BST 6200 Spatial Statistics and Disease Mapping
Homework 2

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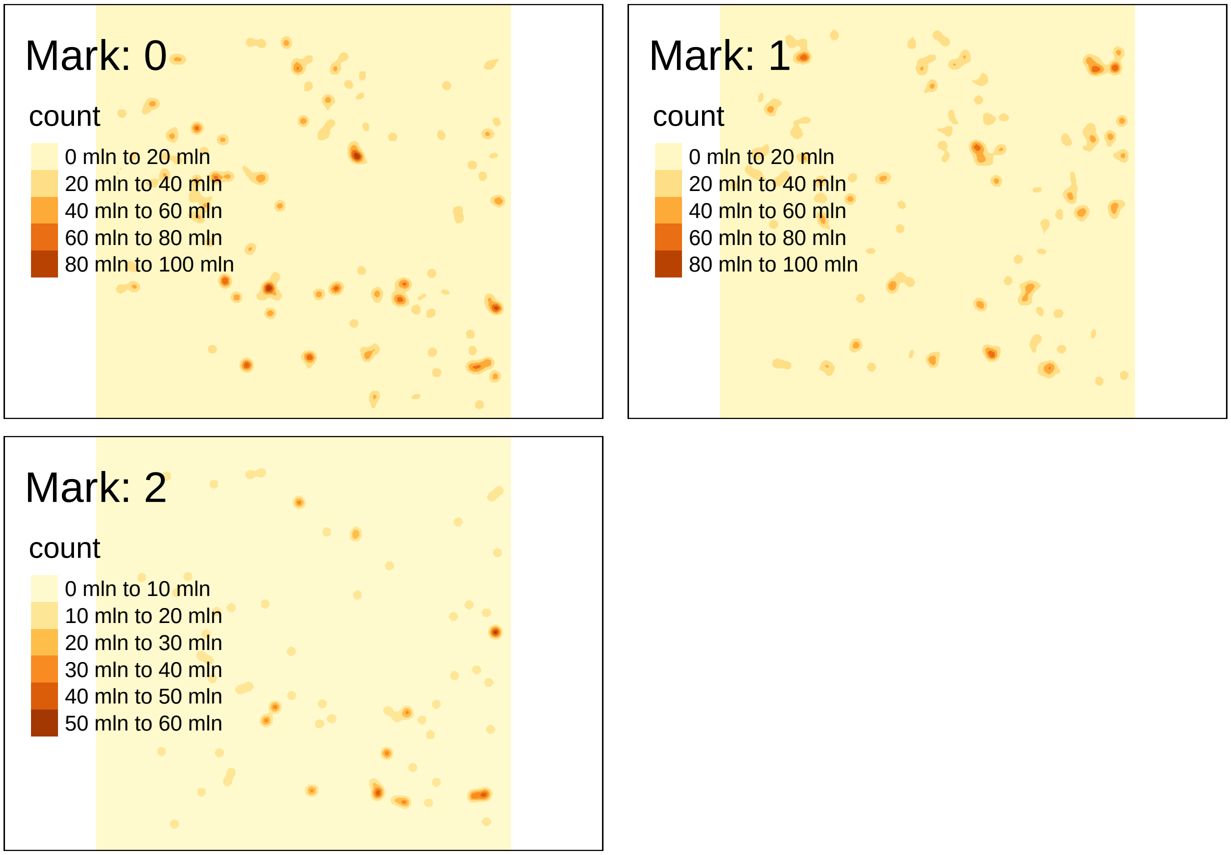
1. Consider the bramblecanes data from class. For each of the three ages of bramble canes (0, 1, or 2) construct the following:

   a) a kernel density estimate and display it with a heat map (use trial and error to get an appropriate bin width)
   b) a hexagonal bin plot (SKIP)
   c) an estimate of the K function along with the envelope for testing CSR.

