The Nature of Pattern Analysis

Pre-1980s (Pre-GIS)

Characteristics of Patterns (Centrography) (1820s to 1960s)

- Statistical Moments of Areal Distributions

    Centroids

        Population center

    Spatial dispersion

        Compactness of a distribution

Nearest Neighbors Analysis
(1950s and 1960s)

- Mathematical Ecology

     Plants: Clustered or Dispersed

- Randomness Hypothesis

    Statistical Significance

- Settlement Patterns

Patterns of Movement and Interaction
(1850s to 1960s)

- Spatial Interaction
- Newtonian Social Physics

  $$p_i p_j / d^2$$

- Zipf's Laws
- Probabilistic Laws

Residuals from Spatial Regression (1960s)

- Regression Assumptions
- Finding the Missing Variables
- The Spatial Twist

Point, Line, and Area Models
(1970s)

- Representations
- Spatial Association

   Recognition of Scale Effects

- Modeling

After 1980

- Rapid Technological Advancement
- Larger Data Sets
- Simulations
- Exploratory Work

Spatial Classification

- Grouping Statistics
- Algorithms
- Spectra
- Supervised Approaches
- Fuzzy Sets
- Neural Nets

Spatial Association

- Tobler's Law: "Everything is related to everything else, [but] near things are more related than distant things."
- Spatial Autocorrelation
- Representation of Spatial Systems by
  Matrices

Matrix Representation

- **W**
- The Spatial Weights Matrix
- The Spatial Association of All Sites to All Other Sites
- d, d^2, 1/0, 1/d

- **Y**
- The Attribute Association Matrix
- The Association of the Attributes at Each Site to the Attributes at All Other Sites
- +,-,/,x

Examples From the Social Sciences

- Geography: Patterns of Human Spatial Interaction
- Sociology: Behavior in Space; Ethnic Patterns; Crime
- Political Science: Spatial Patterns of Voting; Redistricting
- Anthropology and Archaeology: Patterns of
    Human Activities (usually local in scale)
- Economics: Spatial Aspects of Income Distribution
- Transportation: Movement, Accidents
- History: Change in Social Spatial Patterns over Time
- Health Care: Disease Diffusion; Patterns of Care;
     Clustering of Disease

Spatial Pattern Analysis: Approaches

- ESDA
- Spatial Statistics
- Geostatistics
- Spatial Econometrics

Exploratory spatial data analysis

- GIS Functionality (buffers, distances, etc)
- Map Patterns and Comparisons
- Histograms
- Multiple Scatter Diagrams
- Box Plots
- Residuals from Regression
- TECHNOLOGY DRIVEN

Technology Driven

- Geocomputation
- Computer-assisted
- Simulation
- Permutation

Spatial Statistics

- Measures of Association, Segregation
- All Interevent Distances: K-functions
- Clustering Statistics
- Special Tests on Randomness Hypotheses

Geostatistics

- Semivariogram Models
- Kriging for Space Filling
- Kriging Models (Punctual, Universal, Co-, Disjunctive)

Spatial Econometrics

- Models Include Spatial Effects; Regression Models with Spatial Parameters

- Parameter Estimation

- Filtering

Software Developments

- GIS
- Surface Routines
- Remote Sensing
- The Big Stat Packages (SPSS, SAS, etc.)
- Geostatistics packages (Spatial Analyst, GS+)
- SpaceStat
- S+SpatialStats
- Sage, Spider, PPA, Cluster, Stat, Scan
- GWR

Spatial Sampling Issues

- What constitutes a fair spatial sample?

- Coverage

- Dependency

- The worth of an observation

Attributes of Pattern Analysis

- Simplification

- Testing of hypotheses

- Hypothesis generation

- Pattern evolution

- Pattern prediction

- Clustering

- Test spatial regression assumptions

- Assess geostatistics assumptions

What Pattern Analysis Cannot Do By Itself

- It cannot unequivocally determine cause and effect

- It depends on scientist to assign meaning to spatial relationship(s)

- It has difficulty relating non-spatial attributes of points, lines, areas

- It is not independent of scale, dependency, heterogeneity, boundaries, sample size