SIE 512 Spatial Analysis

Instructor: Kate Beard
Tues and Thurs: 2:00 - 3:15
Room 336 Boardman Hall

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Text

Bailey, T. C. and A. C. Gatrell. 1995. Interactive Spatial Data Analysis.
Additional readings will be distributed in class

Assignments

- **Readings**
- **Labs**
- **Paper**
- **Final Project**

Grading

Lab Assignments	**20%**
Midterm Exam	**20%**
Journal article review paper	**15%**
Final project & presentation	**35%**
Class Participation	**10%**

Paper

One short paper that reviews a journal article describing a spatial analysis method from one of the topic areas covered by the course.

Midterm

This will be a take home exam

Final Project

There are two options for the final project:
1) implement a spatial analysis technique, or
2) carry out spatial analysis on a data set of your choice

Labs

Using SPLUS, R, ArcGIS, GeoDa

Available on computers in Boardman 138.

Labs distributed on Tuesday and due the following Tuesday.

Introductory Session?

Course webpage

http://www.spatial.maine.edu/~beard/sie_512_spatial_analysis.htm

Course Outline

- Overview of statistical concepts
- Issues in analyzing spatial data
- General concepts in spatial data analysis
- Methods for point pattern analysis
- Methods for spatially continuous data analysis
- Methods for area data analysis
- Sampling spatial populations

Course Objectives

- Become familiar with particular characteristics of spatial data
- Develop an understanding of techniques for the statistical analysis of spatial data given their unique characteristics
- Learn a range of visualization, exploration and modeling techniques for spatial data.
- Become familiar with some software tools for doing spatial statistics

Spatial Analysis

- The quantitative study of phenomena located in space
- The study of methods for the description and or explanation of a process operating in space based on a sample of observations of the process

Purpose of Statistics

To develop and apply useful knowledge from experiments and data

Descriptive Statistics

Concerned with visualizing, exploring, and summarizing data without fitting the data to any probability model

EDA – Exploratory Data Analysis

Inferential Statistics

Using statistics from sample data to make statements about the whole population. Involves identification of a suitable probability model.

Spatial Statistics

Modifications, extensions, and additions to statistical techniques that explicitly consider the importance of locations or spatial arrangement

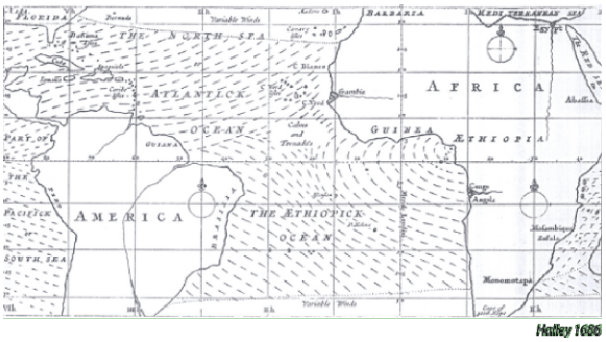
Data are spatially located and explicit consideration is given to the possible importance of their spatial arrangement in the analysis

History of Spatial Statistics

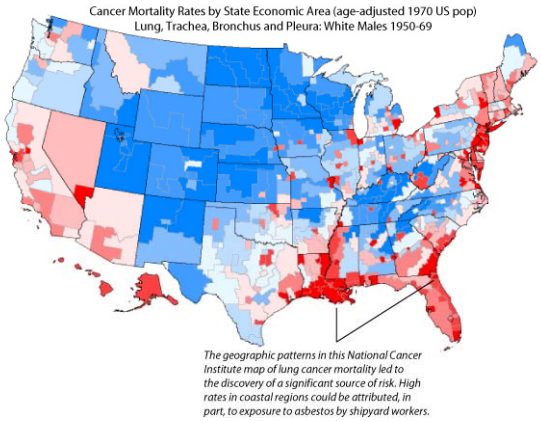
The first use of statistics for spatial data appeared in the form of data maps.

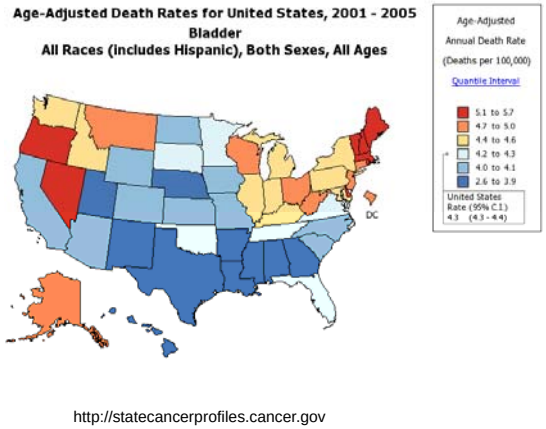
Edmund Halley is credited with first spatial statistical analysis using maps. In the late 17th Century, he superimposed, onto a map of land forms, directions of trade winds and monsoons between and near the tropics and attempted to assign them a physical cause

Edmund Halley's map of trade winds



Dr. John Snow's map of cholera deaths in London in 1854.





http://statecancerprofiles.cancer.gov

Methodological approaches

- Visualization

  Various graphical displays

- Exploration

  Typically involves some assumptions

- Modeling

  Test a hypothesis, formulate a relationship

Spatial Data

Data that are close together in space (and time) are often more alike than those that are far apart. A spatial model incorporates this spatial variation into the model-generating mechanism, in contrast to a non-spatial model.

