# Data Visualization Techniques and Practices

## Introduction to GIS Technology

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# Agenda

Introduction

Geometry

Spatial Quantification of Data

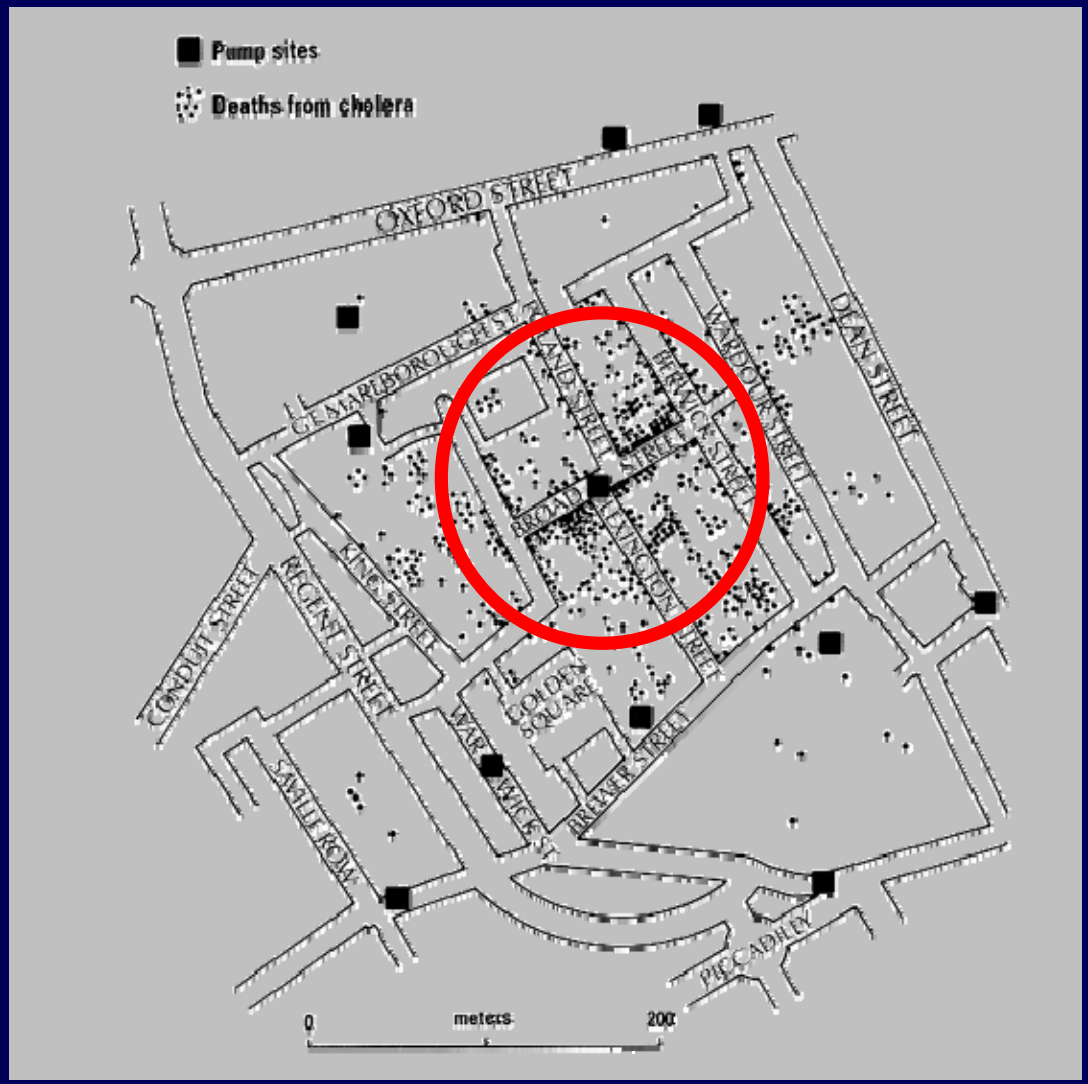
Case Study – Snow's Cholera Map

Conclusion

# Introduction

# Why is Geographic Data Important?

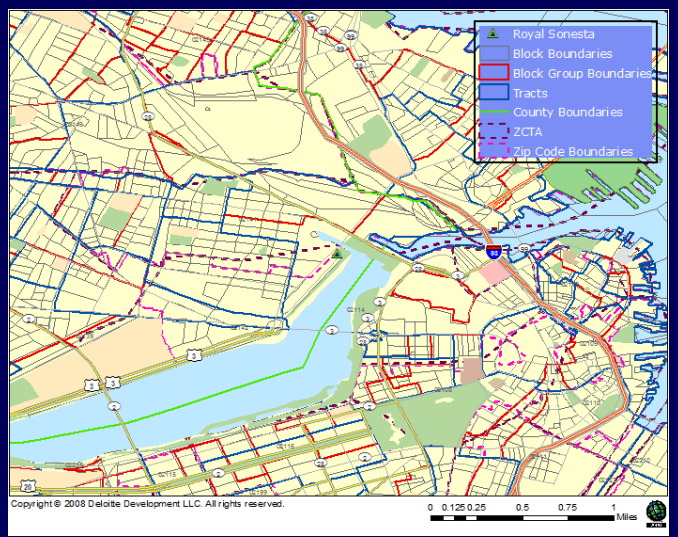
Mapping and geographic techniques allow complex patterns to be represented visually – revealing hidden patterns



