Learning Objectives

• After this segment, students will be able to
  • Compare traditional & location prediction models
  • Contrast Linear Regression & Spatial Auto-Regression
Illustration of Location Prediction Problem

- Nest Locations
- Vegetation Index
- Water Depth
- Distance to Open Water
Neighbor Relationship: W Matrix

(a) Map

(b) Boolean W

(c) Row-normalized W
**Location Prediction Models**

- **Traditional Models**, e.g., Regression (with Logit or Probit),
  - Bayes Classifier, …
- **Spatial Models**
  - Spatial autoregressive model (SAR)
  - Markov random field (MRF) based Bayesian Classifier

<table>
<thead>
<tr>
<th>Classical</th>
<th>Spatial</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = X\beta + \epsilon )</td>
<td>( y = \rho W y + X \beta + \epsilon )</td>
</tr>
<tr>
<td>( \Pr(C_i \mid X) = \frac{\Pr(X \mid C_i) \Pr(C_i)}{\Pr(X)} )</td>
<td>( \Pr(c_i \mid X, C_N) = \frac{\Pr(C_i) \Pr(X, C_N \mid c_i)}{\Pr(X, C_N)} )</td>
</tr>
</tbody>
</table>
Comparing Traditional and Spatial Models

- Dataset: Bird Nest prediction
- Linear Regression
  - Lower prediction accuracy, coefficient of determination,
  - Residual error with spatial auto-correlation
- Spatial Auto-regression outperformed linear regression
Modeling Spatial Heterogeneity: GWR

- Geographically Weighted Regression (GWR)
  - Goal: Model spatially varying relationships
  - Example: \( y = X\hat{\beta} + \varepsilon \)
    
    Where \( \hat{\beta} \) and \( \varepsilon \) are location dependent

Source: resources.arcgis.com
Research Needs for Location Prediction

- **Spatial Auto-Regression**
  - Estimate $W$
  - Scaling issue $\rho W y$ vs. $X \beta$
- **Spatial interest measure**
  - e.g., distance(actual, predicted)

![Diagram](image)

- **Actual Sites**
- **Pixels with actual sites**
- **Prediction 1**
- **Prediction 2. Spatially more interesting than Prediction 1**

Legend:
- $\oplus$ = nest location
- $A$ = actual nest in pixel
- $P$ = predicted nest in pixel

*University of Minnesota*

Driven to Discover™