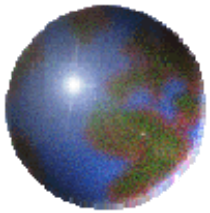


4. The Nature of Geographic Data

Geographic Information Systems and Science

SECOND EDITION

Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind

Overview: Spatial is Special

- The 'true' nature of geographic data
- The special tools needed to work with them
- How we sample and interpolate (gaps)
- What is spatial autocorrelation, and how can it be measured?
- Fractals and geographic representation

Why GIS?

- Small things can be intricate
- GIS can:
  - Identify structure at all scales
  - Show how spatial and temporal context affects what we do
- Allows generalization and accommodates error
- Accommodates *spatial heterogeneity*

Building Representations

- Temporal and spatial autocorrelation
- Understanding scale and spatial structure
  - How to *sample*
  - How to *interpolate* between observations
- Object dimensions
  - Natural vs. artificial units

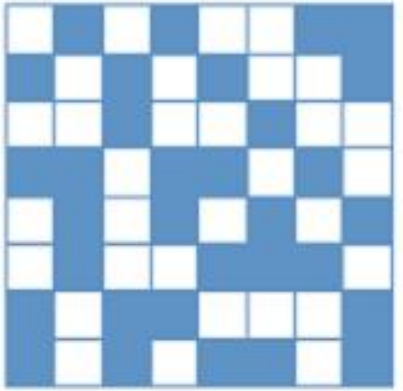
Spatial Autocorrelation

- Spatial autocorrelation is determined both by similarities in position, and by similarities in attributes
  - Sampling interval
  - Self-similarity

(A)

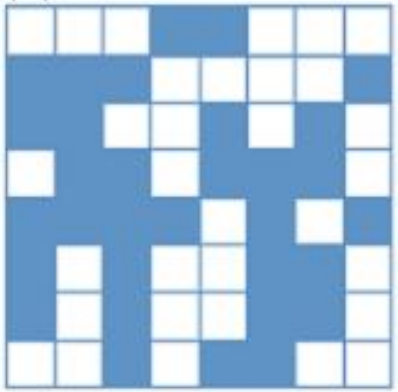
I = -1.000
$n_{BW} = 112$
$n_{BB} = 0$
$n_{WW} = 0$

(B)



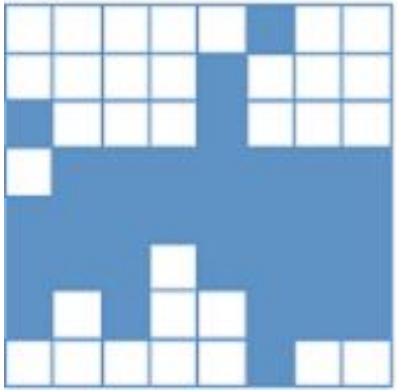
I = -0.393
$n_{BW} = 78$
$n_{BB} = 16$
$n_{WW} = 18$

(C)



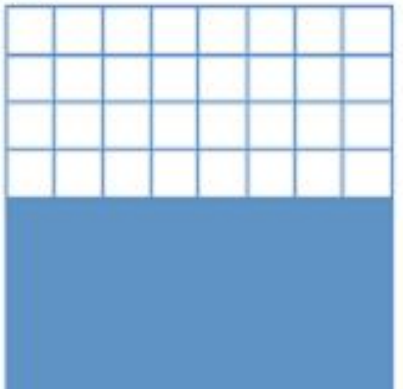
I = 0.000
$n_{BW} = 56$
$n_{BB} = 30$
$n_{WW} = 26$

(D)



I = +0.393
$n_{BW} = 34$
$n_{BB} = 42$
$n_{WW} = 36$

(E)



