



Center for Spatially Integrated Social Science

New Tools for Spatial Data Analysis in the Social Sciences

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Outline

- **Background**
- **Visualizing Spatial and Space-Time Association**
- **DynESDA2**
- **What's Next - Future Directions**

Background

CSISS Tools Program

- **Software Tools Clearing House**
- **The OpenSpace Project**
- **Dynamic ESDA with GIS**

Software Tools Clearing House

➤ Search Engine

- specialized searches focused on spatial data analysis methods and software

➤ Links to Portals

- portals with links to spatial data analysis sites

➤ Links to Tools


- selected software sites, academic, commercial, public sector, individuals

Center for Spatially Integrated Social Science (CSISS) - Microsoft Internet Explorer

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Back Forward Stop Home Search Favorites History Print Mail News RSS

Address <http://www.csis.org/> Go



Center for Spatially Integrated Social Science
Spatial Resources for the Social Sciences

The **CSISS Mission** recognizes the growing significance of space, spatiality, location, and place in social science research. It seeks to develop unrestricted access to tools and perspectives that will advance the spatial analytic capabilities of researchers throughout the social sciences. CSISS is funded by the [National Science Foundation](#) under its program of support for infrastructure in the social and behavioral sciences.

[CSISS News](#) [Apply now for the 2002 CSISS Summer Workshops!](#)

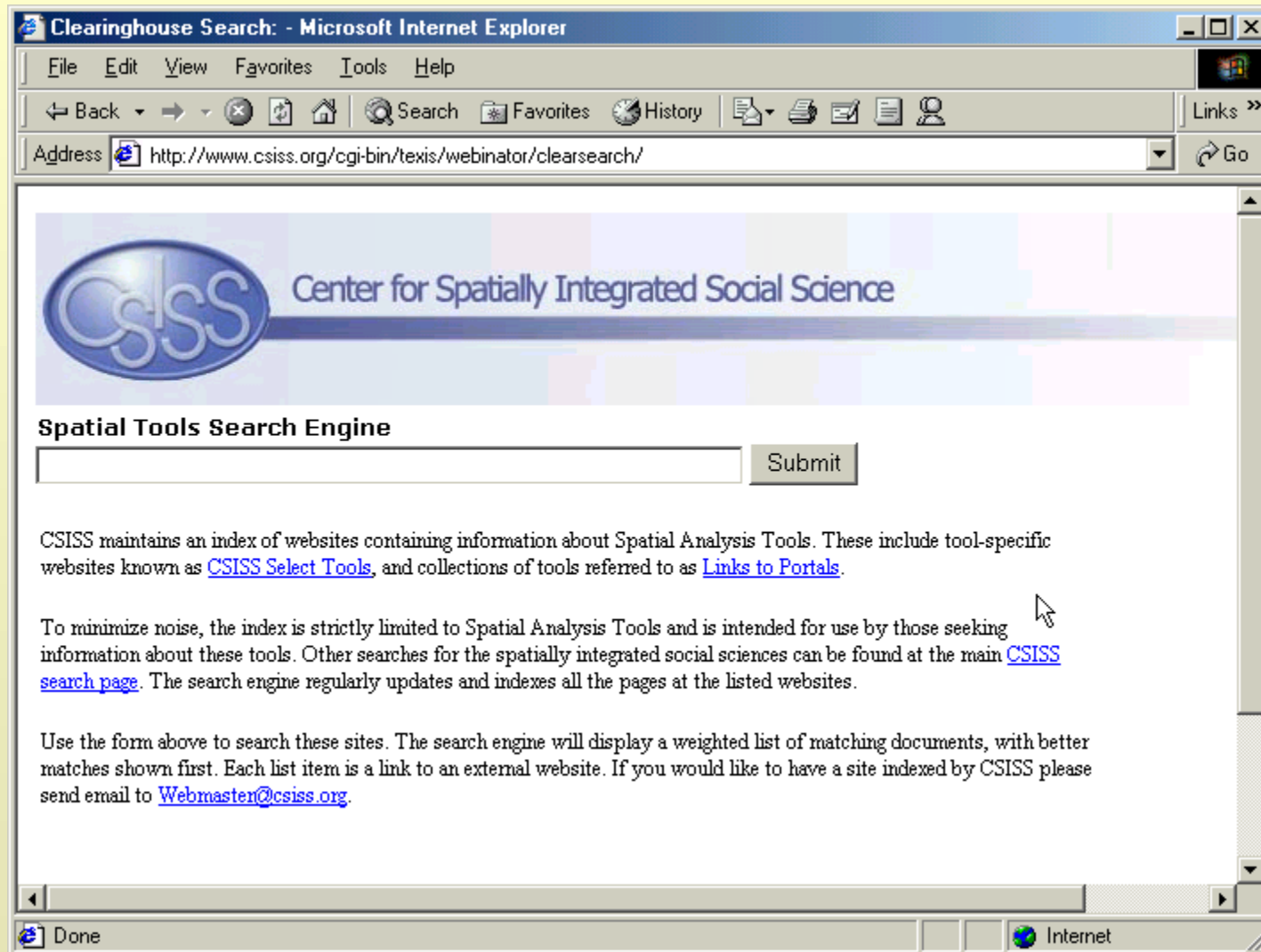
<p>Core Programs</p> <p>These six infrastructure programs form the core of the Center's activities.</p>	<p>Learning Resources</p> <p>These introductory materials include CSISS Classics and select video clips from the CSISS summer workshops.</p>	<p>Spatial Resources</p> <p>CSISS has compiled e-journals, bibliographies, and other spatial resources for the social sciences.</p>	<p>Spatial Tools</p> <p>Spatial Tools Search Engine</p> <p>Select Tools</p> <p>Links to Portals</p>
<p>Search Engines</p> <p>Try CSISS's custom search engine to find spatial analysis resources on the Internet.</p>	<p>CSISS Events</p> <p>Here's where you'll find information and registration for workshops, conferences and specialist meetings.</p>	<p>Community Center</p> <p>Join one of the forums on topics such as spatial equity, spatial externalities, and spatial econometrics.</p>	<p>About CSISS</p> <p>CSISS people, programs and the original NSF proposal are described here.</p>

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Internet

Spatial Tools Search Engine



The screenshot shows a Microsoft Internet Explorer browser window titled "Clearinghouse Search: - Microsoft Internet Explorer". The address bar contains the URL "http://www.csiss.org/cgi-bin/texis/webinator/clearsearch/". The page content includes the CSISS logo and the text "Center for Spatially Integrated Social Science". Below this is the heading "Spatial Tools Search Engine" followed by a search input field and a "Submit" button. The page also contains several paragraphs of text explaining the search engine's purpose and providing contact information for site indexing.

