Point process models

GIS 5923 Spatial Statistics

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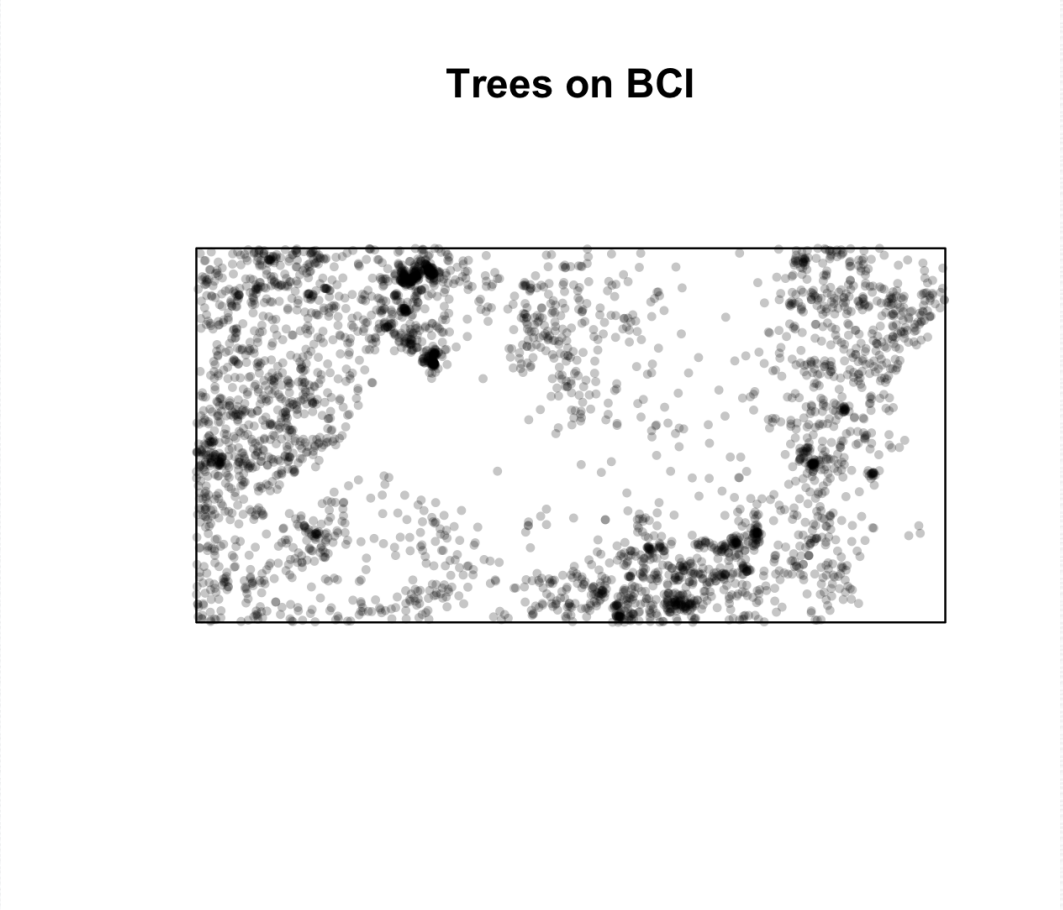
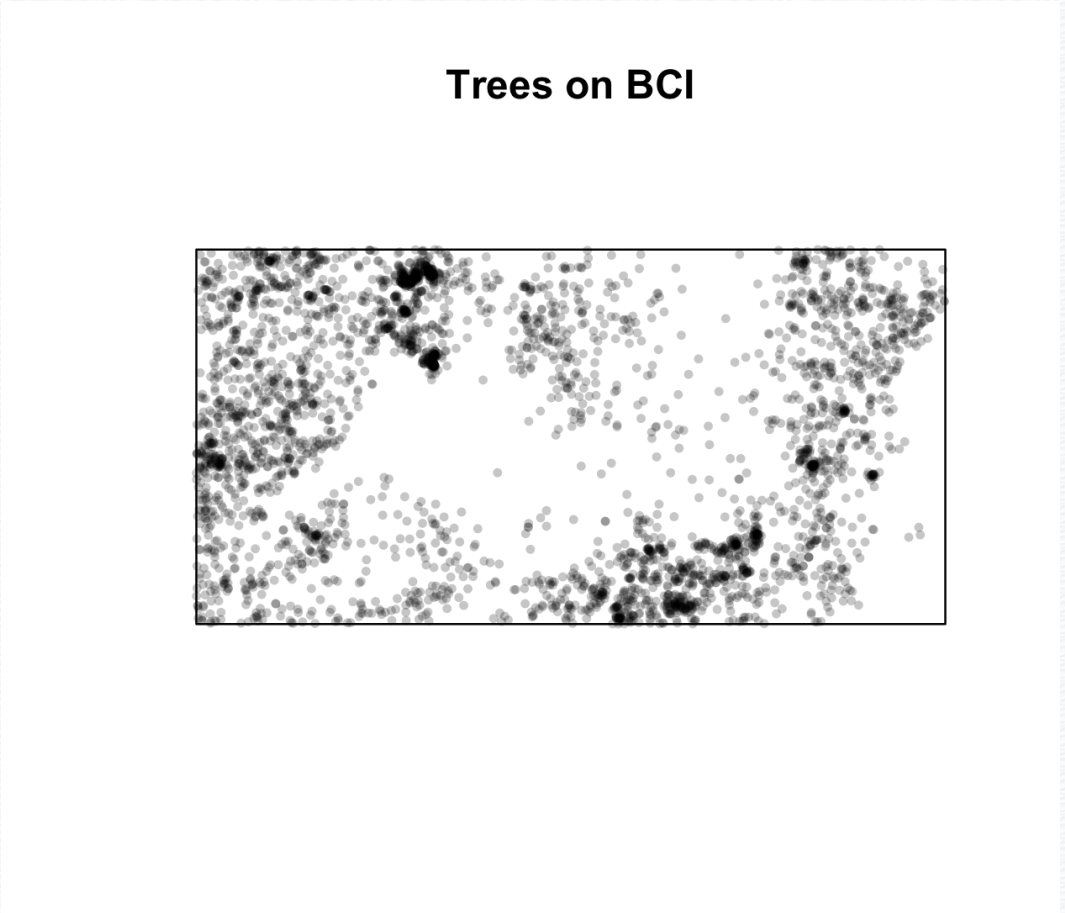
What causes clustering?