# Geographic Information Systems - GIS

Geographic Information Systems are technology suites that allow analysts to quantitatively represent data in a spatial plane

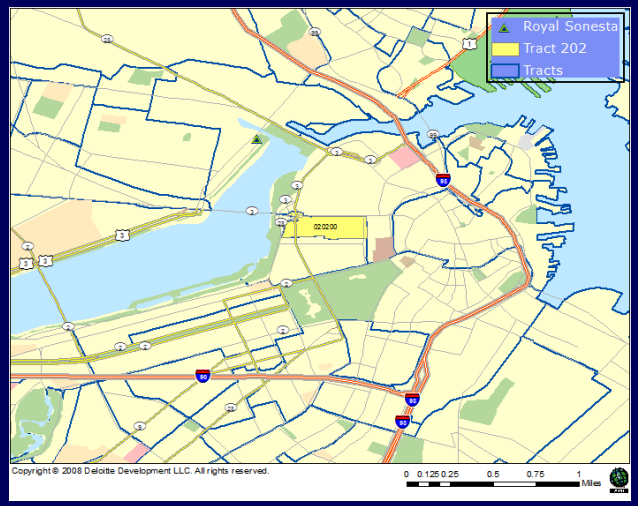
- Coordinate systems – i.e., longitude, latitude
- Representations of spatial concepts through geometry
  - Points, Lines, Polygons
- Allow for multiple “layers” of data to be represented on a single plane

