

Spatial Analysis: An Overview of Methods for Space-Time Analysis of Stocks and Transaction Flows

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Overview

- Motivation
- Spatial dependence, spatial heterogeneity, and time
- Exploratory Spatial Data Analysis
- Spatial-Interaction (SI) modeling concepts
- Exploratory methods for transaction data
- Invitation for demonstrations

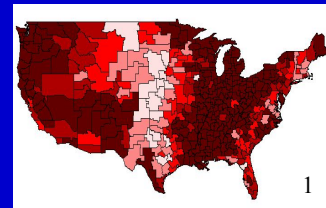
Motivation

- Interested in space-time dependence
 - stock (variable on a map)
 - flows (interactions on a map)

- Visual, exploratory, and modeling approaches

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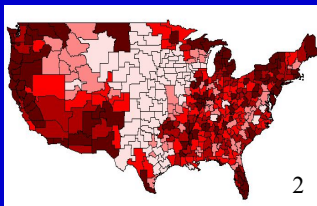
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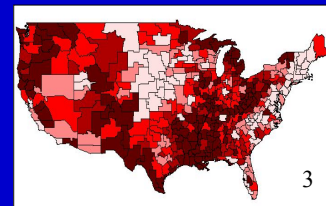
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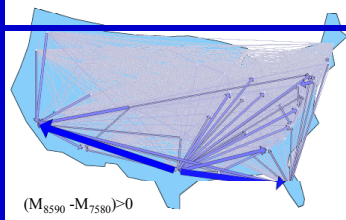
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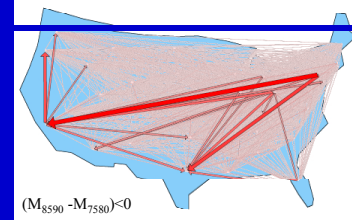
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- Visual, exploratory, and modeling approaches

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- Visual, exploratory, and modeling approaches

Spatial dependence, spatial heterogeneity, and time

- **Spatial dependence:** $y_i = f(y_j)$, $i=1, \dots, n$ and $i \neq j$

- frame dependence (MAUP)
- spatial process

- **Spatial heterogeneity:** $y_i = x_i \beta_i + e_i$

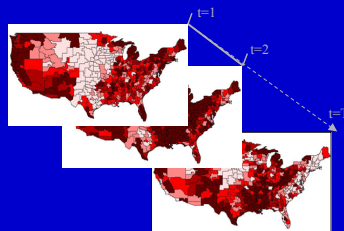
- specification issue

- **W matrix**

$$y^* = Wy$$

$$y = \rho Wy + e$$

$$y = \rho Wy + X\beta + e$$



Exploratory Spatial Data Analysis (ESDA → GeoDA)

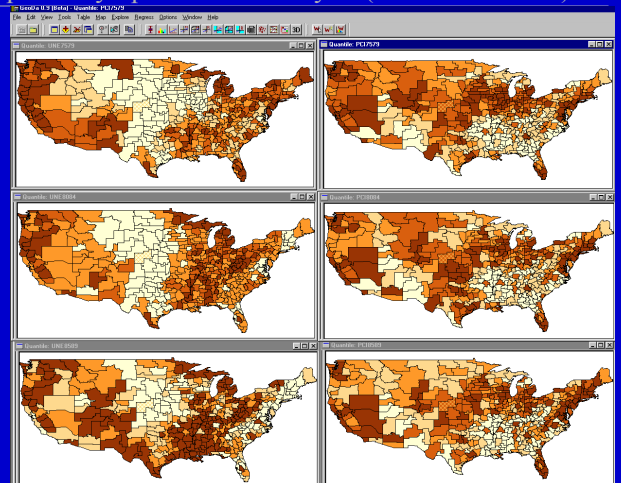
- EDA
 - “discover” potentially interesting patterns
- ESDA
 - explicable spatial patterns in distribution, outliers, regimes (heterogeneity)
 - tool for discover and specification
- ESDA + dynamic = GeoDA
 - linking, brushing, animations... and much more.