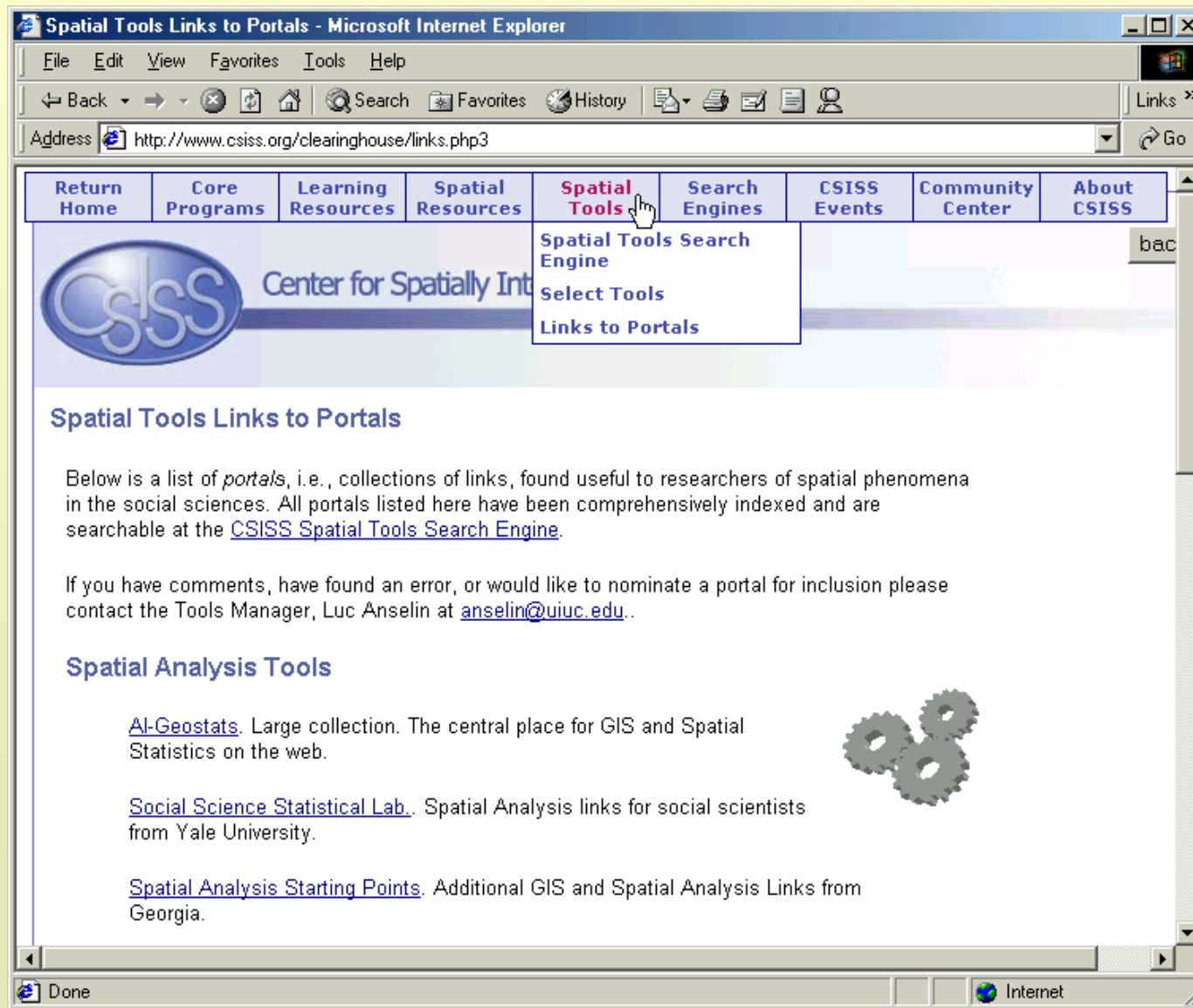
Spatial Tools Search Engine

CSISS maintains an index of websites containing information about Spatial Analysis Tools. These include tool-specific websites known as [CSISS Select Tools](#), and collections of tools referred to as [Links to Portals](#).

To minimize noise, the index is strictly limited to Spatial Analysis Tools and is intended for use by those seeking information about these tools. Other searches for the spatially integrated social sciences can be found at the main [CSISS search page](#). The search engine regularly updates and indexes all the pages at the listed websites.

Use the form above to search these sites. The search engine will display a weighted list of matching documents, with better matches shown first. Each list item is a link to an external website. If you would like to have a site indexed by CSISS please send email to Webmaster@csiss.org.

Links to Spatial Tools Portals




Spatial Tools Links to Portals - Microsoft Internet Explorer

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Back Forward Stop Home Search Favorites History Print Mail News RSS User Links >>

Address <http://www.csiss.org/clearinghouse/links.php3> Go

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 Center for Spatially Int

Spatial Tools Search Engine
Select Tools
Links to Portals

Spatial Tools Links to Portals

Below is a list of *portals*, i.e., collections of links, found useful to researchers of spatial phenomena in the social sciences. All portals listed here have been comprehensively indexed and are searchable at the [CSISS Spatial Tools Search Engine](#).


If you have comments, have found an error, or would like to nominate a portal for inclusion please contact the Tools Manager, Luc Anselin at anselin@uiuc.edu.

Spatial Analysis Tools

[AI-Geostats](#). Large collection. The central place for GIS and Spatial Statistics on the web.

[Social Science Statistical Lab.](#) Spatial Analysis links for social scientists from Yale University.

[Spatial Analysis Starting Points](#). Additional GIS and Spatial Analysis Links from Georgia.



Done Internet

Select Tools


Spatial Tools Clearinghouse - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites History

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 Center for Spatially Int... [Spatial Tools Search Engine](#) [Select Tools](#) [Links to Portals](#) [back](#)

CSISS Select Tools

Below is a list of *Spatial Analysis Tools*. CSISS researchers have chosen these tools for their usefulness in aiding the exploration and analysis of spatial phenomena in the social sciences. This list is by no means complete and, it is hoped, will continue to grow with input from the research community. Inclusion on this list is not an endorsement by CSISS. If you have comments, have found an error, or would like to nominate a tool for inclusion please contact the Tools Manager, Luc Anselin at anselin@uiuc.edu.

All websites on this page have been comprehensively indexed by the [CSISS Spatial Tools Search Engine](#).

Cartographic Data Visualizer (CDV)
<http://www.kinds.ac.uk/kinds/cdy.htm>
A visual, interactive, graphic front end for analyzing spatial datasets.

ClusterSeer
http://www.terraseer.com/csr/clusterseer_features.html
ClusterSeer provides statistics for evaluating disease clusters in space and time.

CrimeStat
<http://www.icpsr.umich.edu/NACJD/crimestat.html>
A spatial statistics program for the analysis of crime incident locations.

Fragstats
<http://www.umass.edu/landeco/research/fragstats/fragstats.html>
Computation of wide variety of landscape metrics for categorical map patterns.