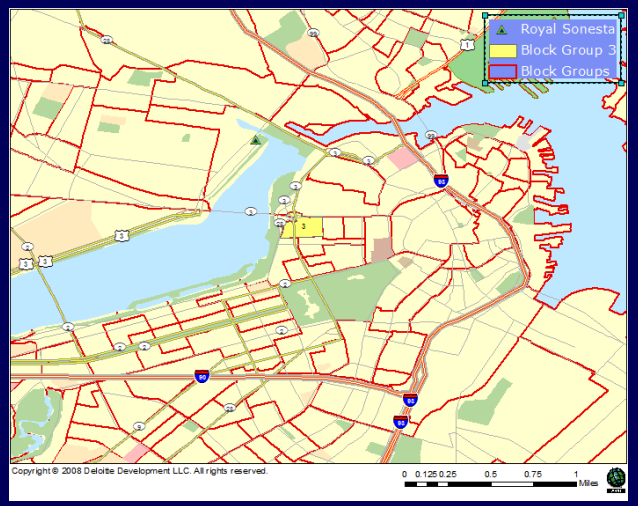


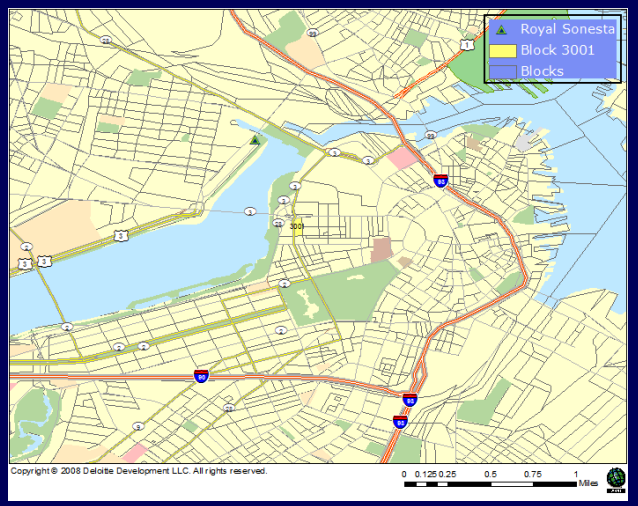
# Background and History

GIS technology has its roots in Urban Planning and areas that require layered information presented on maps

- Many sources are public from public databases
  - Roads
  - Land parcels
  - Boundaries, such as counties, Census areas, ZIP codes

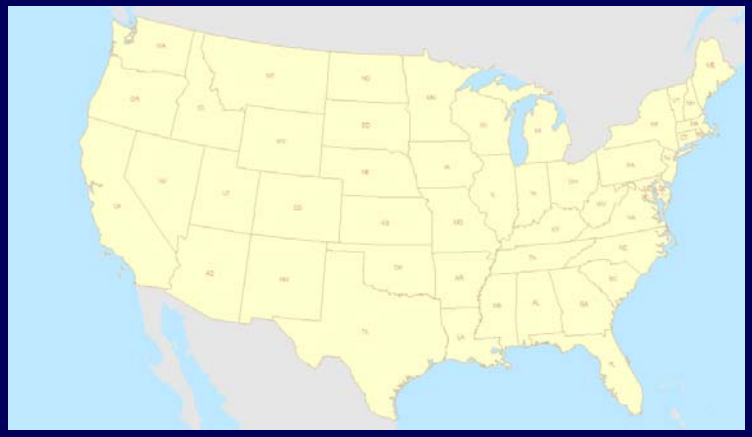


# Geometry

# Basis of GIS is Geometry



Polygons

- State boundaries
- ZIP Codes


Points

- Cities (on a large map)
- Addresses (Longitude/Latitude)

Lines

- Roads/Highways
- Rivers, natural boundaries

# Coordinate Systems

**Measurement Framework**

- Geographic: spherical coordinates
- Planimetric: projected coordinates onto a 2-dimensional surface