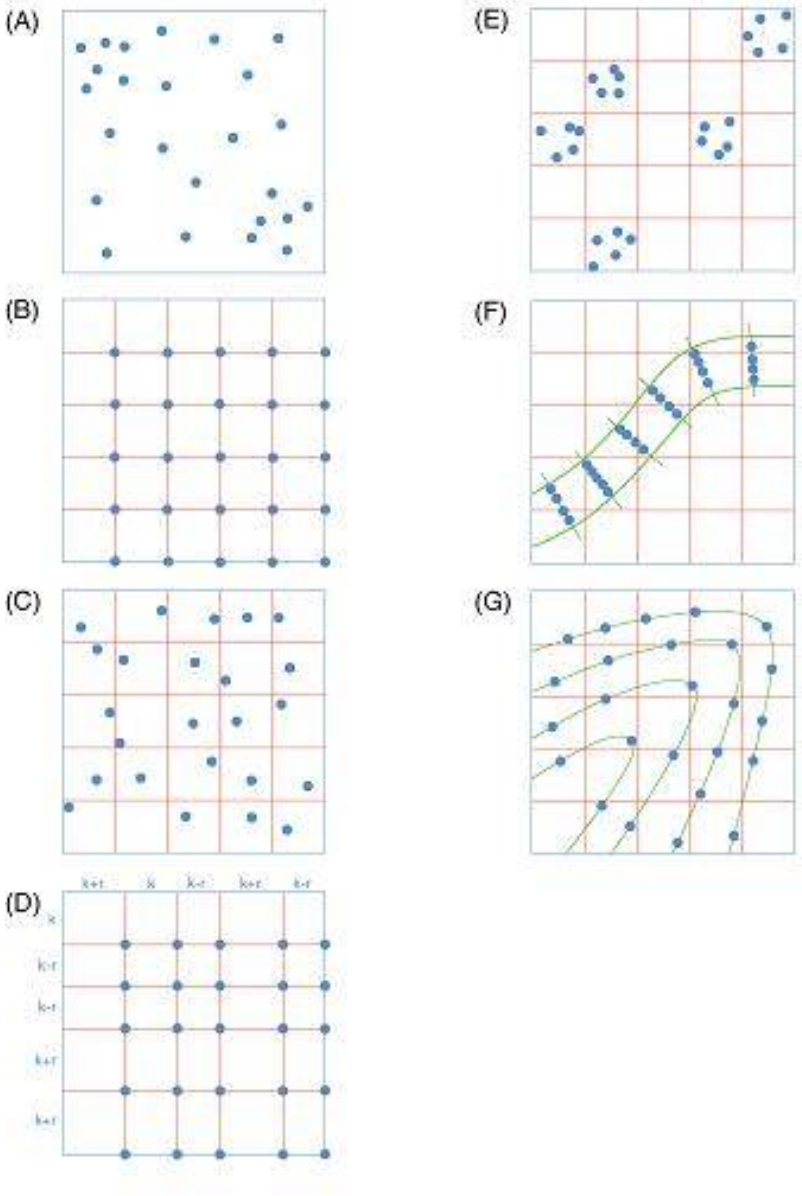
I = +0.857
$n_{BW} = 8$
$n_{BB} = 52$
$n_{WW} = 52$

Spatial Sampling

- Sample frames
- Probability of selection
- All geographic representations are samples
- Geographic data are only as good as the sampling scheme used to create them

Sample Designs

- Types of samples
  - Random samples
  - Stratified samples
  - Clustered samples
- Weighting of observations