- We've learned a number of methods for determining *if* there is clustering in a point pattern.
- Here, we want to ask why, or what *causes*, clustering in a point pattern. What spatial processes are at work?



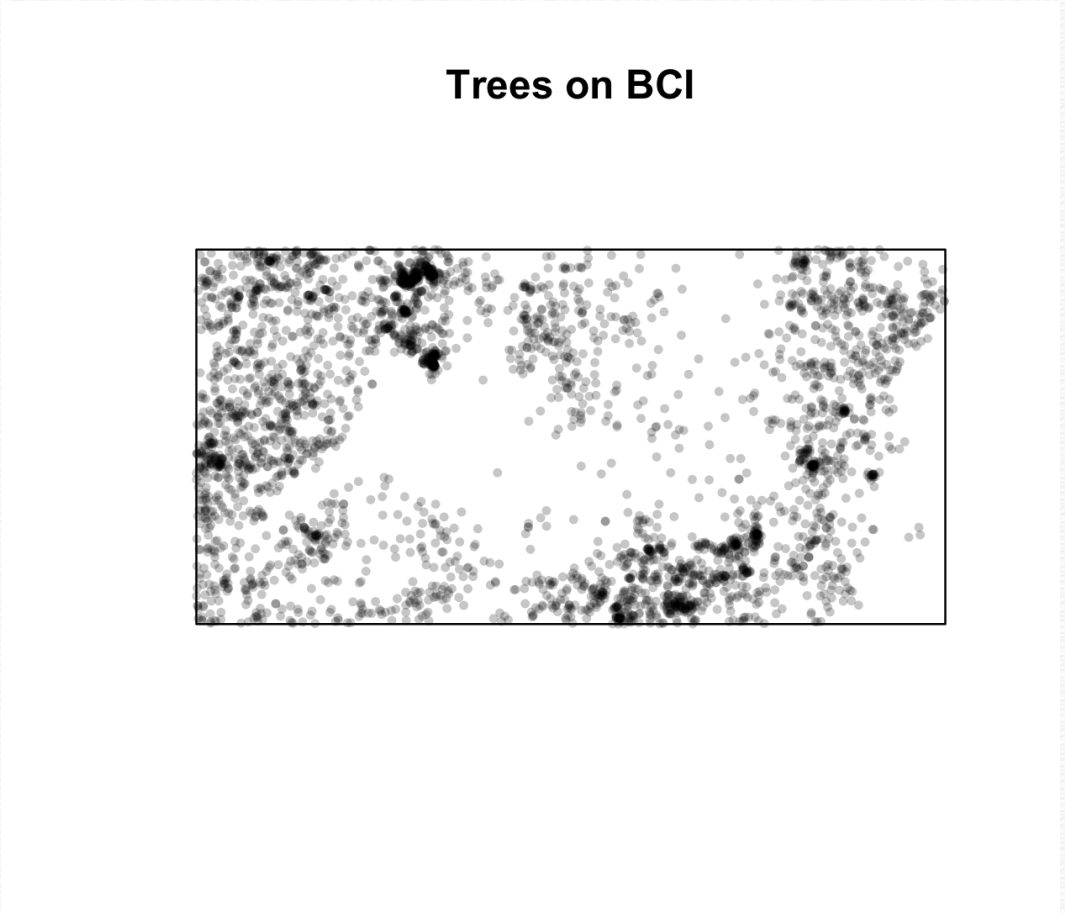
Why might a point pattern deviate from CSR?

- Type I effects: spatial variation of the intensity of the point process (this video).
  - Are there environmental covariates that affect point process intensity?
- Type II effects: interactions among points (not covered)



