, M. (1989), 'Geographic Brushing: Enhancing Exploratory Analysis of the Scatterplot Matrix', *Geographical Analysis* **21**(1), 81–84.

Openshaw, S. & Perrée, T. (1996), User–Centred Intelligent Spatial Analysis of Point Data, *in* D. Parker, ed., 'Innovations in GIS 3', Taylor & Francis, London, U.K., pp. 119–134.

Scott, L. M. (1994), 'Identification of a GIS Attribute Error Using Exploratory Data Analysis', *The Professional Geographer* **46**(3), 378–386.

Symanzik, J., Cook, D., Klinke, S. & Lewin, N. (1998), Exploration of Satellite Images in the Dynamically Linked ArcView/XGobi/XploRe Environment, *in* B. A. Bodt, ed., 'Proceedings of the Third Annual U.S. Army Conference on Applied Statistics, 22–24 October 1997', Army Research Laboratory ARL–SR–74, Aberdeen Proving Ground, MD, pp. 23–33.

Symanzik, J., Klinke, S., Schmelzer, S., Cook, D. & Lewin, N. (1997), The ArcView/XGobi/XploRe Environment: Technical Details and Applications for Spatial Data Analysis, *in* '1997 Proceedings of the Section on Statistical Graphics', American Statistical Association, Alexandria, VA, pp. 73–78.

Symanzik, J., Kötter, T., Schmelzer, S., Klinke, S., Cook, D. & Swayne, D. (1998), 'Spatial Data Analysis in the Dynamically Linked ArcView/XGobi/XploRe Environment', *Computing Science and Statistics* **29**(1), 561–569.

Symanzik, J., Majure, J., Cook, D. & Cressie, N. (1994), 'Dynamic Graphics in a GIS: A Link between ARC/INFO and XGobi', *Computing Science and Statistics* **26**, 431–435.

Symanzik, J., Majure, J. J. & Cook, D. (1995), 'Dynamic Graphics in a GIS: Analyzing and Exploring Multivariate Spatial Data', ASA Statistical Graphics Video Lending Library (contact: dfs@research.att.com).

Symanzik, J., Majure, J. J., Cook, D. & Megretskaia, I. (1997), Linking ArcView 3.0 and XGobi: Insight Behind the Front End, Technical Report 97–10, Department of Statistics, Iowa State University, Ames, Iowa.

Unwin, A., Wills, G. & Haslett, J. (1990), REGARD — Graphical Analysis of Regional Data, *in* '1990 Proceedings of the Section on Statistical Graphics', American Statistical Association, Alexandria, VA, pp. 36–41.

Williams, I., Limp, W. F. & Briuer, F. L. (1990), Using Geographic Information Systems and Exploratory Data Analysis for Archaeological Site Classification and Analysis, *in* K. M. S. Allen, S. W. Green & E. B. W. Zubrow, eds, 'Iinterpreting Space: GIS and Archaeology', Taylor & Francis, London, U.K., pp. 239–273.

Zhang, Z. & Griffith, D. A. (1997), 'Developing User–Friendly Spatial Statistical Analysis Modules for GIS: An Example using ArcView', *Computers, Environment and Urban Systems* **21**(1), 5–29.