GIST 4302/5302: Spatial Analysis and Modeling

Review

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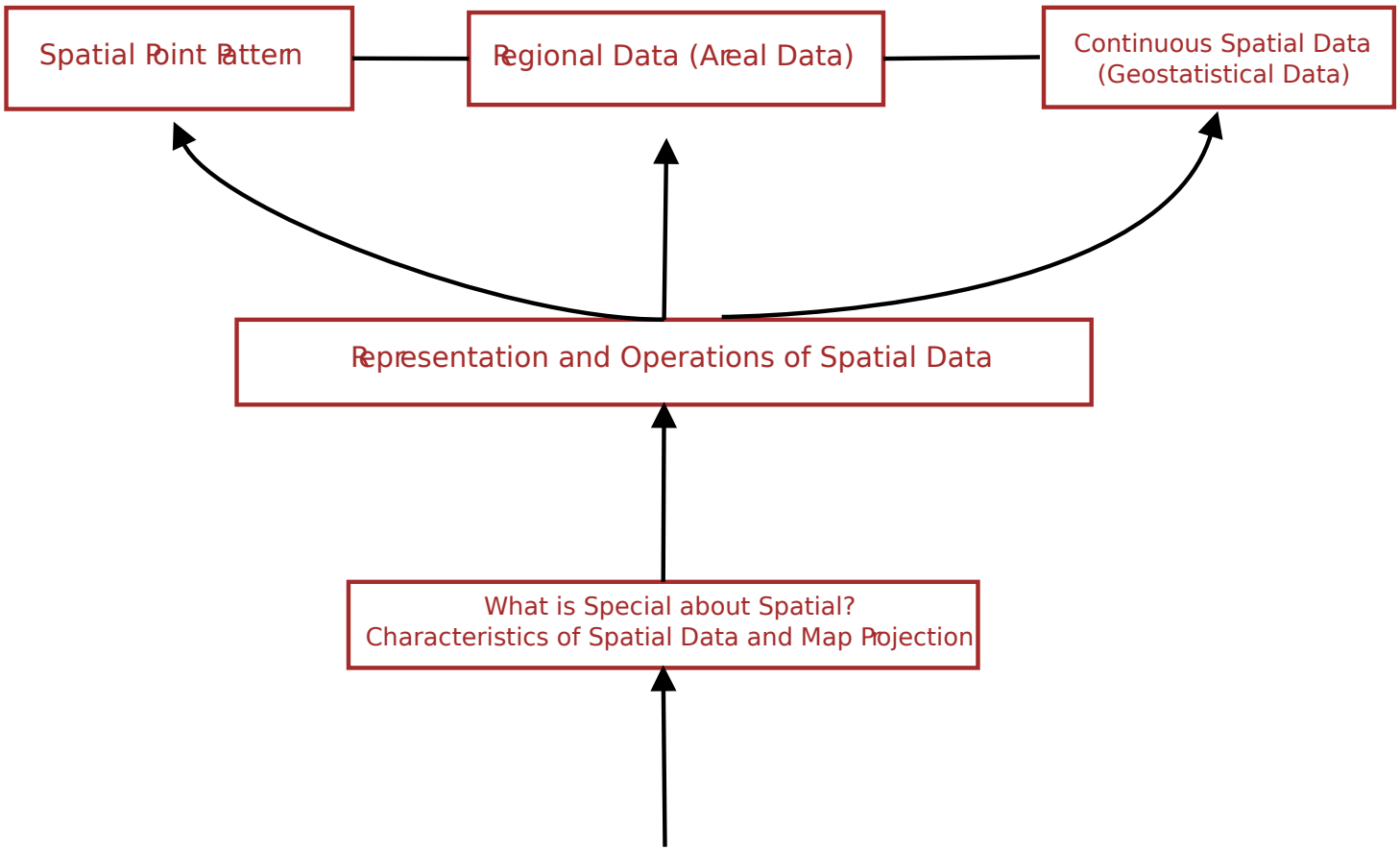
Course Outlines



Review

Map Projection

- Elements in map projection
  - datum
  - developable surface
  - projection
- Distortions
  - distance
  - shape
  - area
  - direction
- how to choose map projections?
  - depending on purposes, you may need to preserve a certain spatial property - most commonly shape or area - to achieve that purpose

Lab

- Lab 1: ArcMap and map projection questions

What is special about spatial

Characteristics of spatial data

- spatial (auto/cross-)correlation (spatial context or spatial pattern in different context)
- spatial heterogeneity
  - Simpson paradox in a spatial setting
- fractal behaviors
  - scale issues
  - measuring the length of coastline of Maine
  - travel traces of 'ants' vs. 'elephant'