Exploratory Spatial Data Analysis (ESDA → GeoDA)

- GeoDA features
 - local and global Moran's I and Multivariate Moran's I
 - parallel coordinate plots
 - scatterplot matrices
 - conditional plots
 - map movies
 - basic GIS functionality
 - !! directly reads ArcView shape files !!

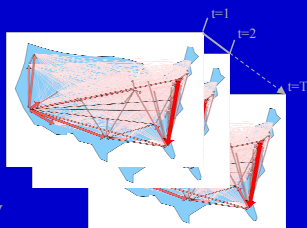
- GeoDA Demonstration

Exploratory Spatial Data Analysis (ESDA → GeoDA)



Spatial-Interaction (SI) modeling concepts

- Complexity of ODT interactions
- Information use in traditional modeling approaches
- Regions: spatial regularities
- Epochs: temporal regularities
- Ideally link regionalization, flow visualization, model fitting, and evaluation.

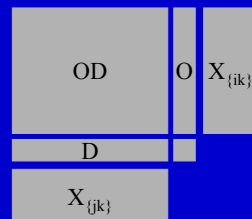


Spatial-Interaction (SI) modeling concepts (cont.)

data = $\{n_{ij}\}$

origins	destinations
n_{11}	n_{12} n_{1j}
n_{21}	n_{22} n_{2j}
...	...
n_{i1}	n_{i2} n_{ij}
n_{j1}	n_{j2} n_{jj}

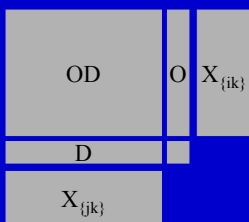
parameter/information sets



one-way: O, D, X
two-way: OD, proxy

Spatial-Interaction (SI) modeling concepts (cont.)

parameter/information sets



one-way: O, D, X
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multiplicative models

$$\hat{n}_{ij} = \tau \tau_i^O \tau_i^D \mathbf{1}$$

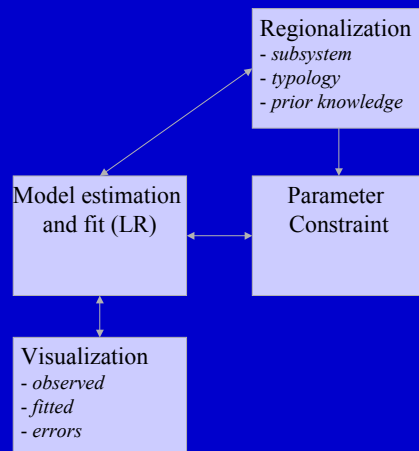
$$n_{ij} = \hat{n}_{ij} = \tau \tau_i^O \tau_i^D \tau_{ij}^{OD}$$

constrained model:

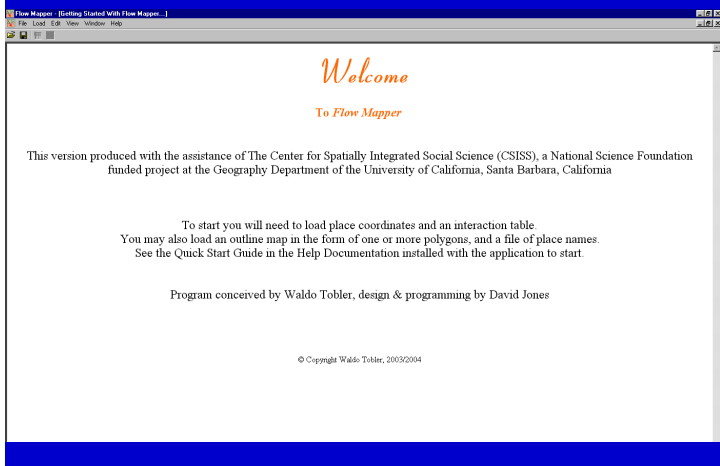
$$n_{ij} = \tau \tau_i^O \tau_i^D \tilde{\tau}_{ij}^{OD}$$