Done Internet

OpenSpace Project

➤ Goal

- develop collection of open source spatial data analysis modules that incorporate state of the art methods
 - » moving target requires open environment

➤ Organization

- core development team at UIUC
- facilitating a community of collaborators

OpenSpace Development

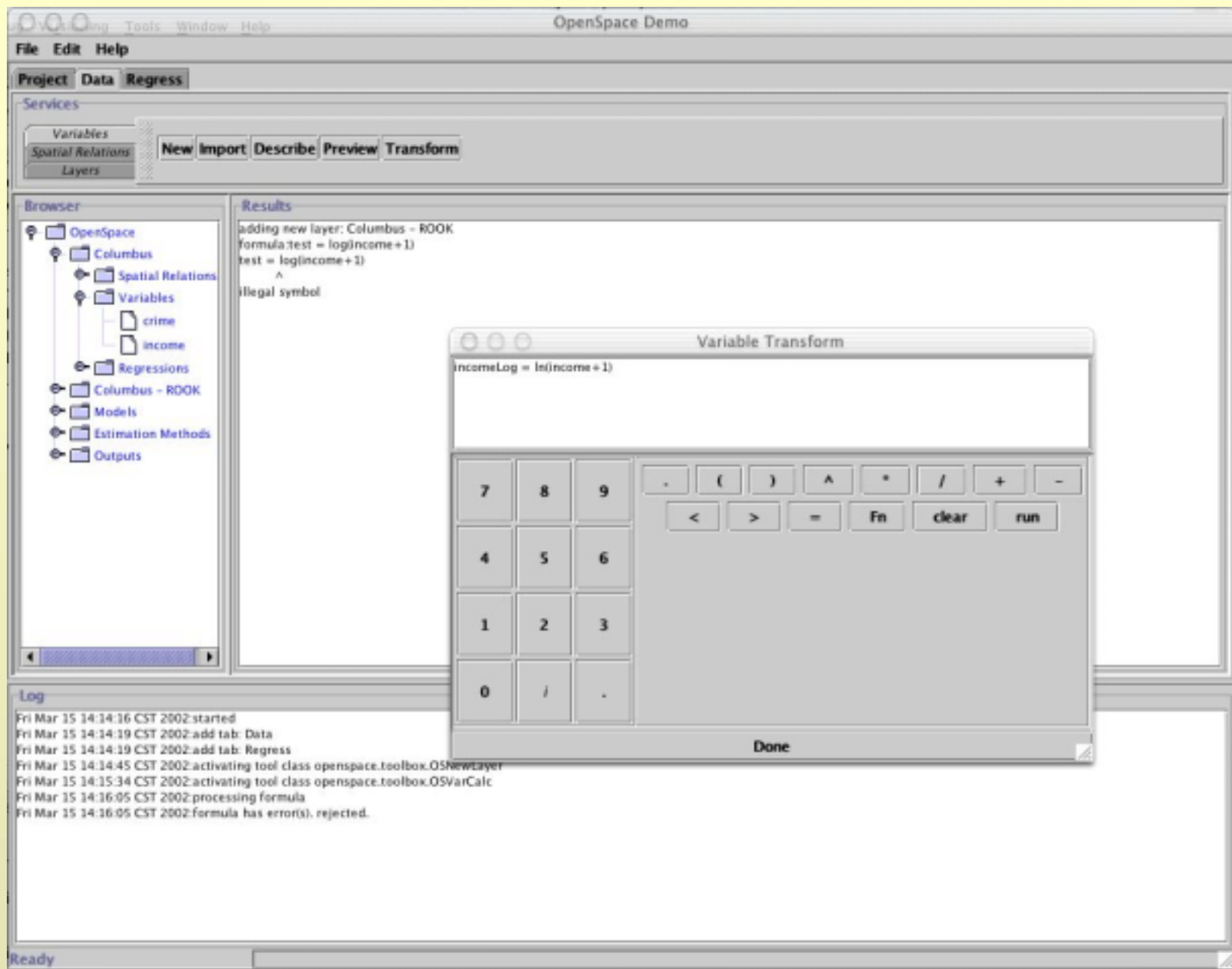
➤ Cross Platform Tools

- open source software development
 - » Python + Numpy, Jython, Java
 - » to run on linux, windows, mac
- open source toolboxes
 - » Xlispstat, R, ...

OpenSpace Functionality

➤ Modular

- common **kernel** of basic classes
- develop **collection of modular components**
 - » library, modules, packages
 - » all the basic techniques (estimation, diagnostics)
 - » open design allows for high end users/programmers



Results

adding new layer: Columbus - ROOK
formula: test = log(income + 1)
test = log(income + 1)
^
illegal symbol

Variable Transform

IncomeLog = ln(income + 1)

7	8	9	.	()	^	*	/	+	-
4	5	6	<	>	=	Fn	clear	run		
1	2	3								
0	/	.								

Done

Log

Fri Mar 15 14:14:16 CST 2002: started
Fri Mar 15 14:14:19 CST 2002: add tab: Data
Fri Mar 15 14:14:19 CST 2002: add tab: Regress
Fri Mar 15 14:14:45 CST 2002: activating tool class openspace.toolbox.OSNewLayer
Fri Mar 15 14:15:34 CST 2002: activating tool class openspace.toolbox.OSVarCalc
Fri Mar 15 14:16:05 CST 2002: processing formula
Fri Mar 15 14:16:05 CST 2002: formula has error(s), rejected.

Ready

Visualizing Spatial and Space-Time Association

Space-Time ESDA

➤ Extensions

- Space-time linking and brushing
- Space-time Moran Scatterplot
- Space-time LISA

Combining Space and Time

➤ Perspectives

- “Lattice data” = **discrete objects** (not surface)
- **Pooled analysis** = combining all time periods
- **Comparative statics** = cross-sectional slices at different points in time
- **True Space-Time dynamics** = dependence of x at i and t on “neighbors” at $t-h$

➤ Metric

- What are **neighbors in space-time**
- Importance of dynamics of the processes studied = **scale**

Moran Scatterplot Extensions

➤ Generalized Moran Scatterplot

- Regression slope of Wz_2 on z_1
 - » Both variables standardized
 - » = visualization of Wartenberg **multivariate Moran statistic**
- Significance testing
 - » Permutation
 - » **Permutation envelope** (2.5% and 97.5% from permutation reference distribution)

➤ Four Types of Association

- High-high, Low-low; High-low, Low-high

LISA Extensions

➤ Generalization of Local Moran

- $z_{1i} \times \sum_j w_{ij} z_{2j}$

- » z_1 and z_2 different variables,
or same variable at different times

➤ Inference

- Null hypothesis

- » random assignment between value of z_1 at i, t
and “neighboring” values of z_2

LISA Extensions (2)

- **Space-Time Cluster = Diffusion/Contagion**
 - High (above avg) values at a **location surrounded** by High values **at different time**
 - » Compare to high-high same time
 - Similar for Low-Low
- **Space-Time Outlier = Change**
 - High (above avg) surrounded by Low (below avg) at different time
 - Similar for Low-High
- **Significance based on permutation**