Spatial Data Types

Data types

- spatial point pattern
- areal data
- geostatistical data
- network data

Representations of spatial data (i.e., spatial database basics)

- object-based
  - geometric primitives: points, lines and polygons
  - convex hull, Voronoi diagram, Delaunay triangulation
  - primitive operations: point-in-polygon, buffer
  - spatial query and spatial join
  - data structures for spatial data
    - spaghetti models
    - NAA
  - spatial index
- field-based
  - points
  - contours
  - raster/lattice
  - triangulation (Delaunay triangulation)

Labs

- Lab 2: Find what's inside
- Lab 3: Find what's nearby
- Lab 4: Raster spatial analysis
- Lab 5: Model builder
- Lab 6: Geocoding

Basic Probability and Statistics

Statistical tools

- histogram
- mean, median, variance
- z-score
- covariance, correlation coefficient
- p-value
- QQ-plot, box-plot

Pitfalls of spatial data

- MAUP
  - zone effect
  - scale effect
- Ecological fallacy

Contents in Exam II start from here

Spatial Point Pattern Analysis

Geographic distribution

- mean center, median center
- standard distance, standard ellipsoid distance

Point pattern analysis methods

- 1st order
  - Quadrat methods
  - Density estimation
- 2nd order
  - nearest neighbour distance
  - distance functions K,G,F

Hypothesis testing of CSR

- CSR: complete spatial randomness
- Hypothesis testing
  - Monte Caro test

Lab

- Lab 7: Point Pattern Analysis
- Homework assignment

Areal data and spatial autocorrelation

Basics

- Spatial neighbourhood
- Spatial weight matrix

Measuring spatial autocorrelation

- Joint count
- Moran's I and Moran's I scatter plot
- Getis-Ord's G and G^*
- Hypothesis testing
  - permutation test

Lab

- Lab 8: Exploratory analysis using GeoDa

Linear regression

- Correlation (coefficient) vs. regression
- Simple regression vs. multiple regression
- Find the best fit
- Evaluation of the Goodness of Fit R^2
- Significant test (t-test, F-test)

Multiple regression

- Find the best fit
- Evaluation of the Goodness of Fit (adjusted R^2, p-value of coefficient, maximum likelihood, AIC)
- Procedures for multiple regression

Linear regression does not prove causal effects

Spatial regression

- Spatial autoregression vs. Correlation
- Diagnostic of spatial dependence (autocorrelation)
- Spatial econometrics approaches
  - Lag model
  - Error model
  - Which to use?
  - Evaluation of Goodness of Fit (AIC)

Lab

- Lab 9: Spatial regression using GeoDa

Spatial Fields

Representation of spatial fields

- Scalar fields vs. vector fields
- Countours
- Lattice
- TIN

Derivatives of spatial fields

- Gradient
- Slope/Aspect

Spatial interpolation

- Deterministic interpolator
  - Nearest neighours
  - Natural neighours
  - Trend surface
  - IDW
  - Spatial splines
  - Triangulation
- Stochastic interpolator
  - Kriging family of methods

Advantage of Kriging methods over the deterministic methods

Kriging

- Semivariogram, covariogram
  - Range, nugget, sill
  - Empirical semivariogram and theoretical semivariogram models
- Kriging
- Procedures to conduct kriging
- Advantages of Kriging over determistic methods, such as IDW

Lab

- Lab 10: Spatial interpolation

Labs and software

Lab topics

- Map projection
- Find what's inside
- Find what's nearby
- Raster spatial analysis
- Model builder
- Geocoding
- Point pattern analysis
- Exploratory analysis (Moran's I)
- Spatial regression
- Kriging

Labs and software

Software

- ArcMap
  - Arctoolbox: 3D analytst, spatial analysis, spatial statistics, geostatistics
- GeoDa (open-source)
- OpenStreetMap (mapathon)

Evaluation

Project report due: Dec 10th before the final exam

- upload your project materials, including presentation, datasets and results to your folder on Techshare

Exam format

- Dec 10th, 1:30-4pm, Science 234
- open books and open notes, but access to any digital devices (e.g, phones, tables, computers) are not allowed
- multiple choices plus writing questions

New class and links

New class avaiable at Fall

- Geog 5330: Applied Spatial and Spatiotemporal Data Analysis
- Graduate level class

Map links

- http://www.gis.ttu.edu/gist4302/links.html
- @ttugis, @guofengcao

Thanks

Thank you, any questions/comments