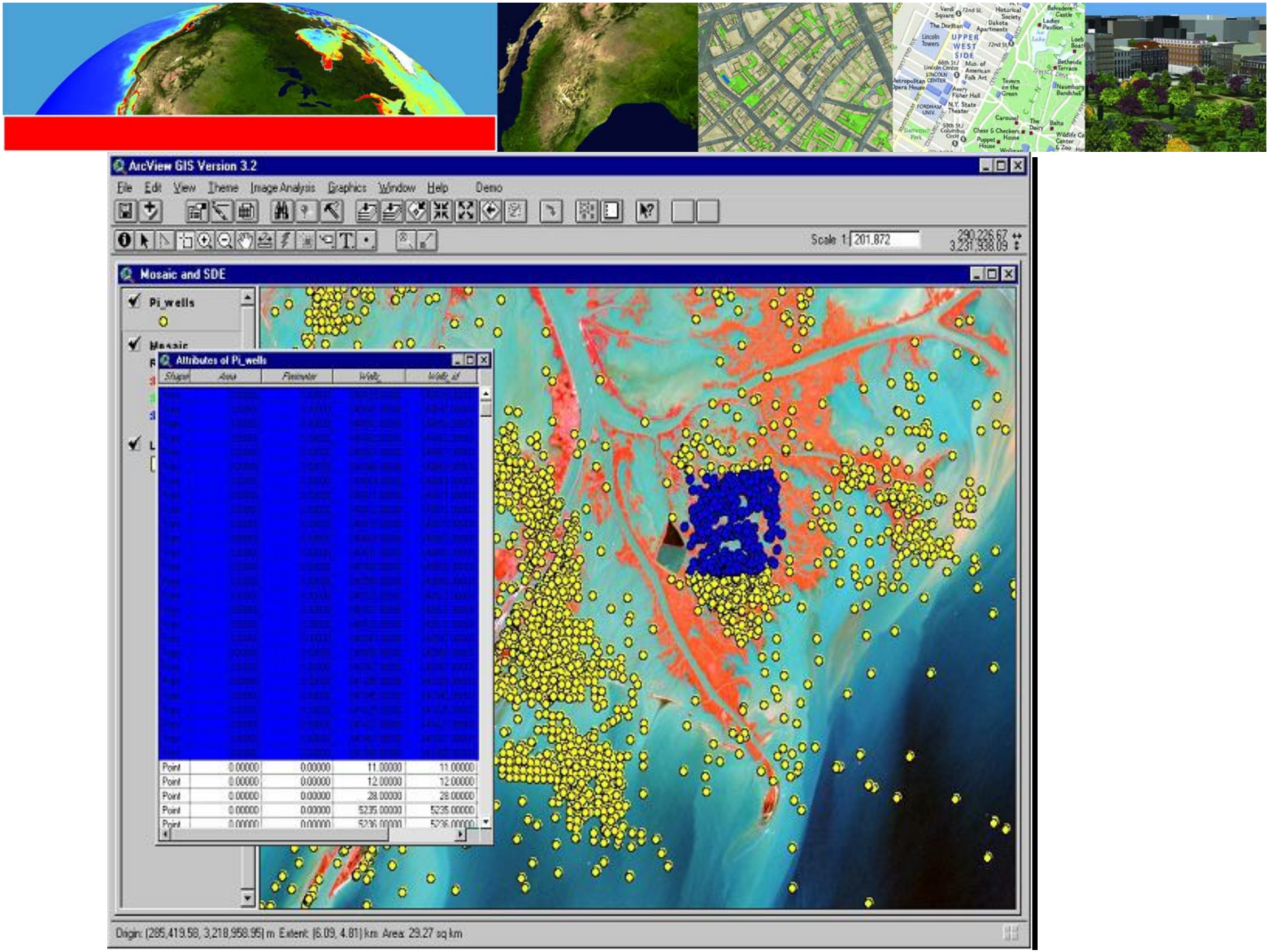


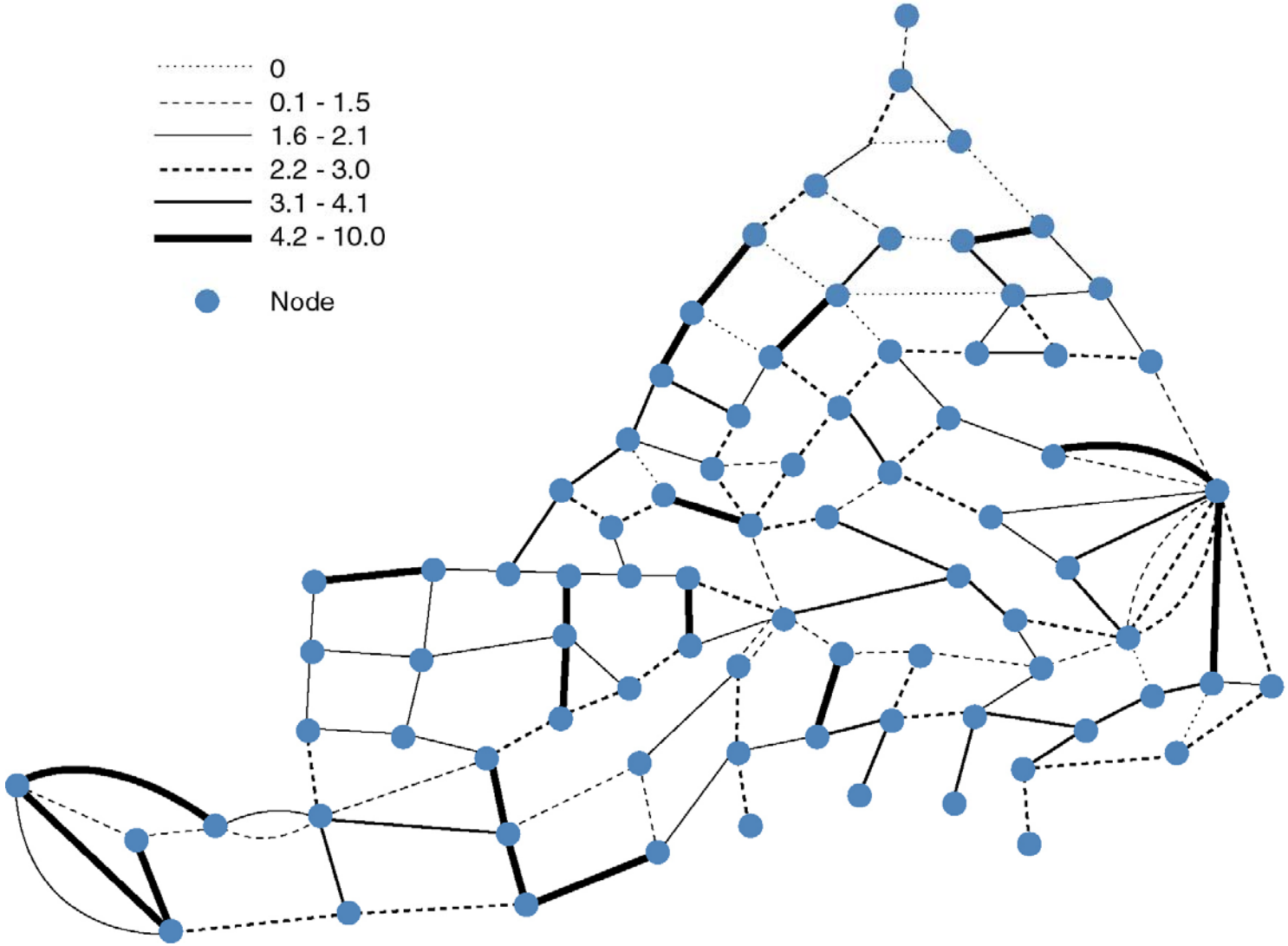
Spatial Interpolation

- Specifying the likely distance decay
  - linear: $w_{ij} = -b\, d_{ij}$
  - negative power: $w_{ij} = d_{ij}^{-b}$
  - negative exponential: $w_{ij} = e^{-bdij}$
- Isotropic and regular – relevance to all geographic phenomena?
  - Inductive vs. deductive approaches