DynESDA2

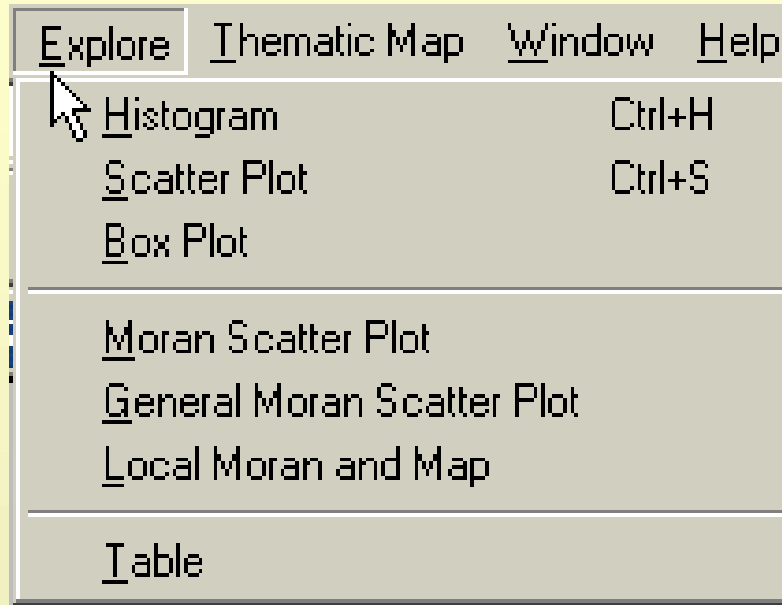
Antecedents

- **Link ArcInfo-SpaceStat**
- **Link ArcView-SpaceStat**
 - SpaceStat Extension for ArcView
 - » visualize **ESDA results** from SpaceStat
 - » construct **spatial weights**
 - DynESDA Extension for ArcView
 - » **dynamic linking** of View and statistical graphs
 - » link map, histogram, box plot, scatterplot
 - » Moran Scatterplot

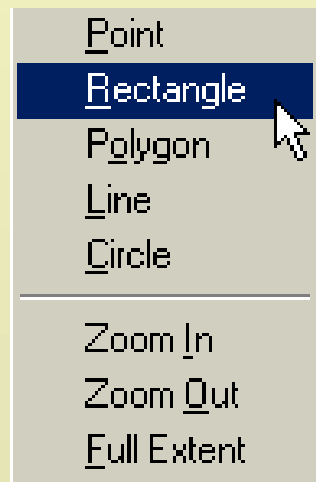
DynESDA2 Design

- **Map as One of the Views**
 - no longer ArcView driven
 - MapObjects Lite for mapping functionality
 - **multiple maps** linked
 - transparent selection identifier
- **Modular Design**
 - modules for statistical graphics
 - modules for mapping function
 - linked through common bitmap