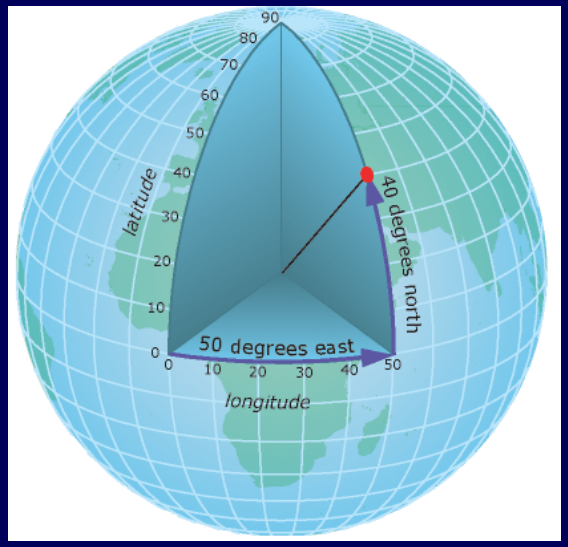
**Unit of Measurement**

- Miles, feet, meters, kilometers
- Decimal degrees

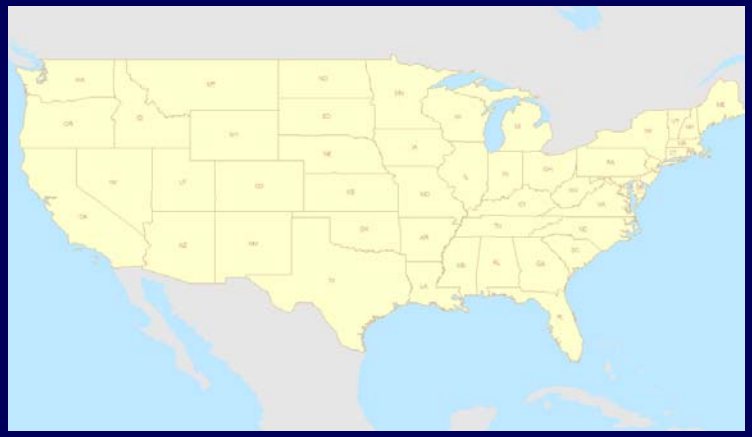
**Other Properties**

- Projection definition
- Spheroid of reference
- Datum
- Standard parallels, central meridian etc

