Introduction to spatial analysis
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Outline
- What is spatial analysis?
  - Spatial data, GIS, spatial statistics
- What are some concerns with spatial analysis?
- How can spatial analysis inform education, outreach, and policy?

An overview of how spatial analysis harnesses location information to improve analysis and communicate results

What is spatial analysis?
- Investigation of data tagged with location
- 3 components:
  - Spatial data
  - GIS
  - Spatial statistics

\[ Y(s) = \beta_0 + \beta_1 X(s) + \ldots + \beta_k X_k(s) + \varepsilon(s) \]

\( s \): Location
\( Y(s) \): Outcome at location \( s \)
\( X(s) \): Covariate at location \( s \)
\( \varepsilon(s) \): \( \sim N(0, \sigma^2) \), spatially correlated

Curriero (2013)
Spatial data

Data tagged with a location

Why collect spatial data?

- To study spatial variation in risk
- Location can serve as an information gateway / proxy for unmeasured factors
  - Environmental
  - Social
  - Demographic
- Proximity to risk factors

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Types of spatial data

Point pattern data: Locations are the data

Where do events occur?

Geostatistical data: Data is tagged with location

Where have we measured?

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Curriero (2013)

Hancock (2002)

Berman (2012)
Spatial area level data: Data is aggregated to an area unit

How many events occur in a given area?

How to aggregate data?

Any way you can!

By legislative district

By City Council district

By census tract

Storing / viewing spatial data: GIS

- Input into Geographic Information Systems (GIS)
  - Database for spatial data
  - Examples: ArcGIS (ESRI), MapInfo (Pitney Bowes), IGIS (ScanPoint Geomatics Ltd.)
- Allows user to combine multiple layers of information into a single product which is usually a visual map
Why use GIS?
To store, organize data

Why use GIS?
To produce maps

Why use GIS?
To generate/refine hypotheses by adding additional spatial data

Did crimes occur close to parks in Baltimore?
Curriero (2013)
Going “beyond the map” to investigate and evaluate spatial data

Example: To investigate large scale trends

Curriero (2013)

Going “beyond the map” to investigate and evaluate spatial data

Examples: To evaluate “hotspots”

Significant cluster of Lyme disease cases in Howard County area, Maryland 2008 - 2010

(Relative risk = 1.95, p<0.001)

Woods (2011)

Going “beyond the map” to investigate and evaluate spatial data

Example: To predict risk at unsampled locations

Berman (2012)
Analyzing spatial data: Spatial statistics

- Going “beyond the map” to investigate and evaluate spatial data
- Example: To evaluate sources of interest

Spatial statistics resources

- Textbooks

- Statistical programs
  - R
  - SAS
  - STATA

Proceed with caution!

- Confidentiality
Proceed with caution!

- Modifiable area unit

<table>
<thead>
<tr>
<th>City Population</th>
<th>City crime incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime rate = 340 per 10,000</td>
<td></td>
</tr>
</tbody>
</table>

Proceed with caution!

- Modifiable area unit

<table>
<thead>
<tr>
<th>Population by census tract</th>
<th>Crime by census tract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime rate = 359 per 10,000</td>
<td>Crime rate = 291 per 10,000</td>
</tr>
</tbody>
</table>

Proceed with caution!

- Modifiable area unit

<table>
<thead>
<tr>
<th>Population by school district</th>
<th>Crime by school district</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime rate = 250 per 10,000</td>
<td>Crime rate = 350 per 10,000</td>
</tr>
</tbody>
</table>
Proceed with caution!

- Modifiable area unit

THE AGGREGATION SCHEME MATTERS!

Maps illustrate the story,

But you tell the story

How can spatial analysis inform education, outreach, and policy?
References


Curriero, FC (2013). Spatial Analysis and GIS I and II. Classes taught at the Johns Hopkins Bloomberg School of Public Health.


Jennings, JJ; Woods, SE; Curriero, FC. The spatial and temporal impact of neighborhood drug markets on rates of sexually transmitted infections in an urban setting. Health and Place. Publication pending.


Thank you!

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