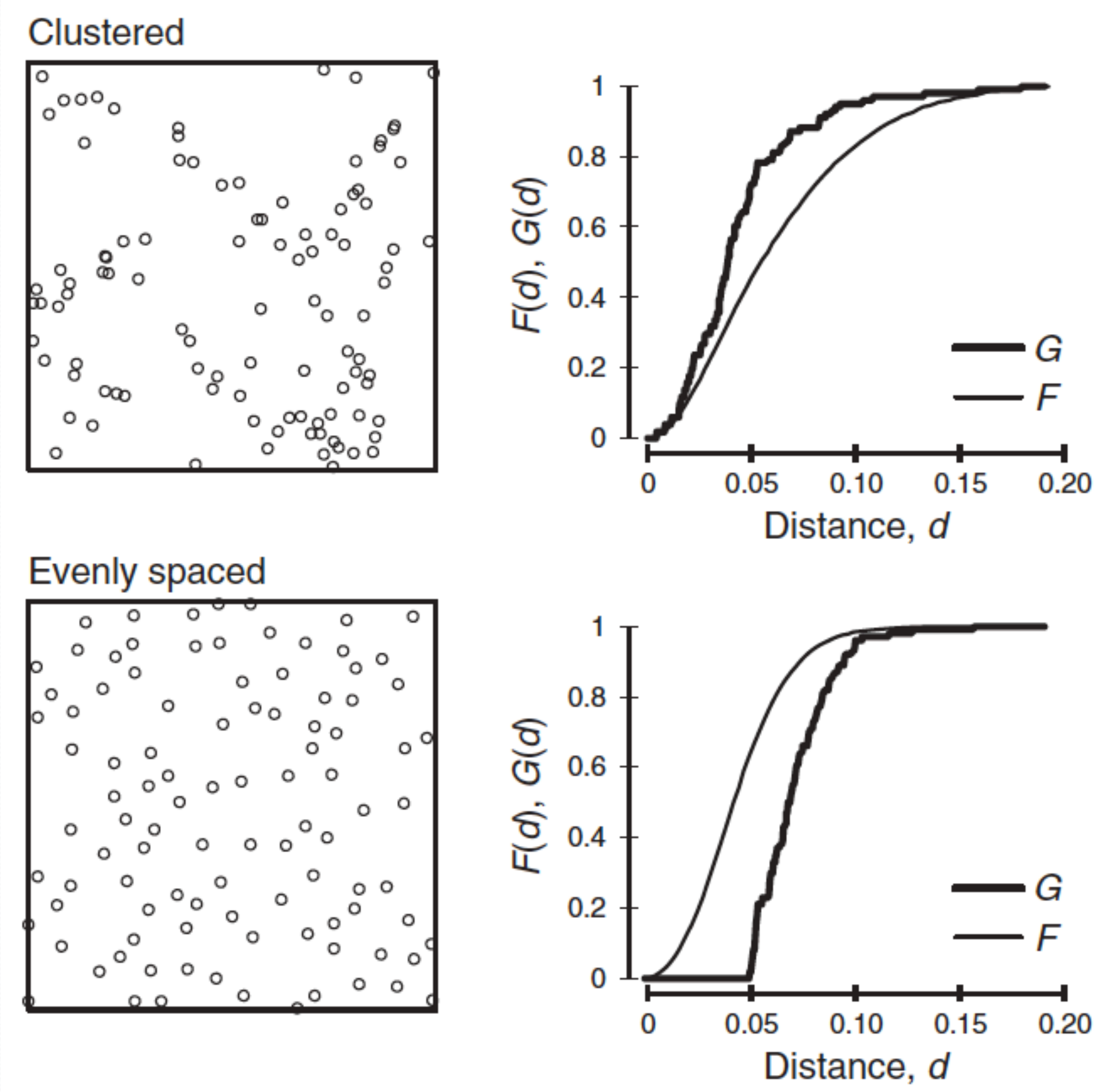
# Point pattern analysis: hypothesis tests

## GIS 5923 Spatial Statistics

COLLEGE OF ATMOSPHERIC AND GEOGRAPHIC SCIENCES
DEPARTMENT OF GEOGRAPHY
AND ENVIRONMENTAL SUSTAINABILITY
The UNIVERSITY of OKLAHOMA

In the last module, we saw how the F, G and K functions can tell us whether a point pattern is more clustered or less clustered than expected under CSR.