It is almost always true that the classical, non-spatial model is a special case of a spatial model, and so the spatial model is more general (spatial-temporal models are even more general).

Spatial Data

Amount of available spatial data is increasing

Driven by new location technologies

GPS, localization in sensor networks

An observation

(location, time, thematic value)

Spatial Models and Time

All data have a more-or-less precise spatial and temporal label associated with them.

A purely spatial model usually has no causative component in it;

Such models are useful when a spatial-temporal process has reached temporal equilibrium (e.g., ore deposition) or when short-term causal effects are aggregated over a fixed time period (e.g., final presidential election returns from the states of the United States).

Analysis Approach

Analysis of patterns of discrete locations

Analysis of attribute values measured at specific locations

Analysis of spatial observations (survey measurements - distances and angles)

Conceptions of spatial phenomena

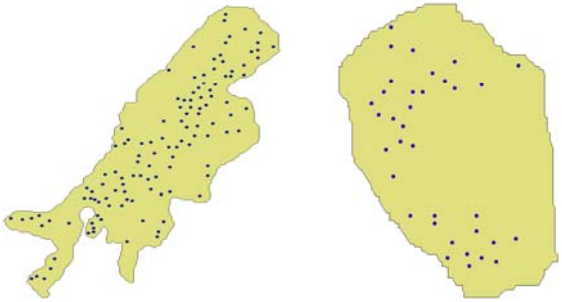
Object view – emphasis is on the discreteness of the spatial phenomena

Field view – emphasis is on the continuity of the spatial phenomena

Classes of problem

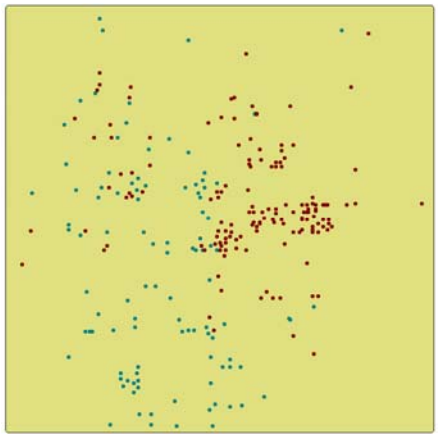
Methods for data comprising point patterns

Primarily an analysis of locations – locations are discrete



Marked Events

Several types of events are noted. Is the distribution of one set of events related to the distribution of the other?

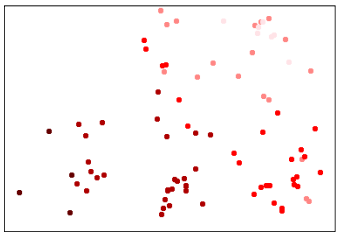


Classes of problem

Methods for measurements taken on spatially continuous phenomena

An analysis of values of a continuous variable in the context of its spatial arrangement

Analyze the strength of correlation of near-by values



Geostatistics

Originally developed by mining engineers in the 1960s, geostatistics is used to evaluate relationships between values (points) and distance.

Graphs called variograms are used to determine how similar values are with distance. Parameters derived from a variogram model are used to predict values for unsampled locations

Geostatistics has been used to model lead concentrations in soil, housing prices, genetic similarity in tree species, ocean fish densities and many others.

Classes of problem

Methods for analysis of area data

An analysis of values of a variable associated with an area.

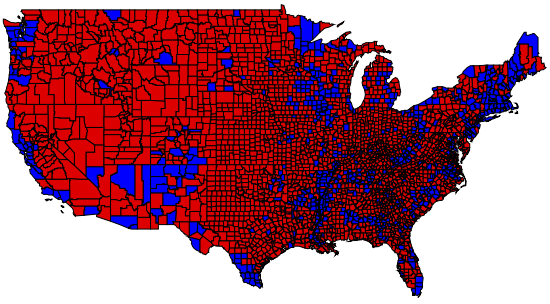
Detection of spatial patterns or persistence in data collected by zones or regions

The zones can be regularly or irregularly distributed

Regular - remote sensing data from satellites

Irregular – census data collected for census units

Presidential election data



Distribution of votes for Bush and Gore

Classes of problem

Methods for analysis of spatial interaction data

Methods for detection or prediction of significant patterns in flows between locations