```
# a) Kernel density estimate
pacman::p_load(GISTools, tmap, tmaptools, spatstat, sf)

data( bramblecanes )
bramblecanes$marks = as.character(bramblecanes$marks)

p_kde = function(group_num = "0"){
  group0 = as(bramblecanes[bramblecanes$marks == group_num], "SpatialPoints")
  proj4string(group0) = CRS('+init=epsg:26978')
  group0_dens = smooth_map(group0)

  p = tm_shape(group0_dens$raster) +
    tm_raster() +
    tm_layout(title = paste0("Mark: ", group_num))
  return(p)
}

tmap_arrange( p_kde("0") , p_kde("1"), p_kde("2"))
```

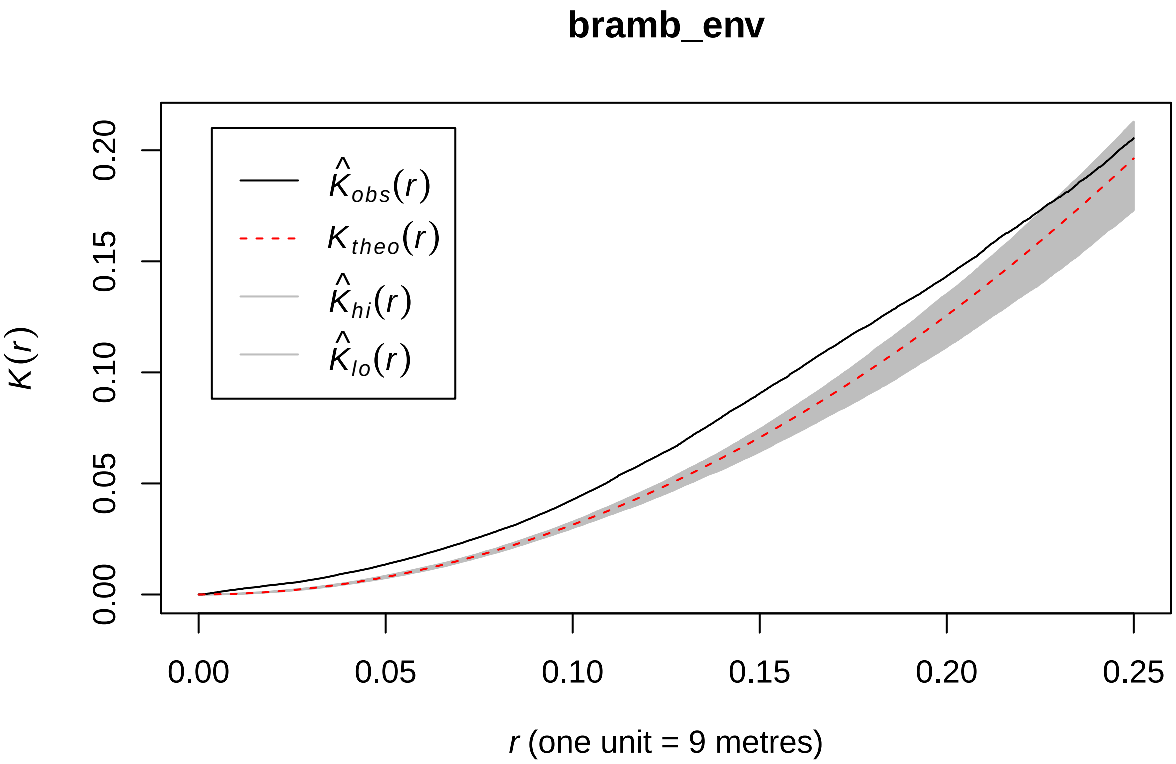
```
##   |                                                                      |
```



```
# c) An estimate of the K function
pacman::p_load(fMultivar)
bramb_env = envelope(bramblecanes, Kest, correction = "border")
```

