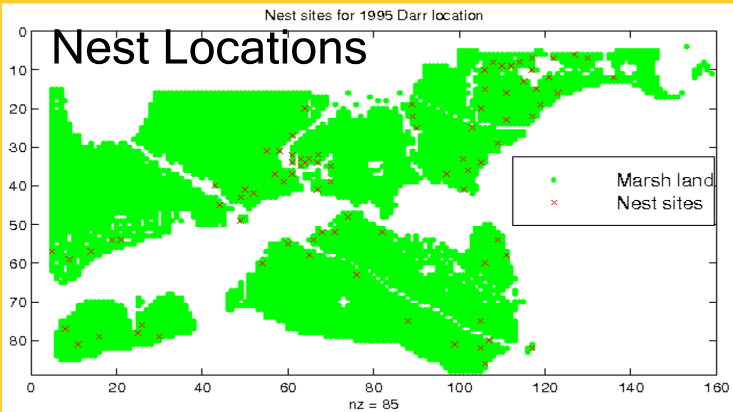
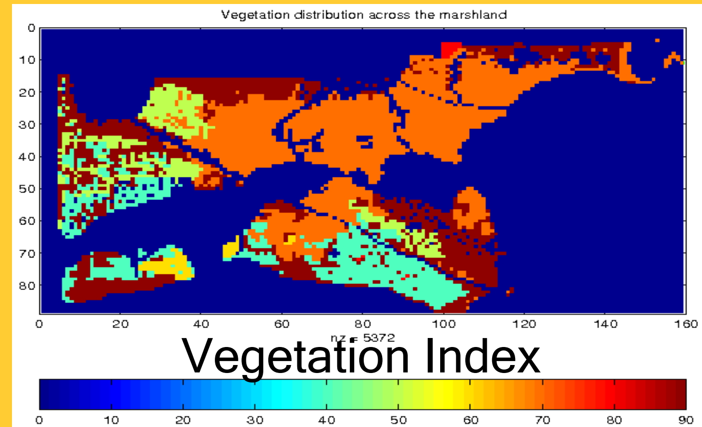
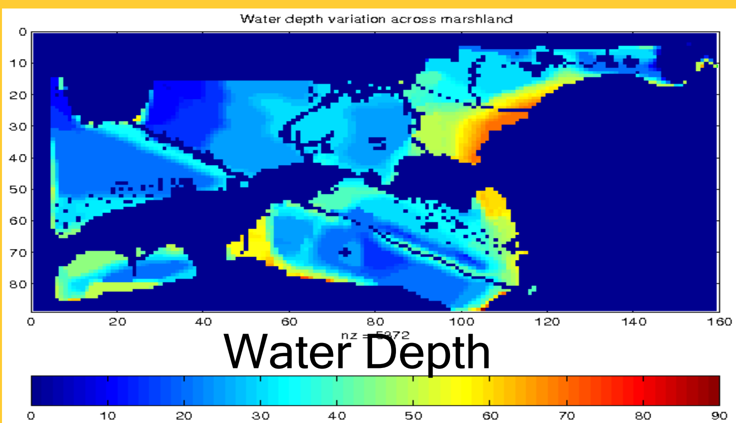
Learning Objectives

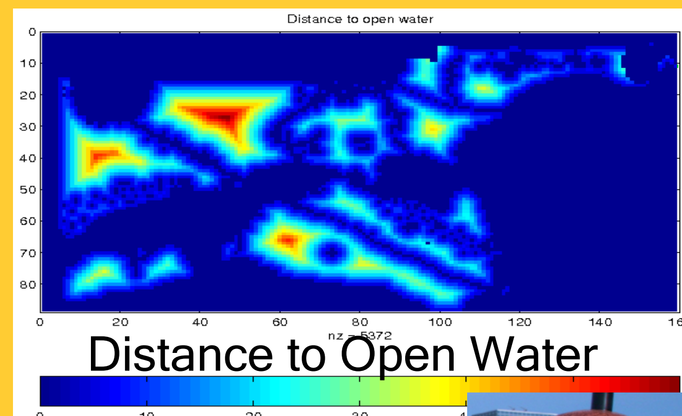
- After this segment, students will be able to
  - Compare traditional & location prediction models
  - Contrast Linear Regression & Spatial Auto-Regression