# Geographic Coordinate Systems

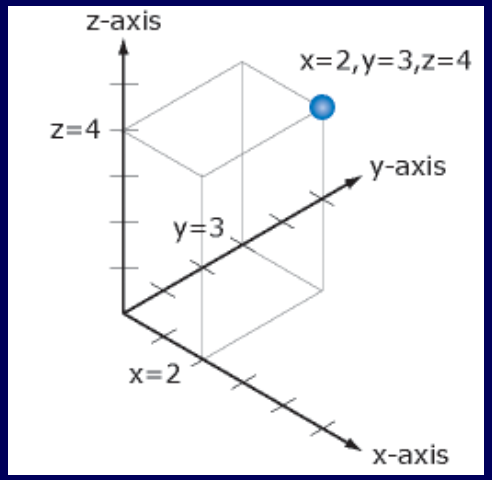


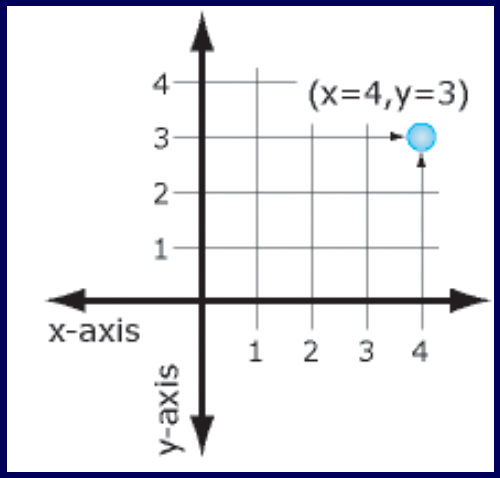

Source: ESRI ArcView

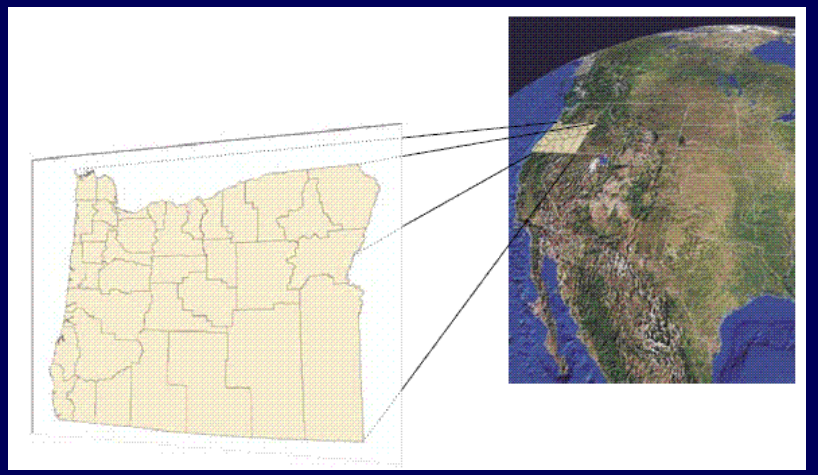


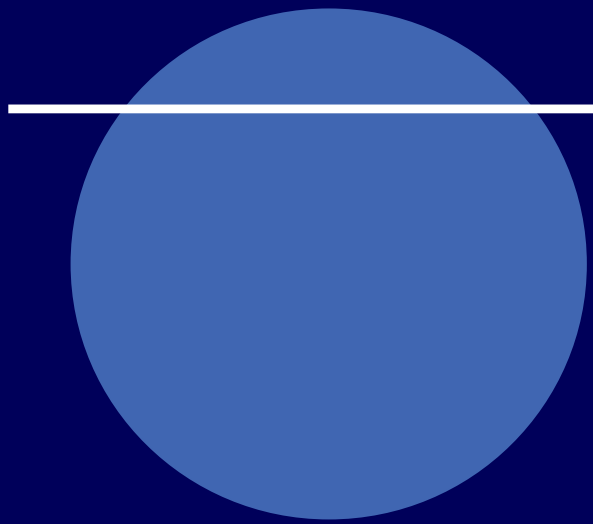
- Spherical measure of position in longitude and latitude (angles such as -180º - +180º)
- Northern Hemisphere and Western Hemisphere often have positive values
- Often more applicable to storage and usage of global data
- Local views plotted using a spherical system can appear distorted

