



Center for Spatially Integrated Social Science

# **Spatial Autocorrelation (4)**

## **Local Spatial Autocorrelation**

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# Outline

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- Concepts
- Local Moran
- G Statistics

Concepts

# Local and Global Analysis

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## ➤ Global

- one statistic to summarize pattern
- clustering
- homogeneity

## ➤ Local

- location-specific statistics
- clusters
- heterogeneity

# LISA Definition (Anselin 1995)

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- LISA satisfies two requirements
  - indicate significant spatial clustering for each location
  - sum of LISA proportional to a global indicator of spatial association
- LISA Forms of Global Statistics
  - local Moran, local Geary, local Gamma

# Use of LISA

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## ➤ Identify Hot Spots

- significant **local clusters** in the absence of global autocorrelation
  - some complications in the presence of global autocorrelation (extra heterogeneity)
- significant **local outliers**
  - high surrounded by low and vice versa

## ➤ Indicate Local Instability

- local deviations from global pattern of spatial autocorrelation

# Local Moran

# Local Moran

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## ➤ Local Moran Statistic

- $I_i = (z_i / m_2) \sum_j w_{ij} \cdot z_j$
- $\sum_i I_i = N \cdot I$

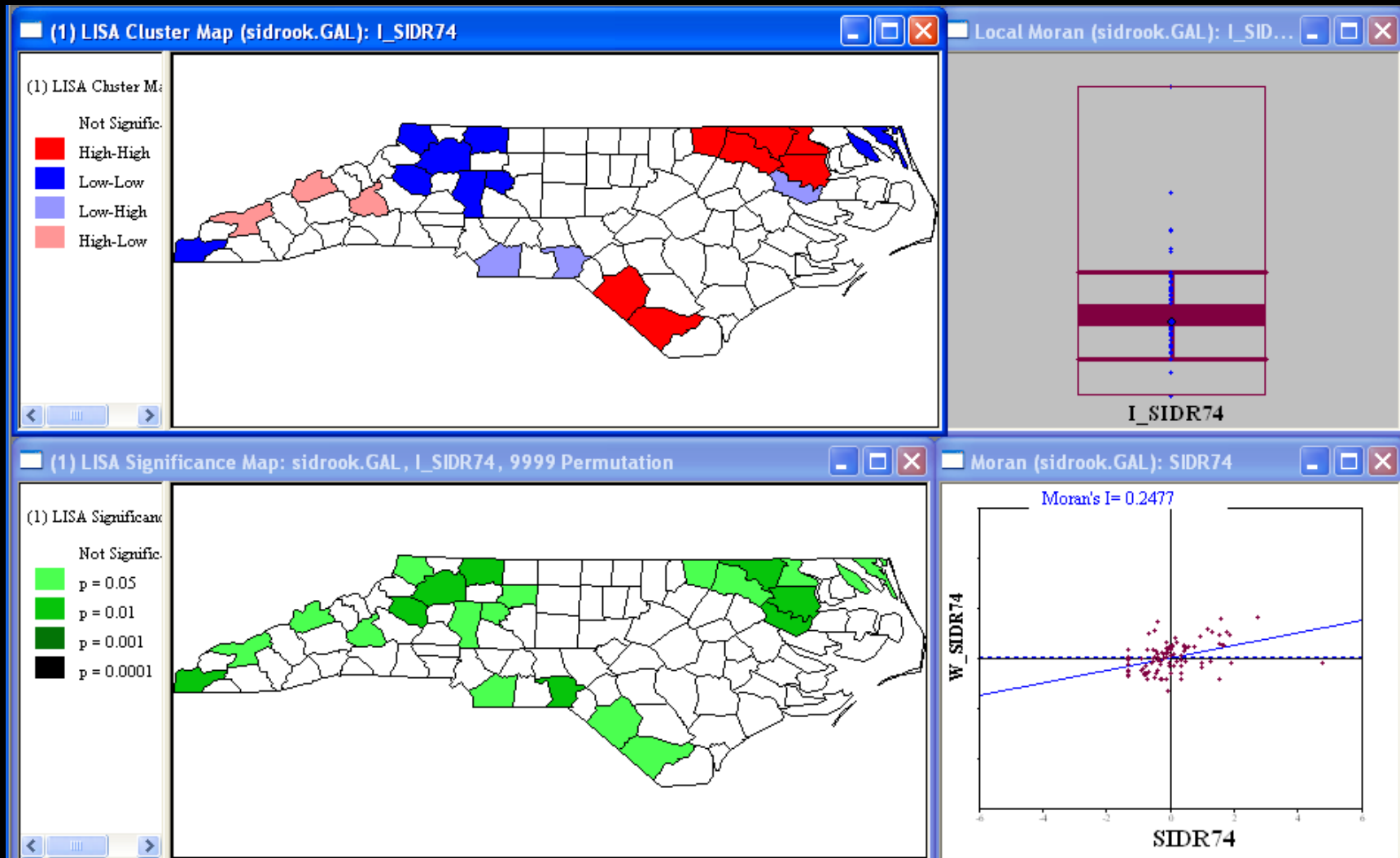
## ➤ Inference

- randomization assumption
- conditional permutation
- local dependence or heterogeneity?