Illustration of Location Prediction Problem

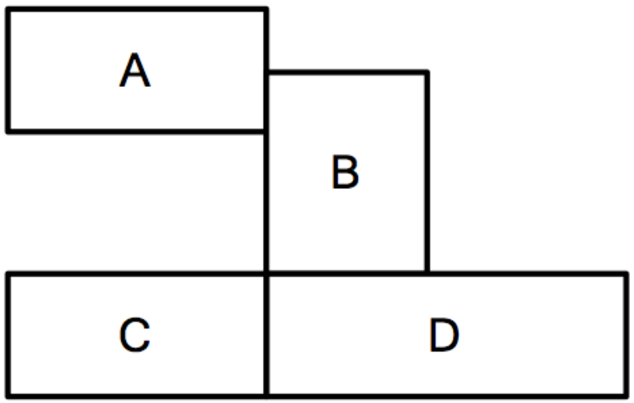








Neighbor Relationship: W Matrix



(a) Map

$$\begin{array}{c|cccc|} & A & B & C & D \\ \hline A & 0 & 1 & 0 & 0 \\ B & 1 & 0 & 1 & 1 \\ C & 0 & 1 & 0 & 1 \\ D & 0 & 1 & 1 & 0 \\ \hline \end{array}$$

(b) Boolean W

$$\begin{array}{c|cccc|} & A & B & C & D \\ \hline A & 0 & 1 & 0 & 0 \\ B & 0.3 & 0 & 0.3 & 0.3 \\ C & 0 & 0.5 & 0 & 0.5 \\ D & 0 & 0.5 & 0.5 & 0 \\ \hline \end{array}$$

(c) Row-normalized W

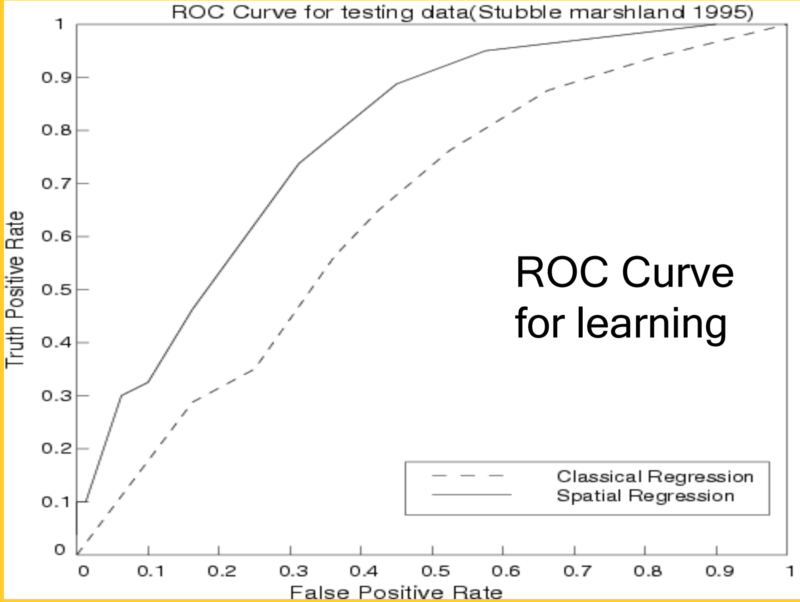
Location Prediction Models

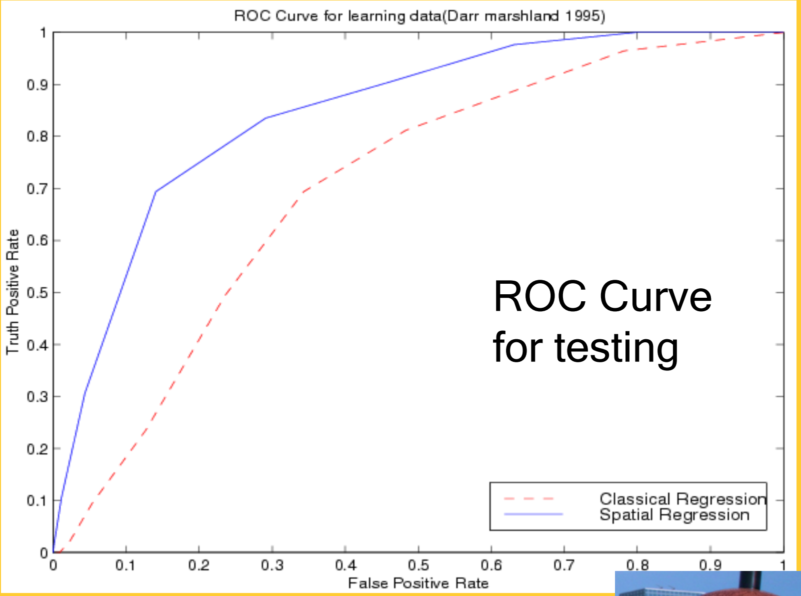
- Traditional Models, e.g., Regression (with Logit or Probit),
  - Bayes Classifier, …
- Spatial Models
  - Spatial autoregressive model (SAR)
  - Markov random field (MRF) based Bayesian Classifier