But, how do we say if this is statistically significant?

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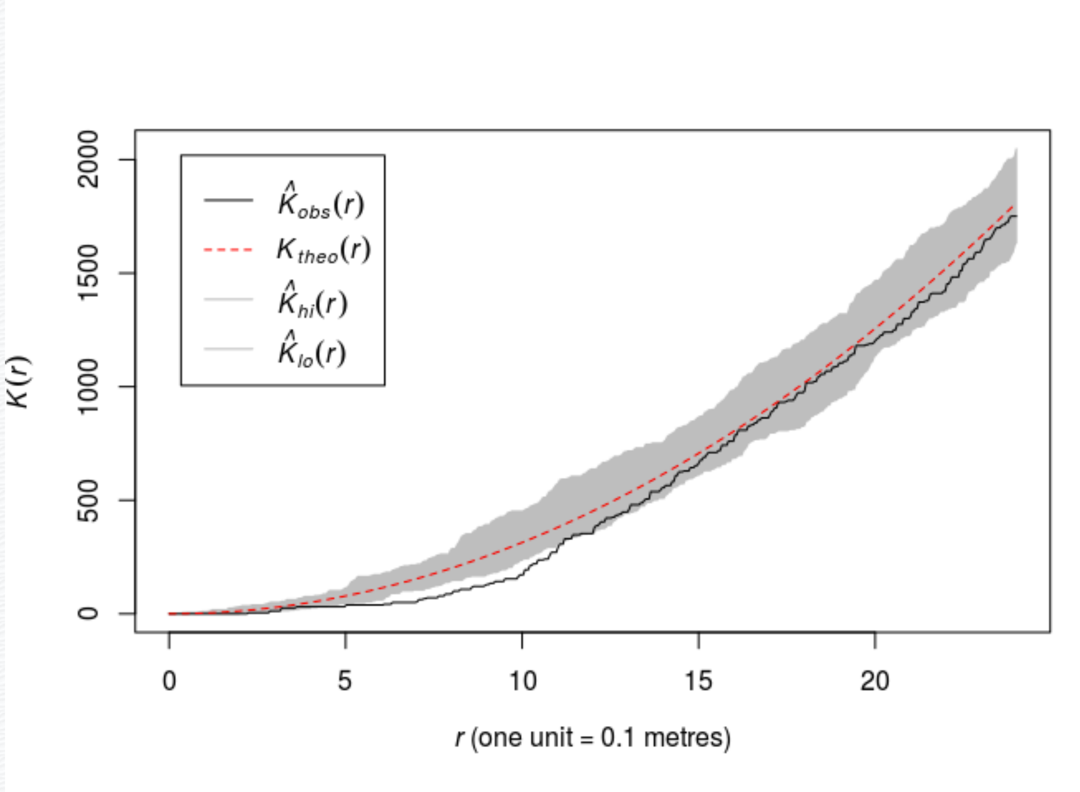
# Hypothesis testing for F, G, K

- Sometimes analytical results are available; for example, researchers have derived exact expressions for the expected values of F,G,K functions, which enables hypothesis testing.
- But, we are still left with the problem of correcting for edge effects and non-rectangular study regions…
- A common approach is to perform a Monte Carlo analysis to generate a distribution of values for a point pattern in a given study region.