where subset of $\tilde{\tau}_{ij}^{OD}$ are not equal to 1

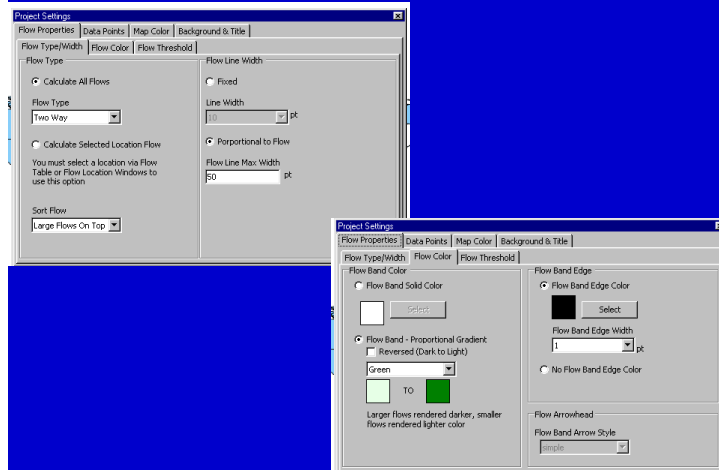
Spatial-Interaction (SI) modeling concepts (cont.)



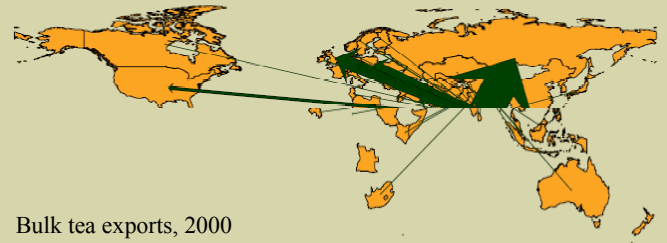
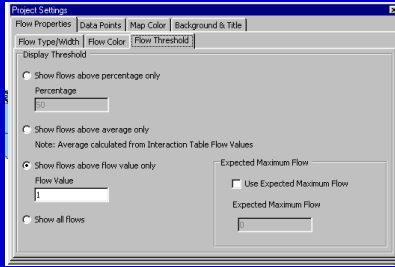
Flow Mapper Software



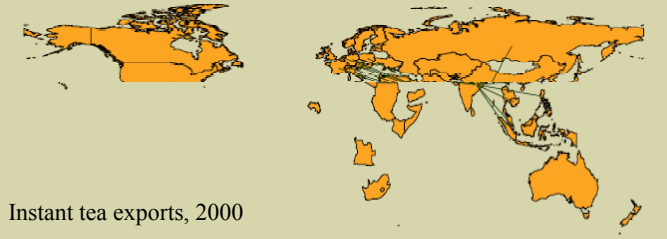
Flow Mapper Software



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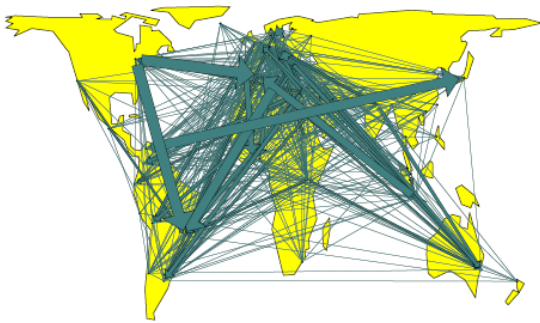
Bulk tea exports, 2000



Instant tea exports, 2000

Flow Mapper Software

Net Trade Map



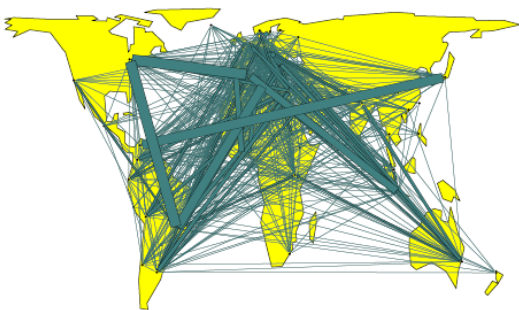
Flow Mapper Software

Net Trade > 20,000



Flow Mapper Software

Actual Trade Map



Flow Mapper Software