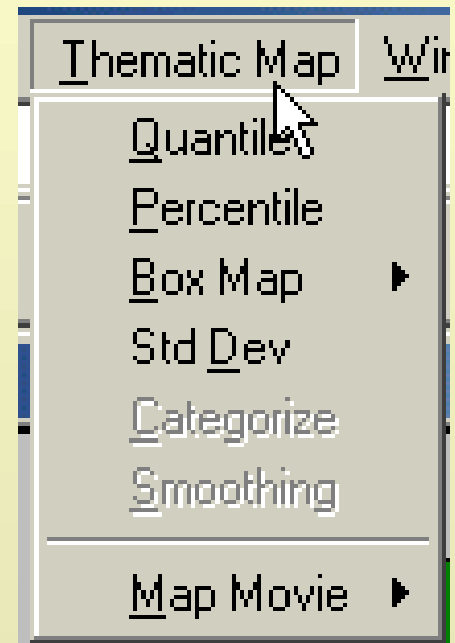
User Interfaces



< Explore Menu



< Selection Tools

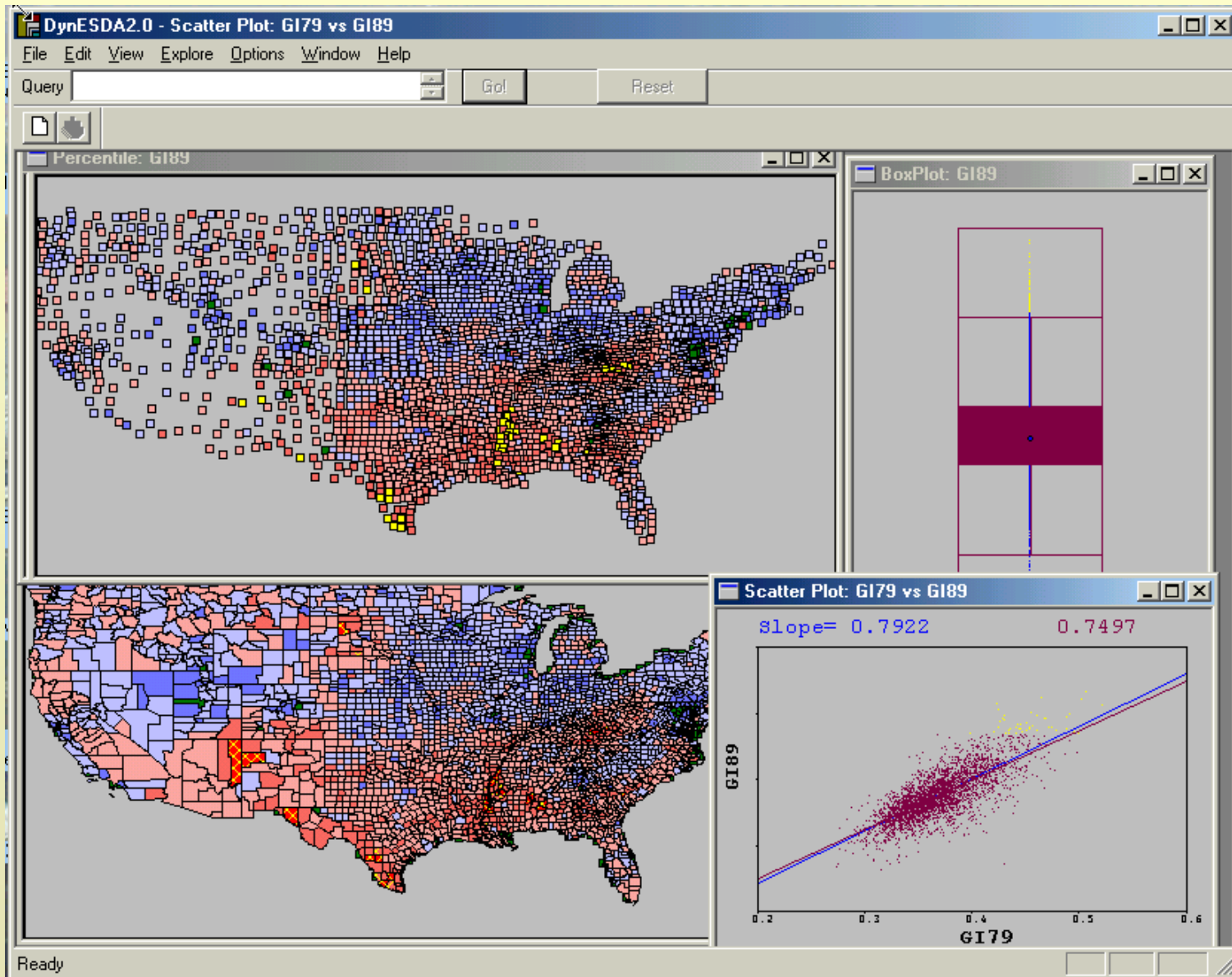


Mapping Menu

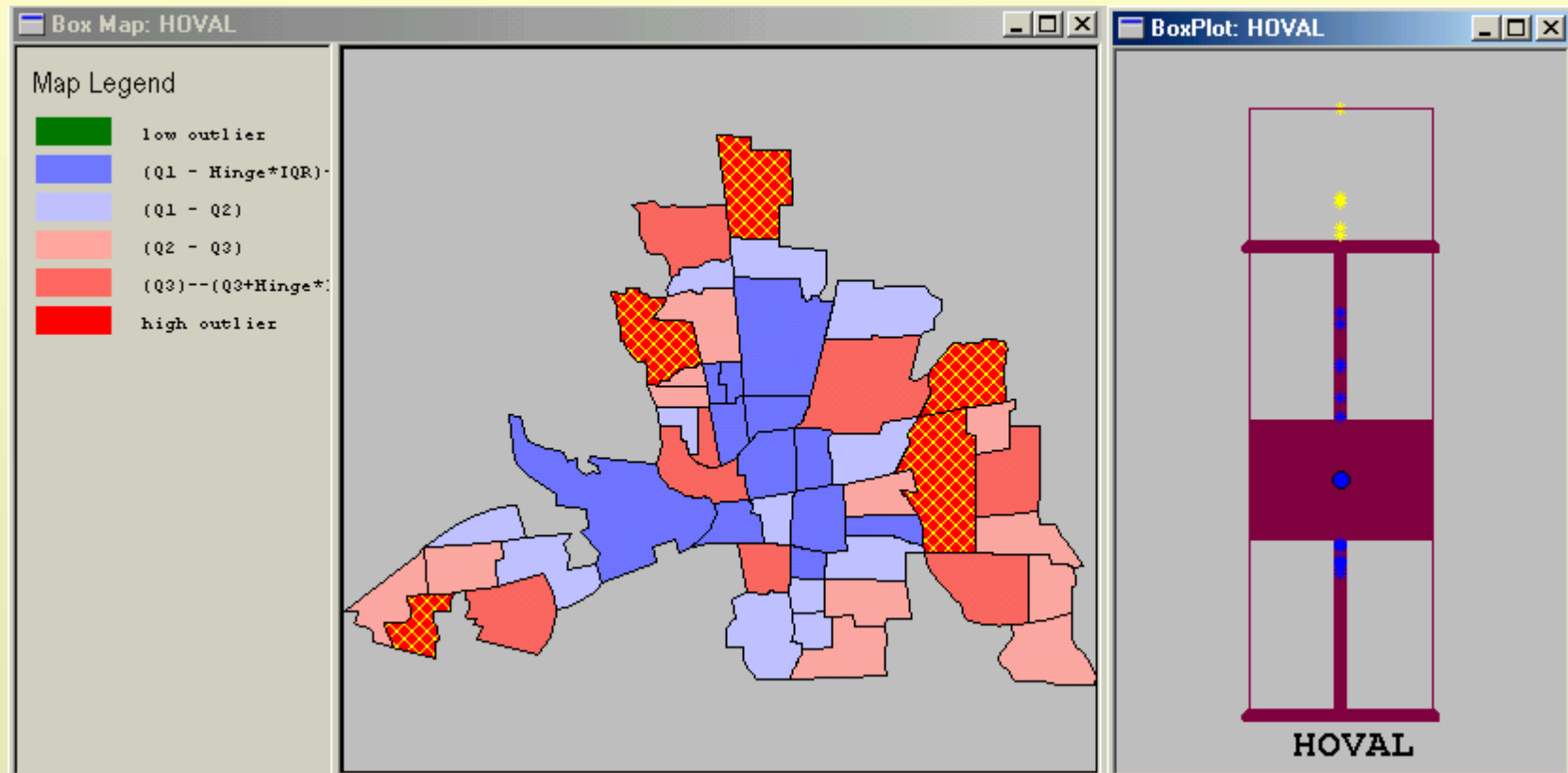
New Features

- **Data Structure**
 - both **polygon and point** shape files
 - Thiessen polygons – centroids
- **Brushing**
 - brushing of **multiple maps**
 - linking to table
- **Visualizing Spatial Autocorrelation**
 - **generalized Moran** scatterplot
 - linking and brushing **LISA maps**