# Projected Coordinate Systems

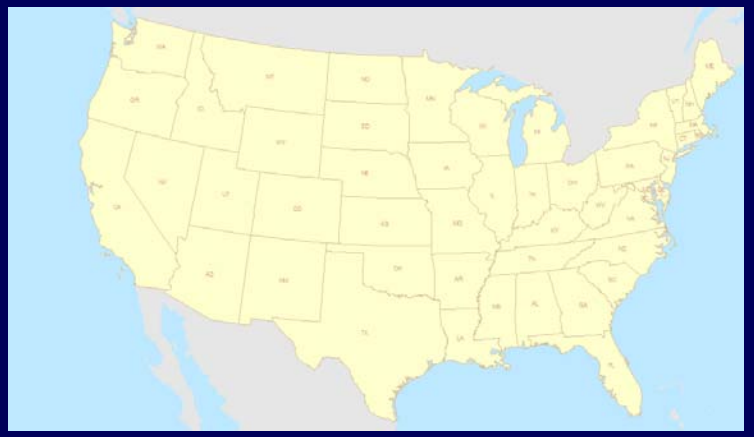




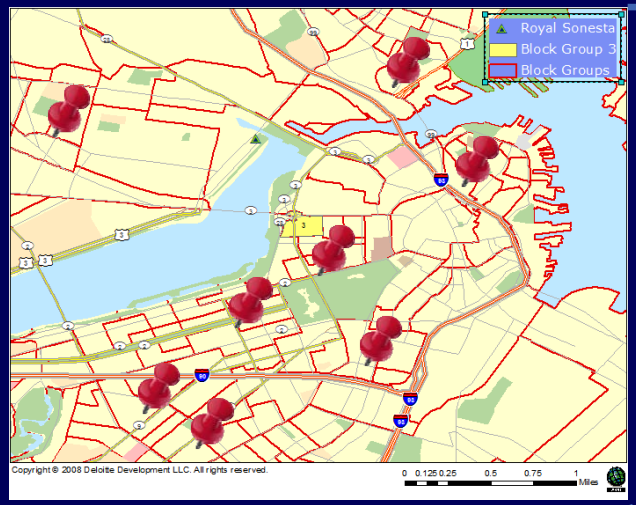
Projection Plane



Source: ESRI ArcView

# Spatial Quantification of Data

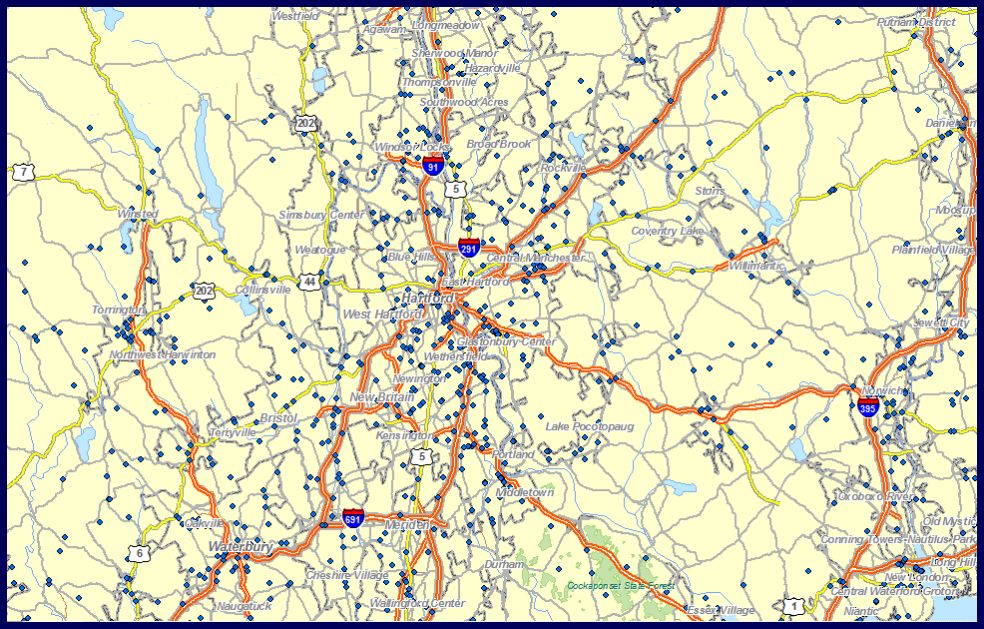
# What makes GIS so powerful?




| ZIP Code | Median Age | Median Income | Loss Freq. | Relative Loss Severity |
|---|---|---|---|---|
| 02115 | 30 | 60,000 | 0.155 | -10% |
| 02116 | 35 | 80,000 | 0.13 | +1% |
| 02114 | 45 | 120,000 | 0.08 | +5% |
| 02118 | 40 | 50,000 | 0.25 | +5% |