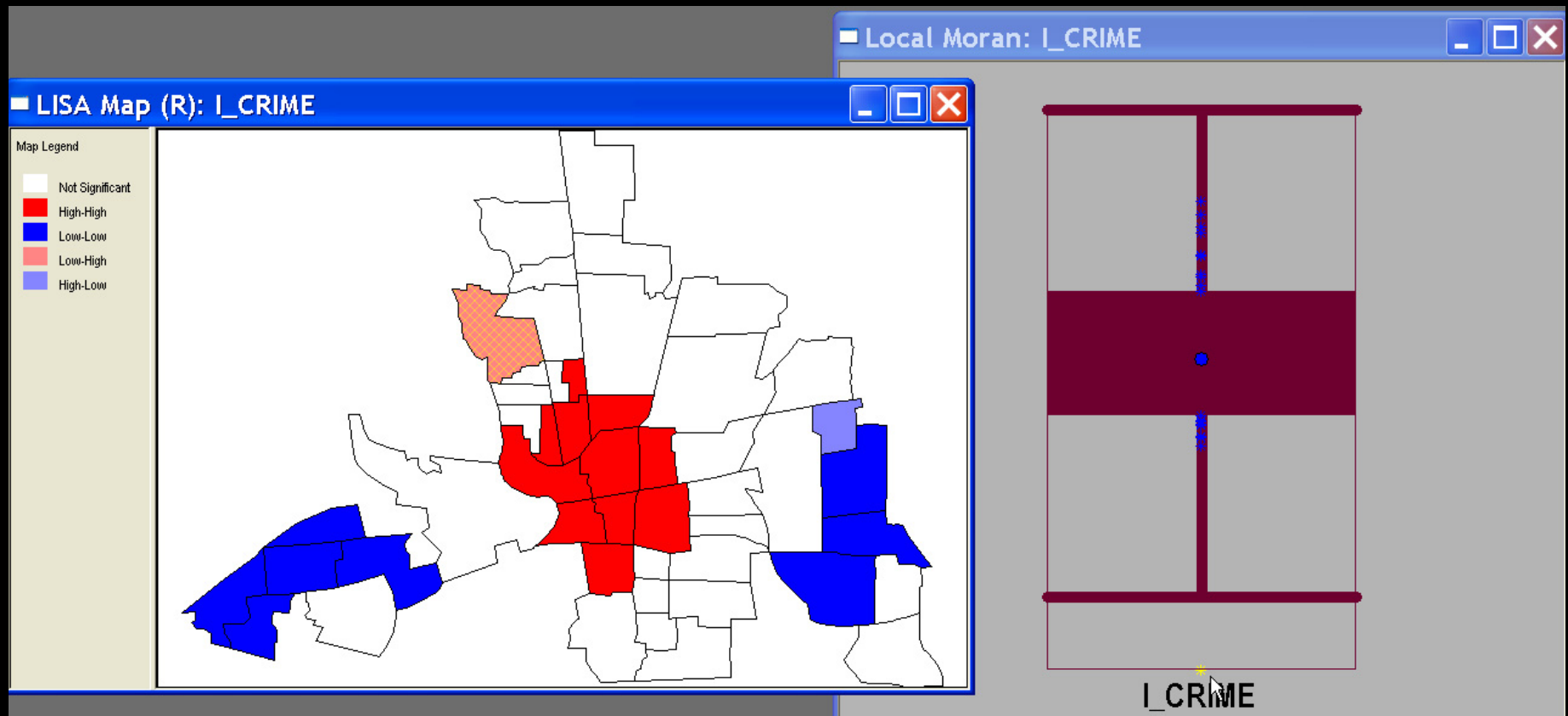
## ➤ Visualization

- LISA map and Moran Significance Map

# LISA MAPS



# Outliers in Local Moran



# Interpretation and Limitations

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- Most Important
  - assessing lack of spatial randomness
  - suggests “significant” spatial structure
- Multivariate Association
  - univariate spatial autocorrelation may result from
    - multivariate association
    - scale mismatch
  - need to control for other variables = spatial regression
- LISA Clusters and Hot Spots
  - suggest interesting locations
  - do not explain