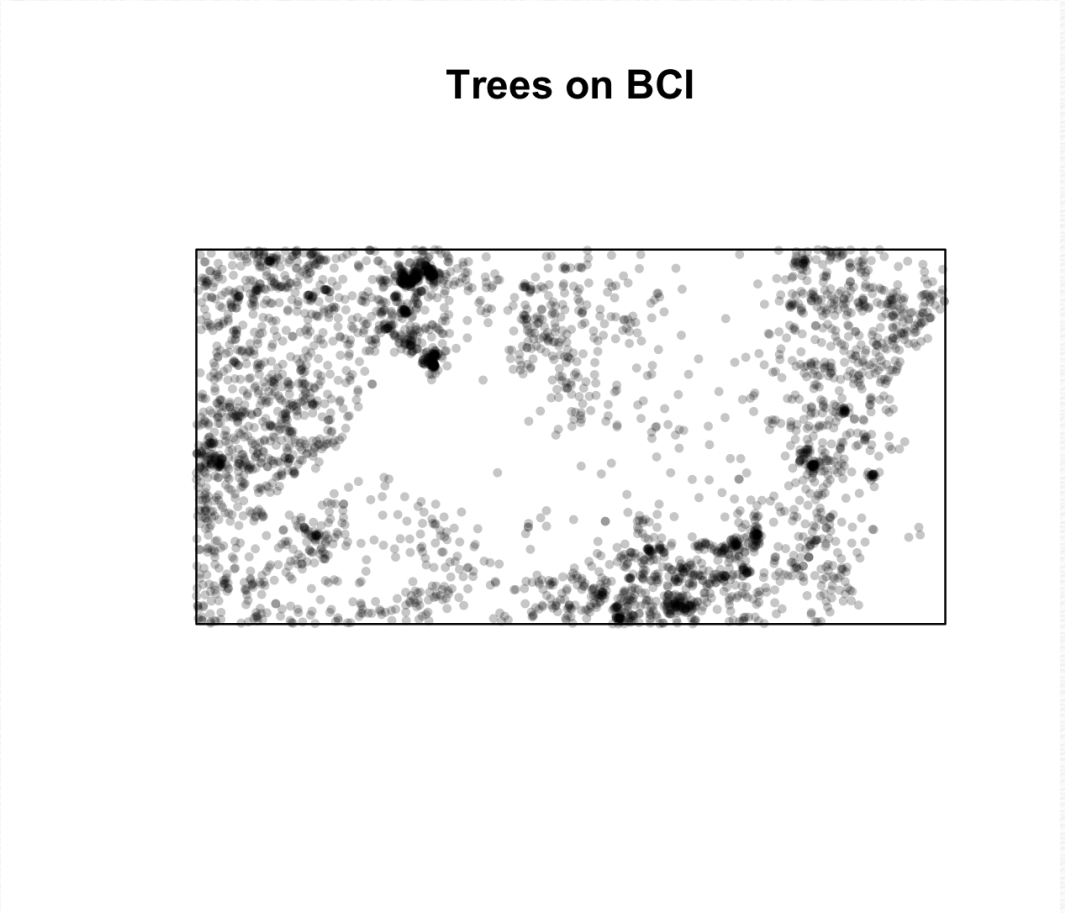
Point process models

- Here, we'll learn to fit *point process models.* These models attempt to how the intensity of a point pattern varies spatially as a function of spatial coordinates and/or spatial covariates
- Spatial covariates are variables that are potentially explanatory that are observed *everywhere in the study region* (not just at the locations of the events).



Point process models

- Consider a model that explains the density of trees on BCI (right). Assume that seeds are dispersed randomly, but the germination probability depends on soil type. The resulting pattern of plants is an inhomogeneous Poisson process.



Point process models

- We'll align our notation with vignettes that discuss PPM models.
- For a point pattern $\boldsymbol{x}$ in a study region W, the conditional intensity is a function $\lambda(u, \boldsymbol{x})$ of spatial location $u \in W$ and the point pattern $\boldsymbol{x}$.
- For example, a spatially homogeneous Poisson process (CSR) has a constant conditional intensity β:

$$\lambda(u, \boldsymbol{x}) = \beta$$

Inhomogeneous Poisson models

- If the point pattern results from an inhomogeneous Poisson process, it may have some local intensity function $\beta(u)$ that governs the conditional intensity:

$$\lambda(u, \boldsymbol{x}) = \beta(u)$$

- In other cases, we might hypothesize that the conditional intensity depends on some environmental covariates θ. To fit these models, intensity function must be log-linear in the parameter θ:

$$\log(\lambda(u, \boldsymbol{x})) = \theta \cdot \beta(u)$$

Using AIC to assess models

- If we fit a point process model, how do we tell if it is significantly different from our null hypothesis (CSR), i.e., a homogeneous Poisson process?
- Unfortunately, standard Analysis of Deviance approaches don't work because the homogeneous Poisson model is not a nested sub-model of the inhomogeneous models.
- So, we will compare models using AIC

Akaike Information Criterion

- Informally, the Akaike Information Criterion (AIC) is a measure of how well a statistical model fits a data set.
- The range of possible values for AIC will depend on the data set, but lower values are better.
- When comparing multiple models, the “best” model is the one with the lowest AIC score.
- However, if the difference in AIC between the best and competing models is less than 2, it is common to conclude that there is support for both models.

Examples in R…

- Look at ppm in R