Visualizing Active Travel using GIS

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OVERVIEW

- Introduction – Universities and active transportation
- Collecting the right data
- Spatial modeling and bivariate cartography
- Implications for stakeholders
INTRODUCTION

Universities and Active Transportation

- **Benefits:**
  - Reduce environmental externalities
  - Student recruitment
  - Beacon of sustainability
  - Educate next generation of planners/decision makers
  - Faculty/student retention
INTRODUCTION

- **Research goal:**
  - Identify indicators that may cause a mode shift to active transportation

- **Possible Factors:**
  - Neighborhood conditions
  - Family constraints
  - Socioeconomic conditions
  - Limited access to school
  - Traffic conditions
  - Distance
  - Weather
  - Social stigmas
  - Etc…

- **Required tools:**
  - Survey instrument
  - GIS
  - Spatial model
  - Cartography
DATA

Survey Instrument

- Gender,
- University classification
- Home address
- Transportation mode to UM-Flint campus
  - Auto
  - Bicycle
  - Bus
  - Walking
  - Scooter, etc.

- Attitudes re: alternative transportation on campus:
  - 13 Interventions to \textit{increase} biking
  - 7 Barriers to \textit{decrease} biking
  - 8 Interventions to \textit{increase} walking
# DATA

## Trip-start factors

- **Neighborhood Context**
  - Census Block Group
    - Socioeconomic status
    - Land-use diversity
  - Density
  - Design

- **University Classification**

- **Transportation environment**
  - Bicycle and Pedestrian Crashes

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Gross residential density (housing units per acre) on unprotected land</td>
</tr>
<tr>
<td>Diversity of land use</td>
<td>Employment and housing entropy</td>
</tr>
<tr>
<td>Urban design</td>
<td>Street intersections per square mile</td>
</tr>
<tr>
<td></td>
<td>High-speed road network density</td>
</tr>
<tr>
<td>Transit service</td>
<td>Aggregate transit service frequency, afternoon peak period</td>
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<tr>
<td></td>
<td>Distance to nearest transit stop</td>
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<tr>
<td>Destination accessibility</td>
<td>Working-age population within a 45-minute transit commute</td>
</tr>
<tr>
<td>by transit*</td>
<td>Jobs within a 45-minute drive</td>
</tr>
<tr>
<td>Demographics</td>
<td>Percentage of households with no car, 1 car, or 2 or more cars</td>
</tr>
<tr>
<td>Employment totals</td>
<td>Employment totals broken down by 5-tier classification scheme</td>
</tr>
</tbody>
</table>
MODELING APPROACH

- Geocoding/Spatial Joining
  - University Respondents & Smart Location Data

- Exploratory Analysis
  - Descriptive Statistics

- Cluster Analysis
  - Active travel & Predictors

- OLS & GWR
  - Global & Local model

- Coefficient Mapping
Two different types of modeling approaches can be implemented in ArcGIS:

- **OLS (Ordinary Least Squares)**
  - Global regression model
  - One equation, calibrated using data from all features
  - Relationships are fixed
  - Does not account for spatial heterogeneity \((\text{Wen et al., 2010})\)

- **GWR**
  - Local regression model
  - One equation for every feature, calibrated using data from nearby features

For each explanatory variable, GWR creates a coefficient surface showing you where relationships are strongest. \((\text{Esri, 2010})\)
SPATIAL MODELING

- **GWR outputs include:**
  - Best-fit ($R^2$)
  - Parameter Estimates (magnitude of influence, -+)
  - $T$-values (distribution of significance, -+)

  - Mapping only the parameter estimate can be misleading (where is it significant?)

  - $T$-values have been displayed as contour lines over the parameter estimates

  - Can be “messy” or differences may be too large to interpret

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**Adjusted R2 Values**

- 0.057 - 0.216
- 0.216 - 0.484
- 0.484 - 0.564
- 0.564 - 0.652
- 0.652 - 0.739
SPATIAL MODELING

- Coupling GWR parameter estimates and statistical significance

1. Interpolate for local estimates ($\beta$’s) for each explanatory variable using Inverse Distance Weighting (IDW)

2. Interpolate t-values for each explanatory variable
   - Inverse Distance Weighting
   - T-values become the z’s

3. Classify t-value surface for statistical significance
   - Choose 3 classes and manually change ranges (break values) to -1.96 and 1.96

4. Symbolize for statistical significance, i.e., implement mask
   - Choose “no-color” for the 1st and 3rd classes (transparent - unique). Choose white for the 2nd class (opaque)

5. Produce bivariate color scheme to display sig. parameter estimates

(Matthews et al., 2012)
Where are the parameter estimates *significantly* affecting active mode choice potential?
BIVARIATE CARTOGRAPHY

T-value partitions

1.96 is the approximate value of the 95% point of the normal distribution used in statistics.

Other critical values can be queried:
99%, 2.58
90%, 1.645
BIVARIATE CARTOGRAPHY

- Setting up the significance mask
We can now visualize where the parameter estimates may be affecting local active transportation mode choices, positively or negatively.
IMPLICATIONS

- Spatially explicit modeling approaches and novel symbolization techniques can highlight specifically where alternative travel “best-practices” should be implemented.

- Bivariate mapping of parameter estimates and t-values provides deeper understanding of active travel potential.

- The models and cartographic techniques can easily be transferred to other applications.
Thank You