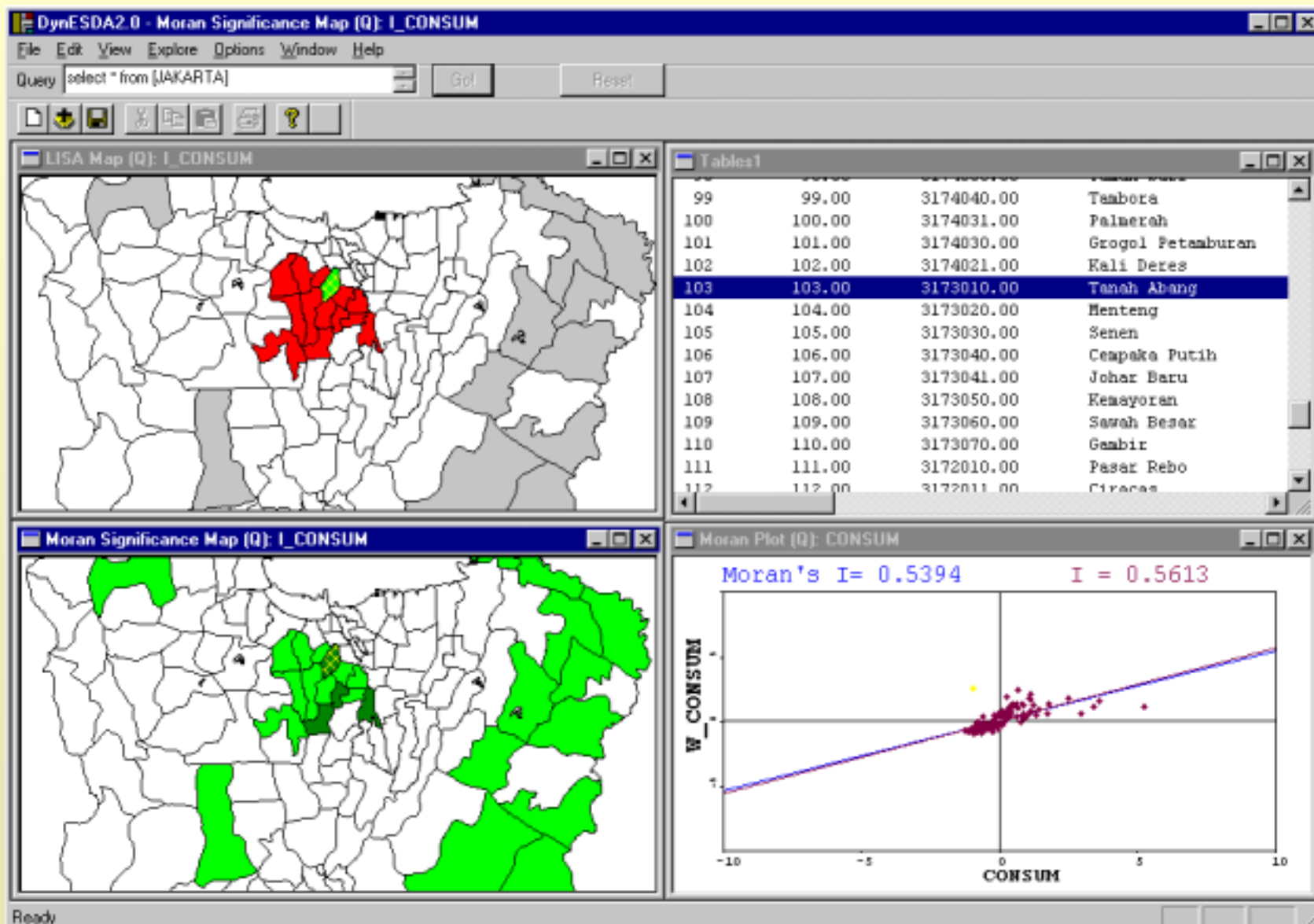
Linking Point and Polygon Maps



Box Map and Box Plot

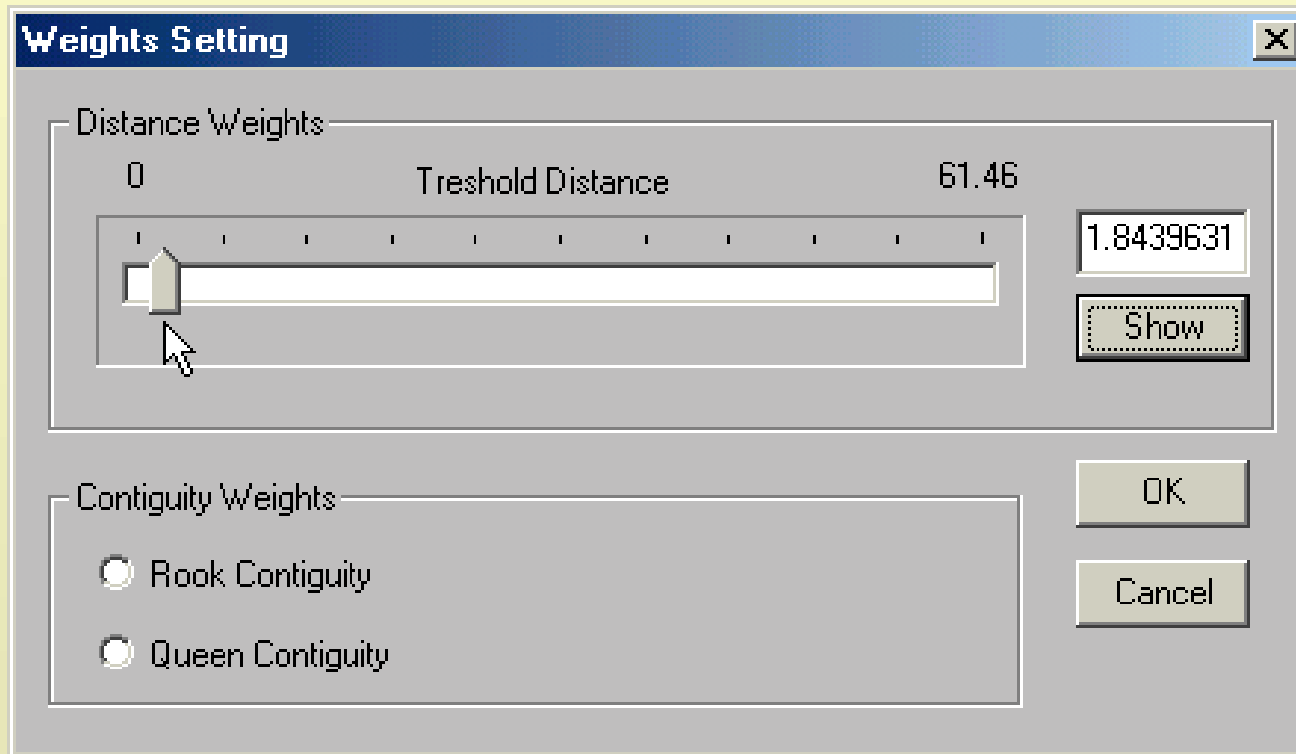


LISA Maps Linked to Table and Moran Scatterplot



Weights Construction

Distance Weights
Contiguity Weights



The image shows a software dialog box titled "Weights Setting" with a close button (X) in the top right corner. The dialog is divided into two main sections: "Distance Weights" and "Contiguity Weights".

Distance Weights Section:

- Labels "0" and "61.46" are positioned at the left and right ends of a horizontal slider, respectively.
- The text "Treshold Distance" is centered above the slider.
- The slider has a vertical bar with tick marks along its top edge.
- A mouse cursor is pointing at the slider's handle, which is currently positioned near the left end.
- To the right of the slider is a text input field containing the value "1.8439631".
- Below the input field is a button labeled "Show".

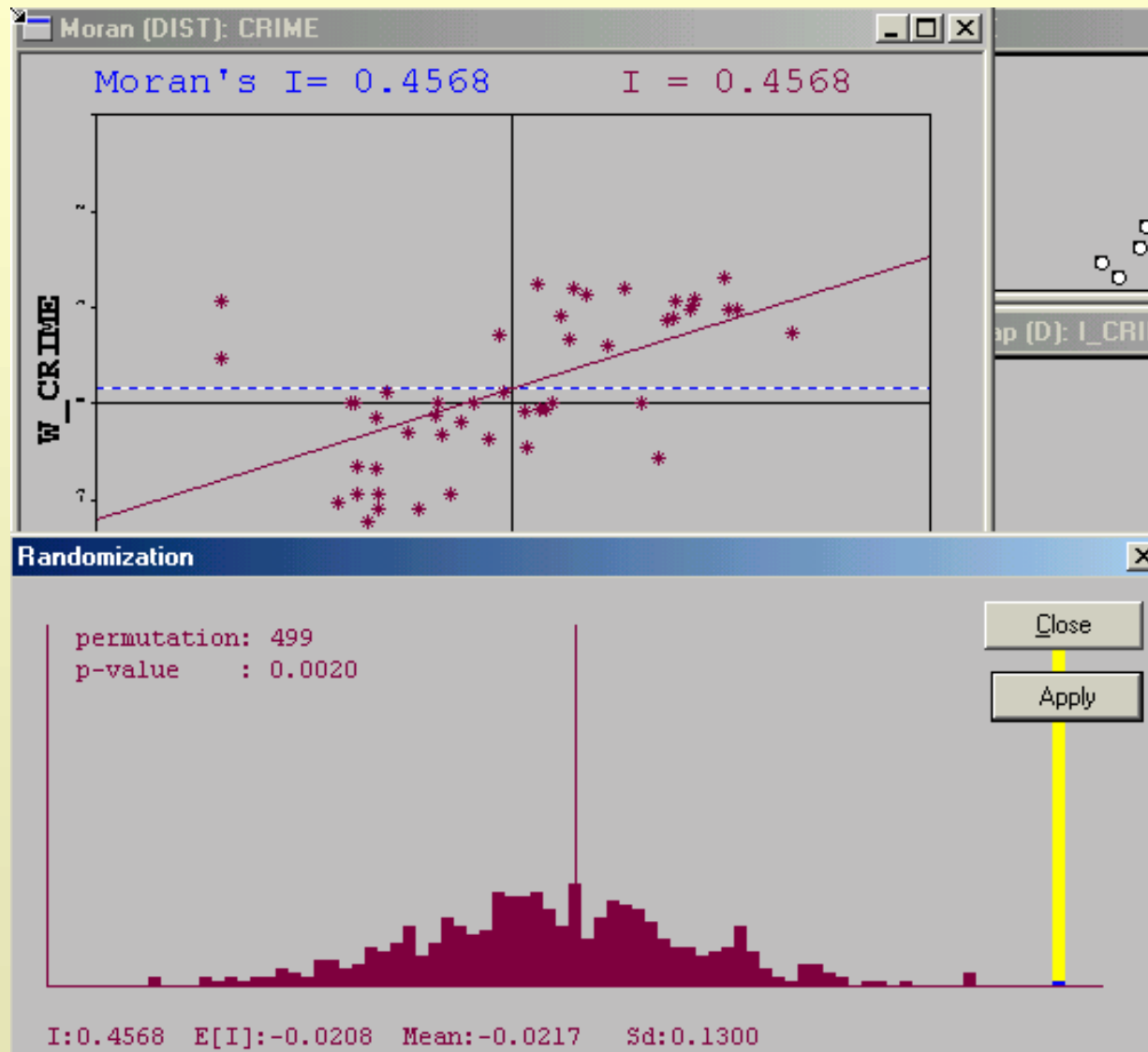
Contiguity Weights Section:

- Two radio buttons are present, labeled "Rook Contiguity" and "Queen Contiguity".
- The "Queen Contiguity" radio button is selected.

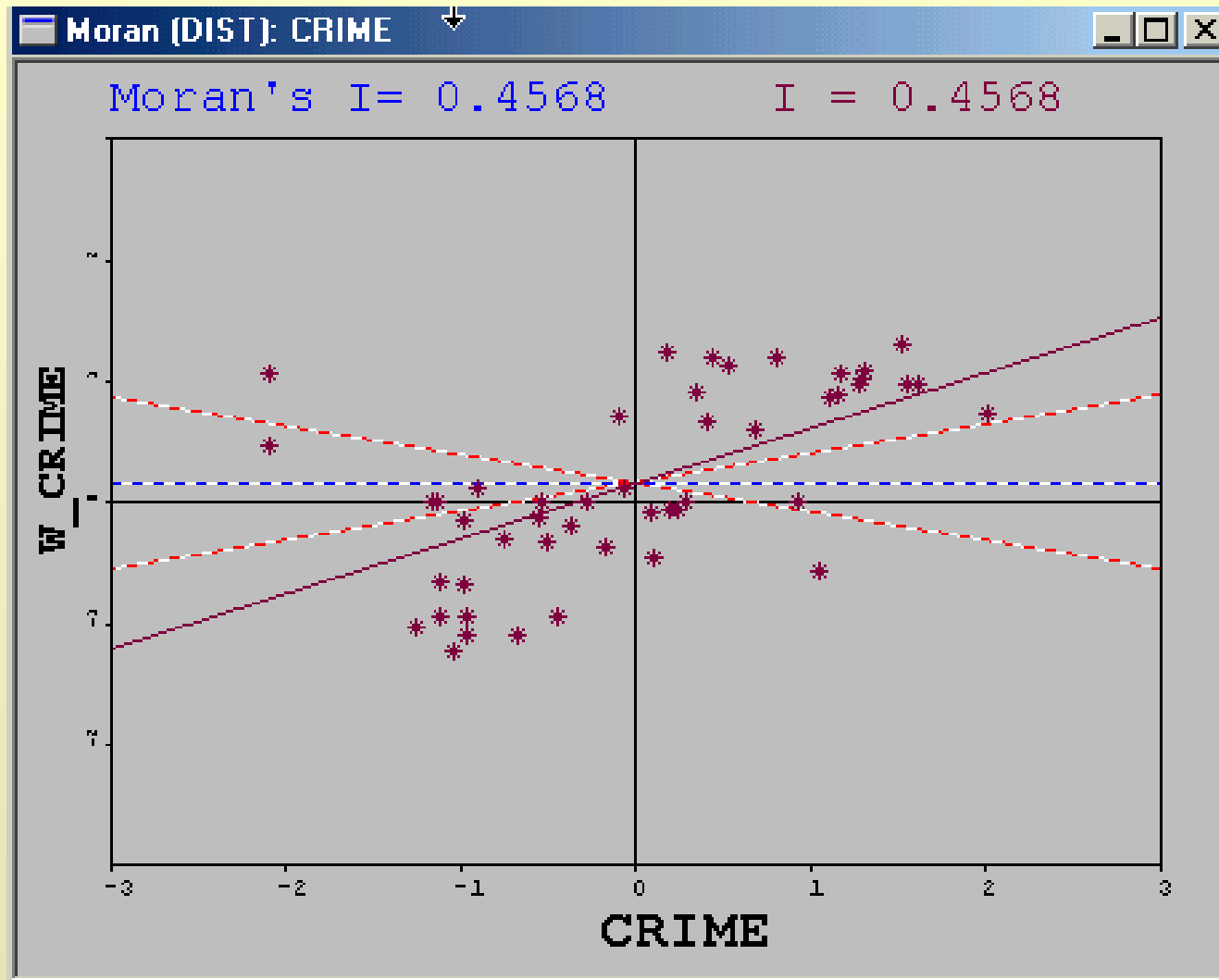
Buttons:

- An "OK" button is located to the right of the "Contiguity Weights" section.
- A "Cancel" button is located below the "OK" button.