Spatial Autocorrelation Measures

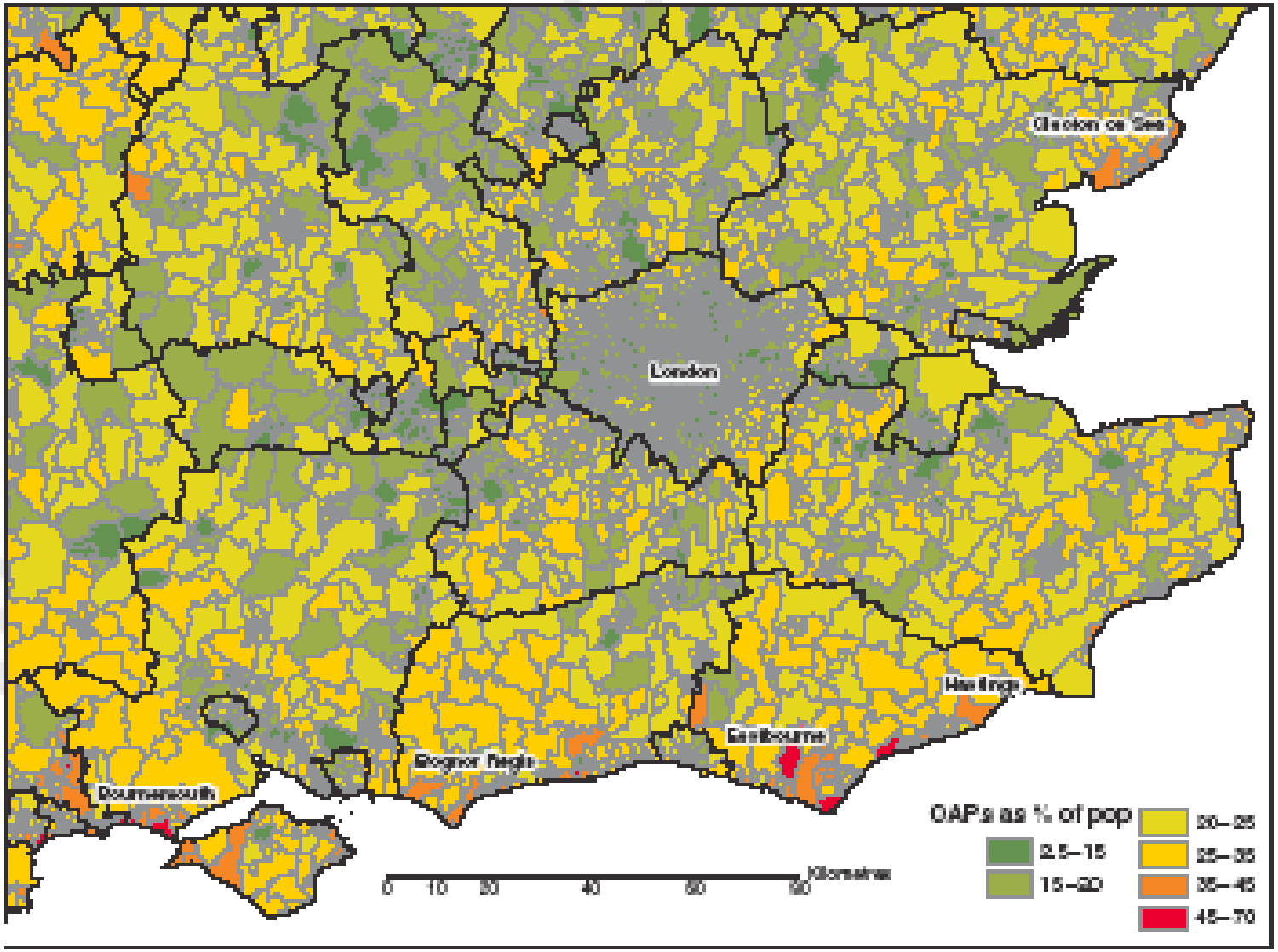
- Spatial autocorrelation measures:
  - Moran; nature of observations
- Establishing dependence in space: regression analysis
  - $Y = f(X_1, X_2, X_3, \ldots, X_K)$
  - $Y = f(X_1, X_2, X_3, \ldots, X_K) + \varepsilon$
  - $Y_i = f(X_{i1}, X_{i2}, X_{i3}, \ldots, X_{iK}) + \varepsilon_i$
  - $Y_i = b_0 + b_1 X_{i1} + b_2 X_{i2} + b_3 X_{i3} + \ldots b_K X_{iK} + \varepsilon_i$