# Generalized LISA

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## ➤ Generalization of Local Moran

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

- $z_1$  and  $z_2$  different variables
- same variable at different times

## ➤ Inference

- Null hypothesis

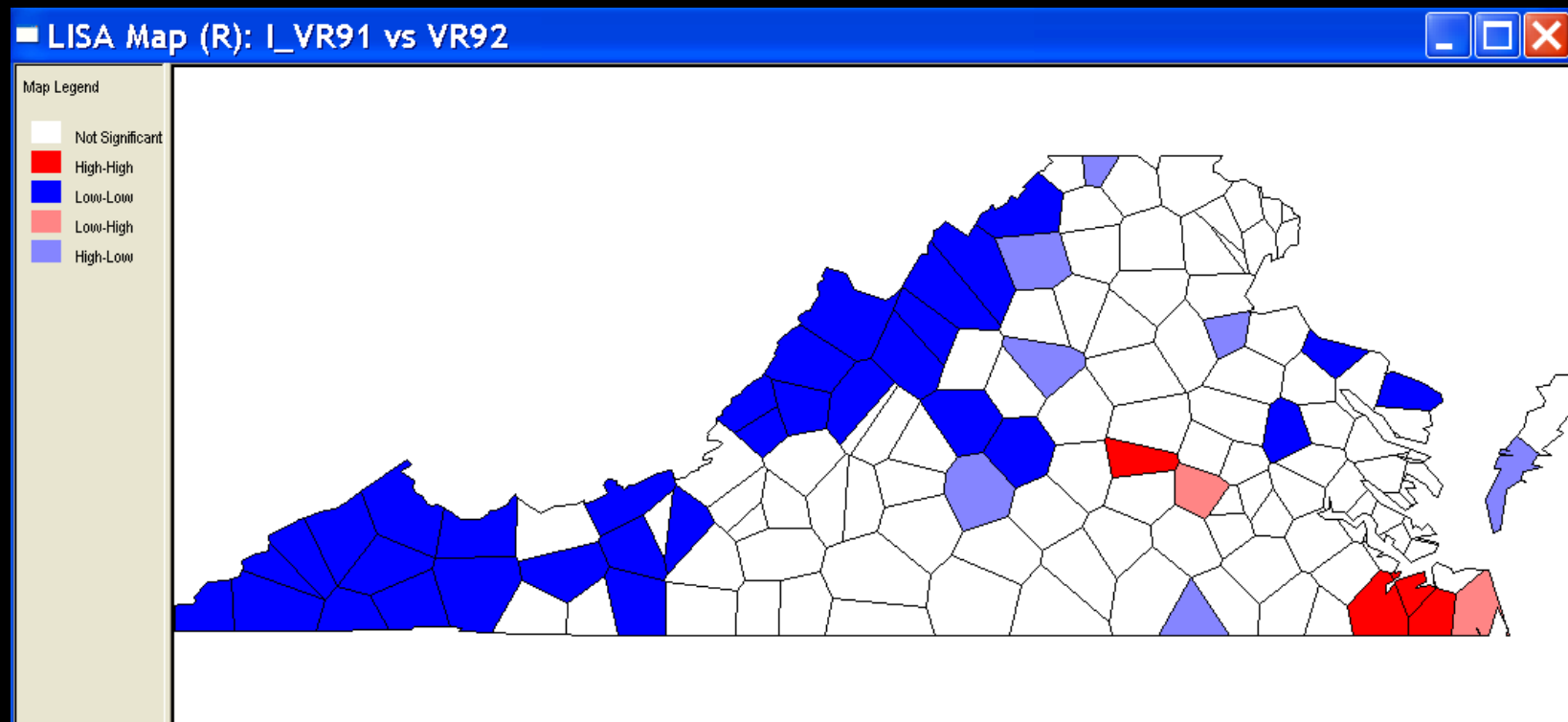
- random assignment between value of  $z_1$  at  $i$ ,  $t$  and “neighboring” values of  $z_2$

# Space-Time Patterns

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- Space-Time Cluster = 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