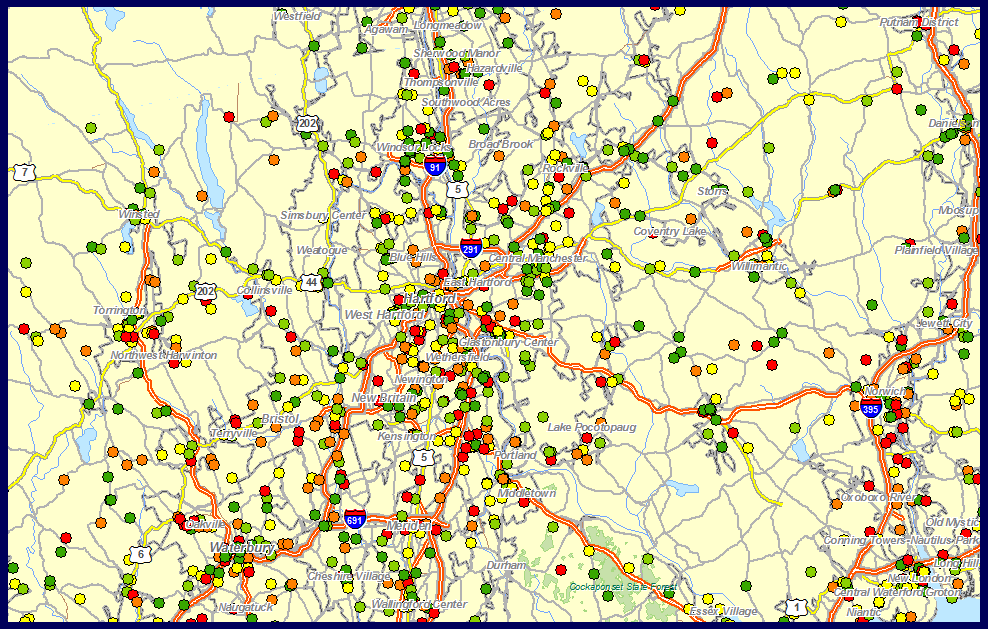
**Merging data associated with geographic areas and individual points can lead to powerful results**

# Integration of 2-D Space in Analysis




- Association of quantitative data and spatial techniques
- Spatial calculations take 2 dimensions into consideration
- Application of clustering, smoothing, and other mathematical methods

# Clustering Techniques

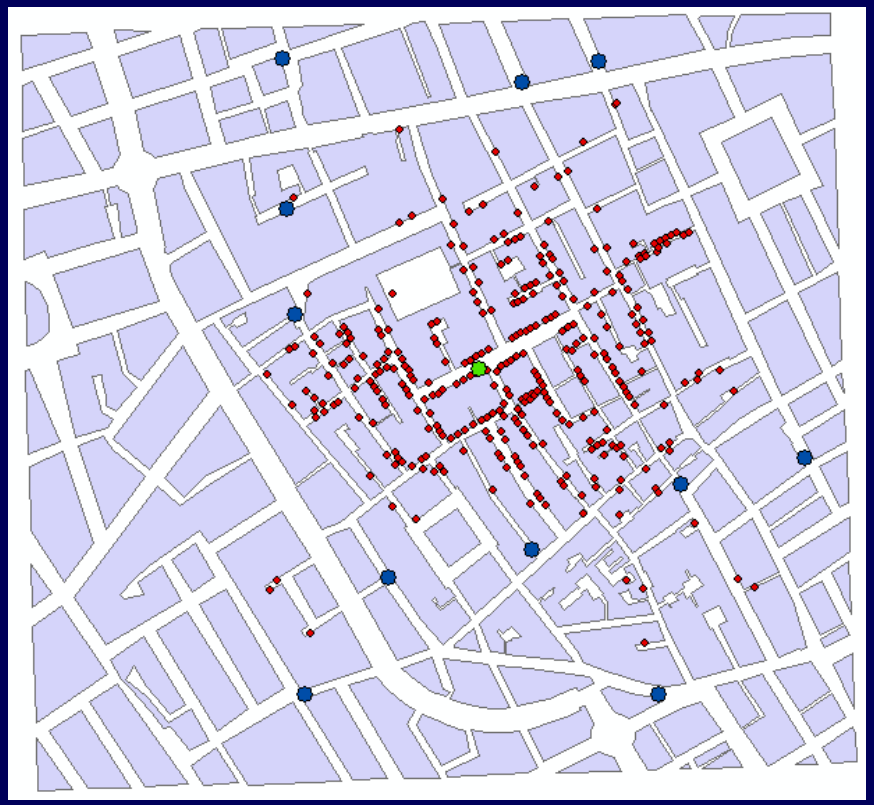



- Hotspot Analysis can be used to uncover hidden clusters
  - Getis-Ord G* - Local averaging of a quantity within a distance radius
- Cluster and Outlier Analysis
  - Moran's I – Spatial Autocorrelation
- Developed during analysis of crime statistics