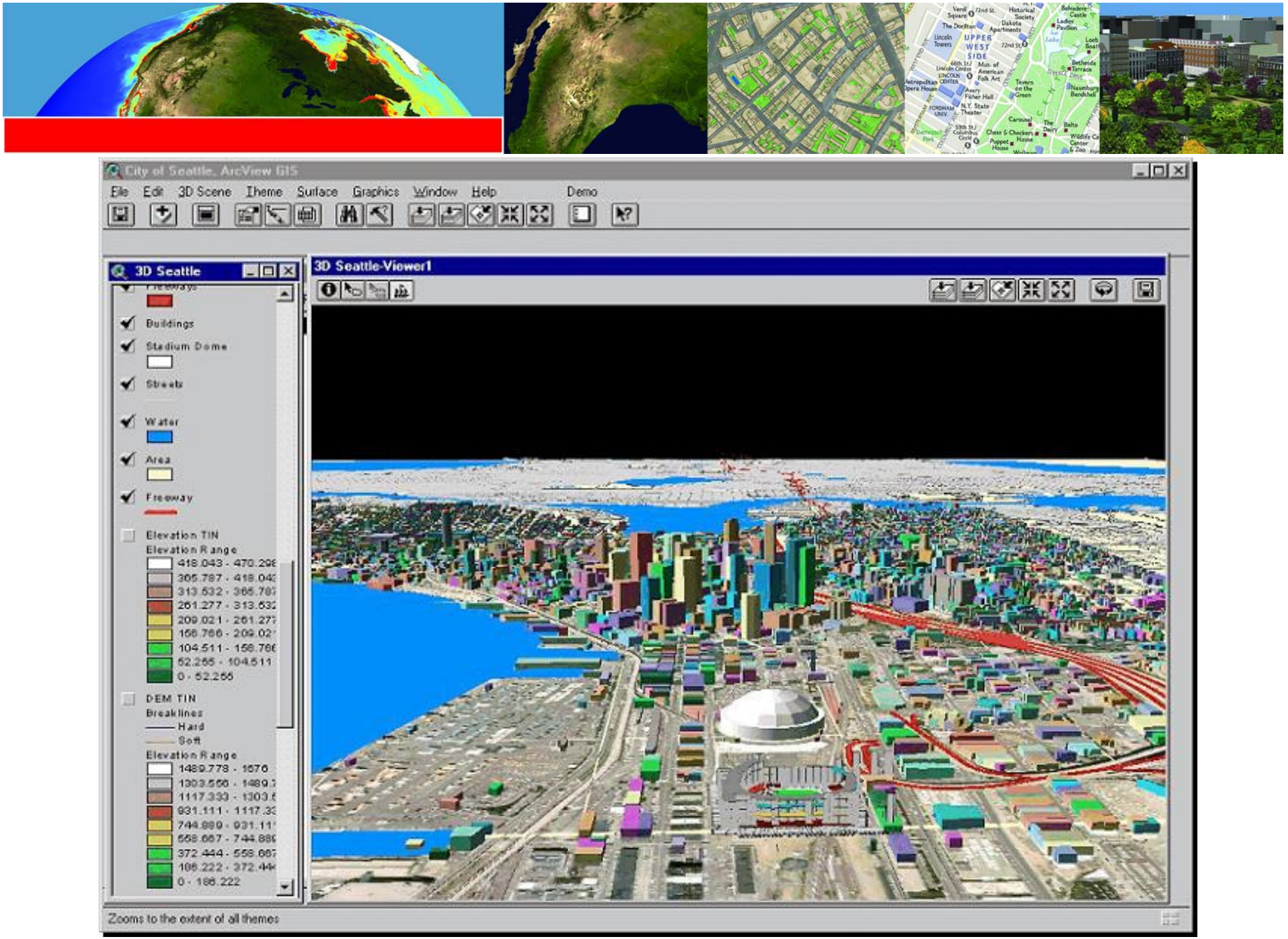

ArcView GIS Version 3.2
File Edit View Theme Image Analysis Graphics Window Help Demo
Scale 1: 201,872
290,226.67
3,231,938.09
Mosaic and SDE
Pi_wells
Attributes of Pi_wells
Point 0.00000 0.00000 11.00000 11.00000
Point 0.00000 0.00000 12.00000 12.00000
Point 0.00000 0.00000 28.00000 28.00000
Point 0.00000 0.00000 5235.00000 5235.00000
Origin: (285,419.58, 3,218,958.95) m Extent: (6.09, 4.81) km Area: 29.27 sq km
UPPER WEST SIDE




UPPER
WEST
SIDE

(c)


London
Clacton on Sea
Hastings
Eastbourne
Bognor Regis
Bournemouth
OAPs as % of pop
20–25
25–35
35–45
45–70
15–20
0 10 20 40 60 80
Kilometres


City of Seattle, ArcView GIS
File Edit 3D Scene Theme Surface Graphics Window Help Demo
3D Seattle
Buildings
Stadium Dome
Streets
Water
Area
Freeway
Elevation TIN
Elevation Range
DEM TIN
Breaklines
Hard
Soft
Elevation Range
3D Seattle-Viewer1
Zooms to the extent of all themes

- Functional form
- The assumptions of inference
  - Tobler's Law
  - Multicollinearity

Discontinuous Variation

- Fractal geometry
  - Self-similarity
  - Scale dependent measurement
  - Regression analysis of scale relations

Consolidation

- Induction and deduction
- Representations build on our understanding of spatial and temporal structures
- Spatial is special, and geographic data have a unique nature