# Space-Time LISA Maps



# G Statistics

# Distance Statistics for Local Spatial Association

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- Getis-Ord  $G_i$  and  $G_i^*$ 
  - one statistic for each location
  - contiguity as distance bands,  $w_{ij}(d)$
- $G_i$  Statistic
  - does not include observation  $i$
  - $G_i = \frac{\sum_j w_{ij}(d) \cdot y_j}{\sum_j y_j}$
- $G_i^*$  Statistic
  - includes observation  $i$  in sum

# Interpretation of $G_i$ Statistics

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## ➤ Local Spatial Association

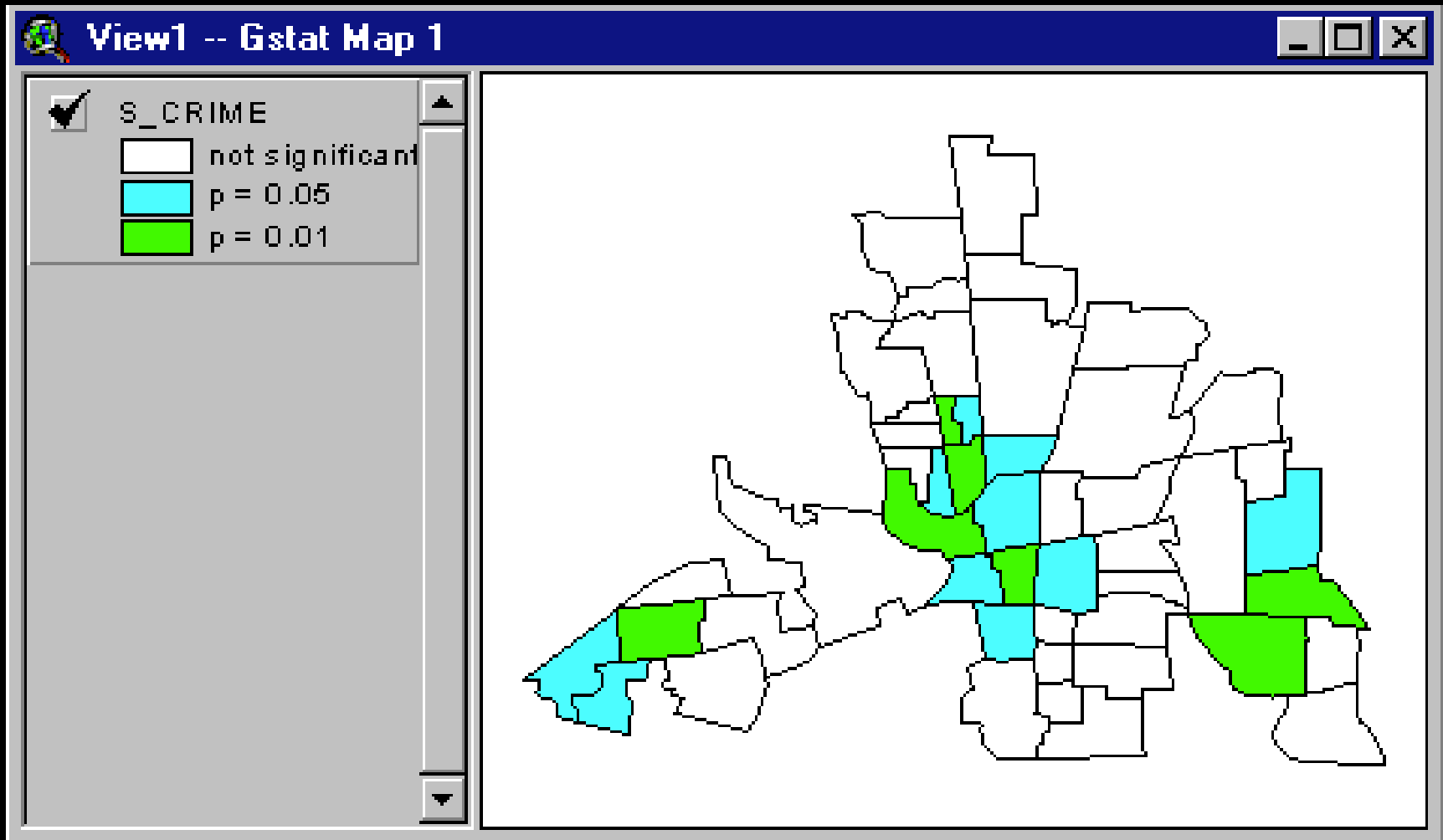
- positive: clusters of high values
- negative: clusters of low values

## ➤ Inference

- randomization
- permutation

## ➤ Visualization

- **map** of locations with significant  $G_i$  or  $G_i^*$



Columbus crime, locations with significant  $G_i^*$