# Case Study – Snow's Cholera Map

# Snow’s Cholera Map

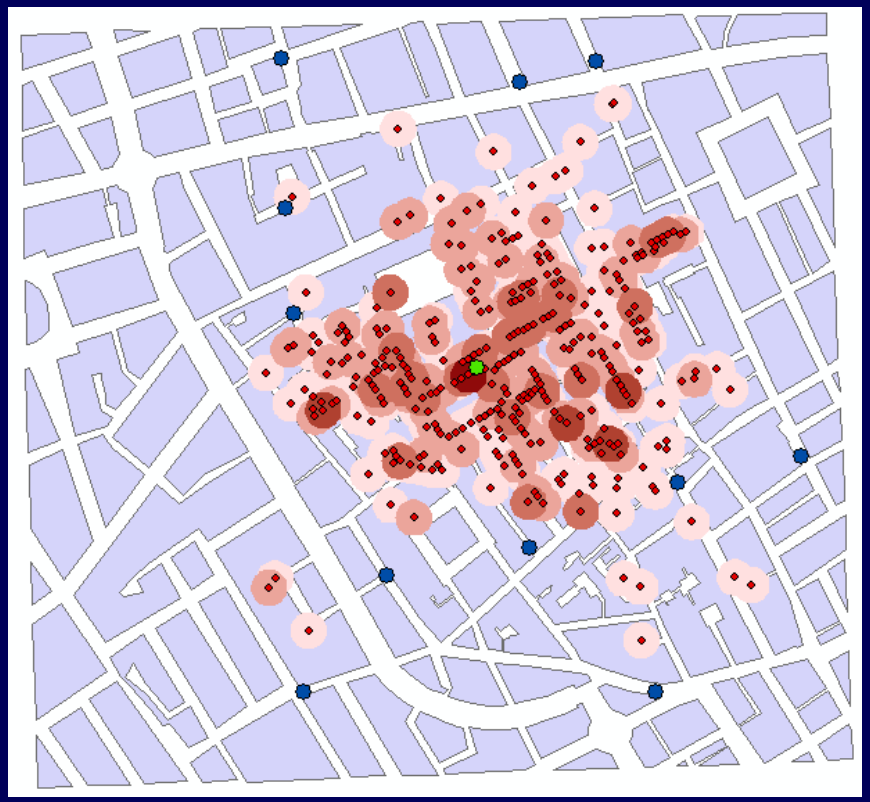
# Spatial Autocorrelation



Moran's I: Spatial Autocorrelation

- Based on spatial distance and a feature (number of deaths)
  - Range -1 to 1 indicates clustering
  - Statistical test: Z score
- Cholera Outbreak:
  - Moran's I: 0.0103
  - Z score: 2.45 (p value < .05)

# Hot Spot Analysis



Getis-Ord G* - Hot Spot Analysis

- Draw buffers around each point
- Calculate sum of value intersecting points within each buffer
- Compare to expected, calculate Z-score

# Conclusion

# Applications to Insurance

- Improved territory analysis
  - GAMS/GLM
  - Clustering
- Fraud detection
  - Clustering: Moran's I
  - Hot Spot Analysis: Getis-Ord G*
- Agent analysis and insights
  - Source and dispersion of customer base
  - Distribution of quotes versus current book

# Tools and References

- ESRI ArcGIS Product
  - http://www.esri.com
- R
  - http://www.r-project.org
  - R GIS package
- John Snow's Cholera Map
  - Prof. Waldo Tobler
    National Center for Geographic Information and Analysis
    Geography Department
    University of California Santa Barbara CA 93106-4060
    email: tobler@geog.ucsb.ed
  - http://www.ncgia.ucsb.edu/pubs/snow/snow.html
  - http://www.asdar-book.org/RC1

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