Classical	Spatial
$y = X\beta + \varepsilon$	$y = \rho W y + X \beta + \varepsilon$
$\Pr(C_i \mid X) = \dfrac{\Pr(X \mid C_i) \Pr(C_i)}{\Pr(X)}$	$\Pr(c_i \mid X, C_N) = \dfrac{\Pr(C_i) \Pr(X, C_N \mid c_i)}{\Pr(X, C_N)}$

Comparing Traditional and Spatial Models

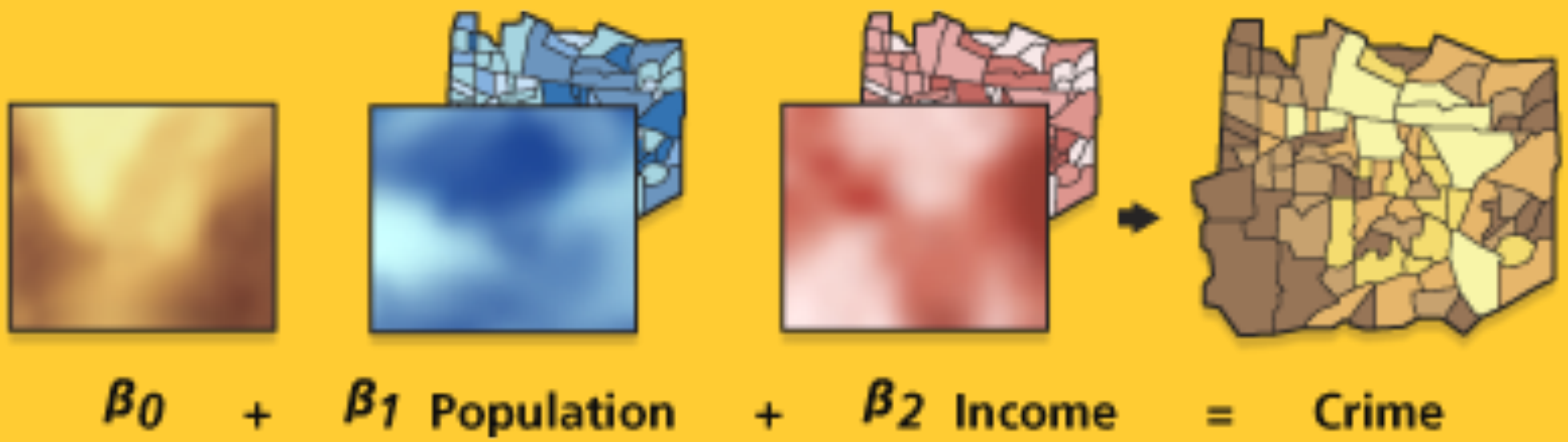
- Dataset: Bird Nest prediction
- Linear Regression
  - Lower prediction accuracy, coefficient of determination,
  - Residual error with spatial auto-correlation
- Spatial Auto-regression outperformed linear regression





Modeling Spatial Heterogeneity: GWR

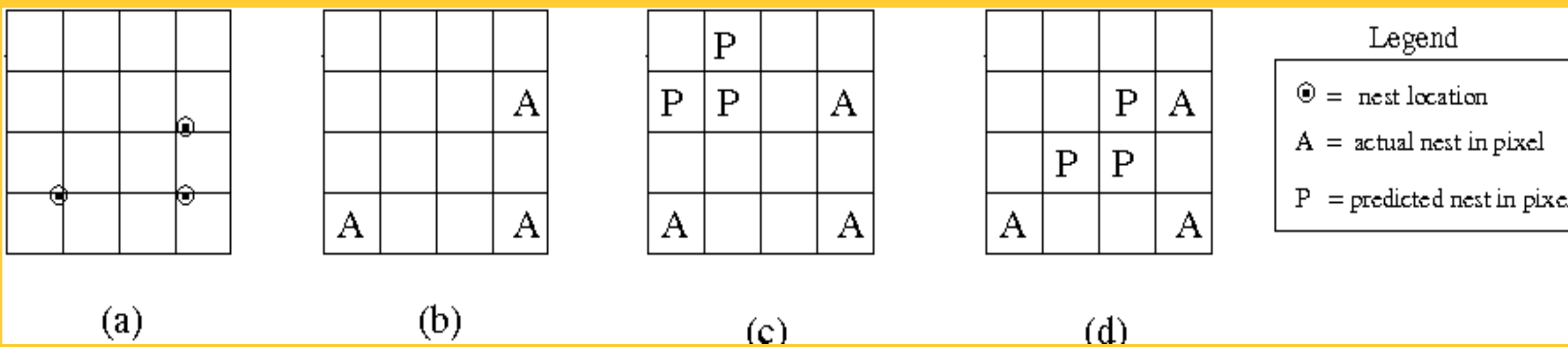
- Geographically Weighted Regression (GWR)
  - Goal: Model spatially varying relationships
  - Example: $y = X\beta' + \varepsilon'$
    Where β' and ε' are location dependent



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)



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