# Algorithm for MC envelopes

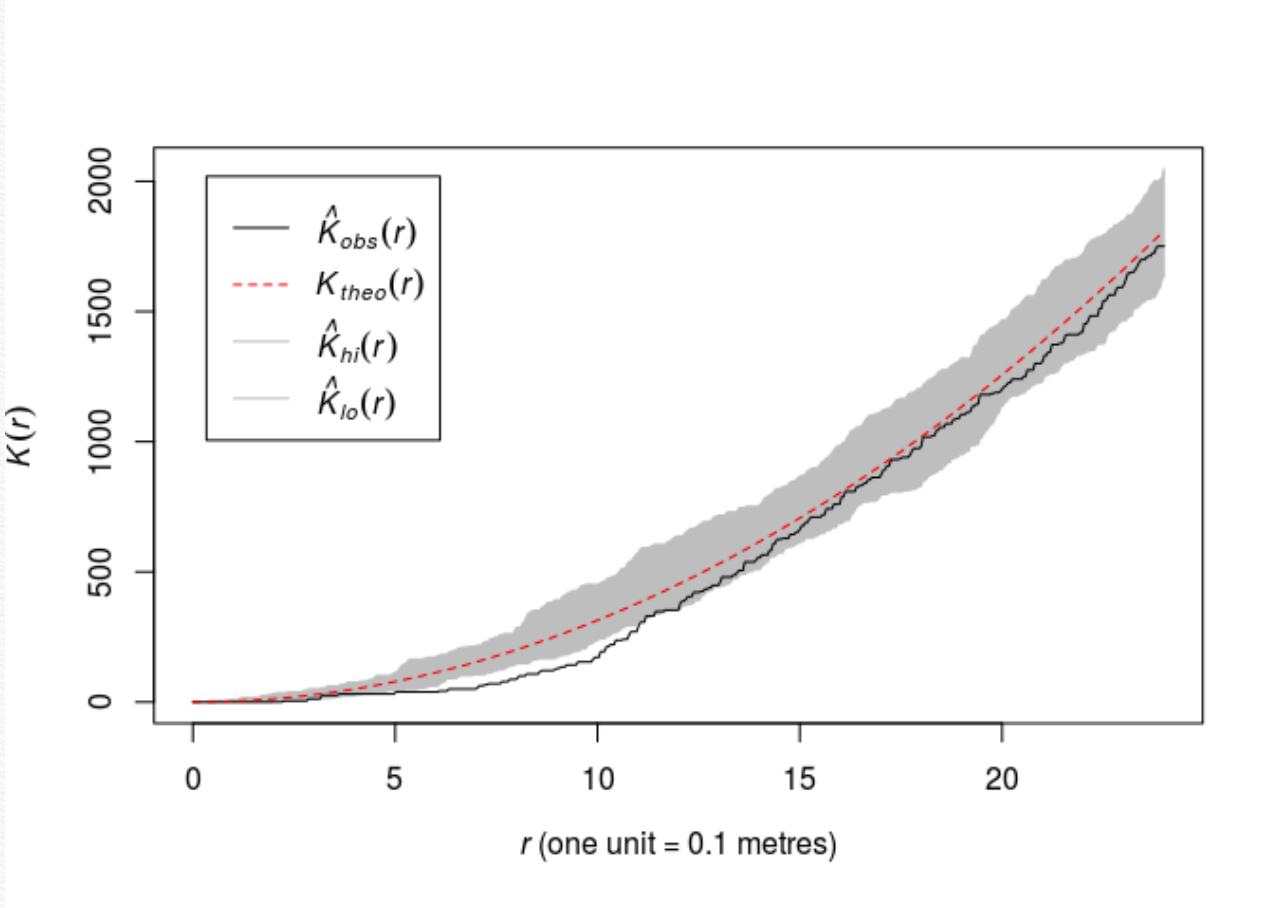
1. Repeat a large number of times:
   i. Generate a random point pattern in the study area
   ii. Measure the K (or G or F) function on that point pattern
2. Draw an "envelope" whose boundaries are determined by the top *n* and bottom *n* functions generated in step 1.ii



# Hypothesis testing on MC envelopes

- MC envelopes are "acceptance intervals", i.e., the range of values that are not statistically different from the null hypothesis (e.g., CSR).

- We reject the null hypothesis if the observed value of K (i.e., from the real point pattern) lies outside the acceptance interval.



# Advantages of Monte Carlo approach

- By using the same study region in the simulation as in the observed data, edge effects and study area shape become part of the expected distribution. Thus, no need for complex corrections for edge and study region area effects.

- Spatial process models other than IRP/CSR are easily investigated. We could use MC methods to test hypotheses about *any* spatial process, and calculate the probability that a point pattern could have been generated by that spatial process. This is very powerful if we want to test the likelihood that a point pattern (e.g., incidents of disease) could have resulted from some complex spatial process (e.g., a proposed spatial simulation model of the spread of that disease).

# R and MC envelopes

- We will work through some examples of using envelope() to calculate acceptance intervals and p-values for point patterns in R…