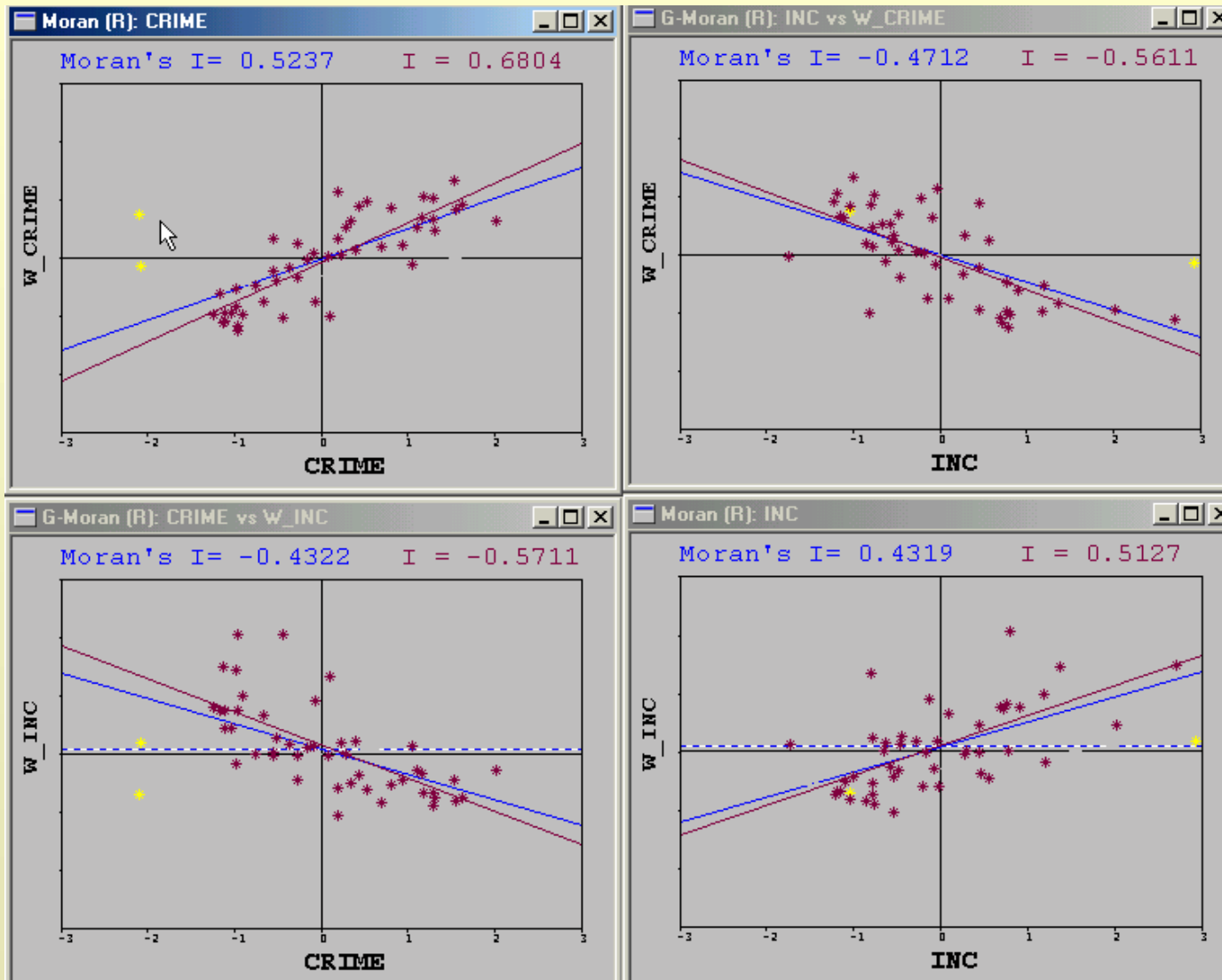
Randomization in Moran Scatterplot



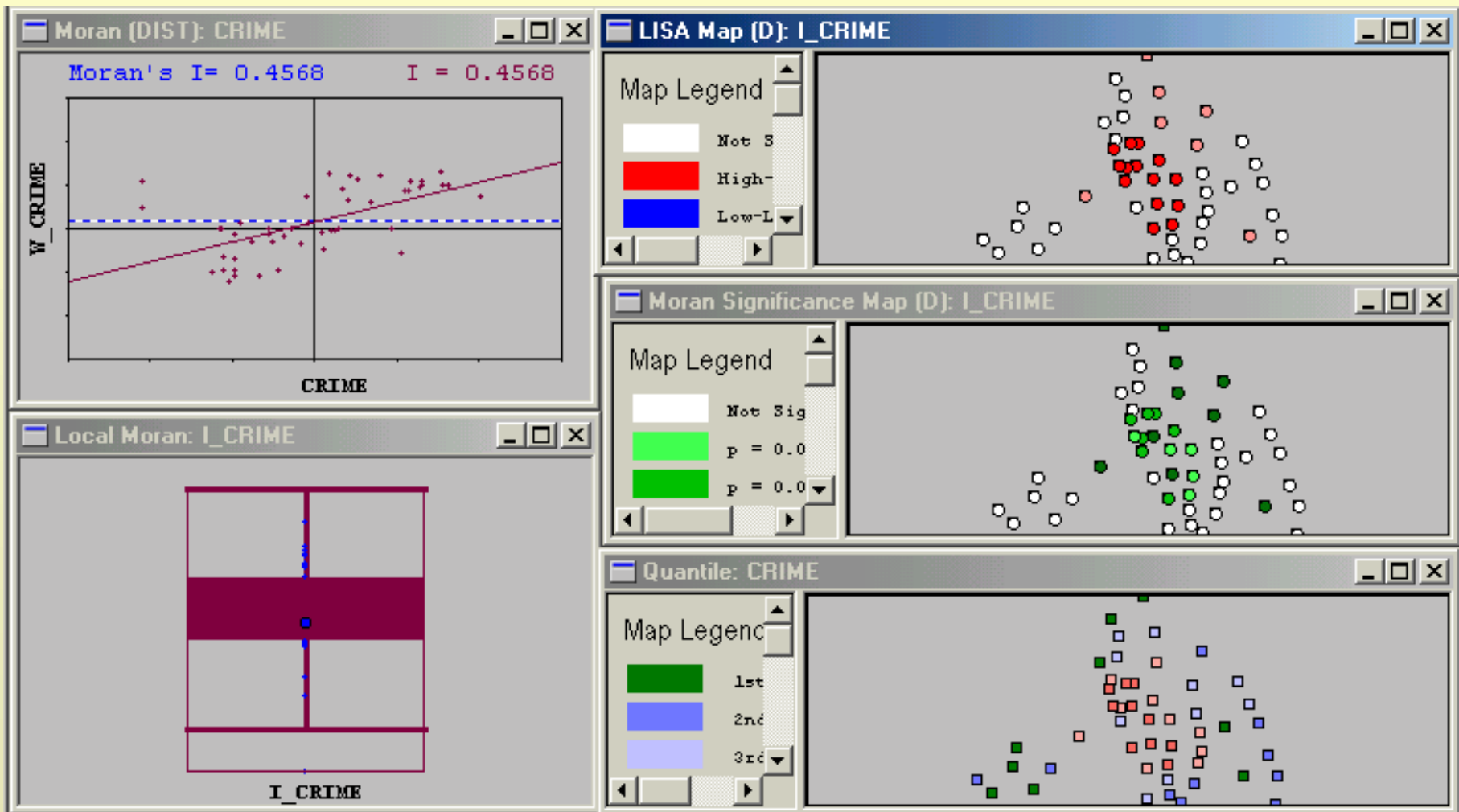
Significance Envelope



Generalized Moran Scatterplot Matrix



Linked LISA Map Suite



Future

What's Next

- **Tool Developers Specialist Meeting**
 - compendium/showcase of tools
 - white paper on standards, interoperability
- **DynESDA2 Beta Release**
 - late spring
- **Template for Linear Regression**
 - libraries in Xlispstat, Python, Java
 - links to related work (R project)
 - » diagnostics for spatial effects
 - » ML estimation of spatial regression
 - » IV/GMM estimation of spatial regression

Future Directions

➤ Performance Issues

- extend DynESDA functionality to large data sets

➤ New Methods

- space-time regression models
- spatial probit

➤ New Platforms

- web-based spatial data analysis