```
## Generating 99 simulations of CSR  ...
## 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 2
## 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 
## 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98,  99.
##
## Done.
```

```
plot(bramb_env)
```



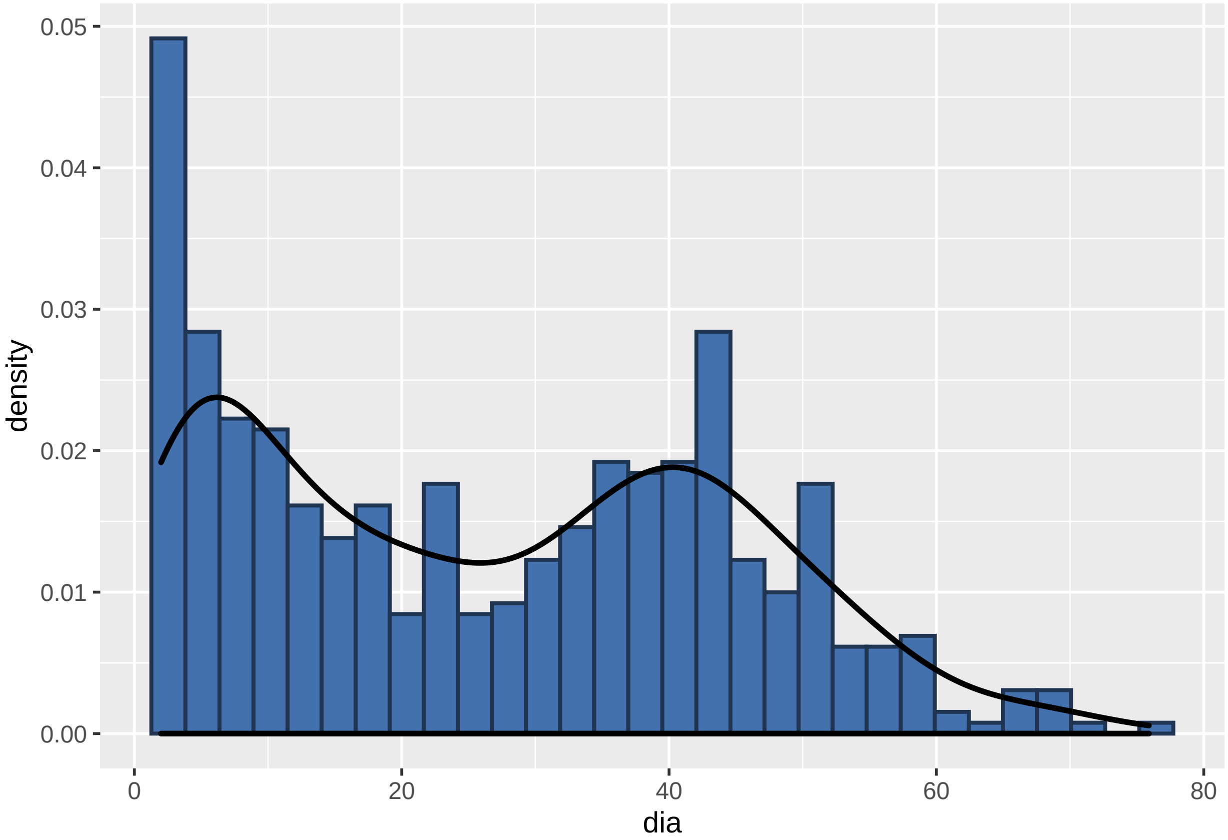
2. Consider the location of trees in the trees.csv data set given on Blackboard.
    a) Create a ppp object that has region [0,200] by [0,200].
    b) The tree diameters are given in the variable dia. Make a histogram for the tree diameters.
    c) Construct a kernel density and display it with a heat map.
    d) Display the kernel density with a set of contours. (SKIP)
    e) Estimate the K function and plot it along with the envelope for testing CSR.
    f) Consider only the trees with diameter less than or equal to 20. Repeat part (e).

```
# a) a ppp object
trees = data.table::fread("homework/trees.csv")
trees_ppp = trees[,ppp(x, y, xrange = c(0, 200), yrange = c(0, 200))]
class(trees_ppp)
```

```
## [1] "ppp"
```

```
# b) tree diameters
pacman::p_load(ggplot2)
trees %>%
  ggplot(aes(x = dia)) +
  geom_histogram(aes(y = ..density..),
    color = "#1F3552",
    fill = "#4271AE",
    size = 0.7) +
  geom_density(size = 1)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

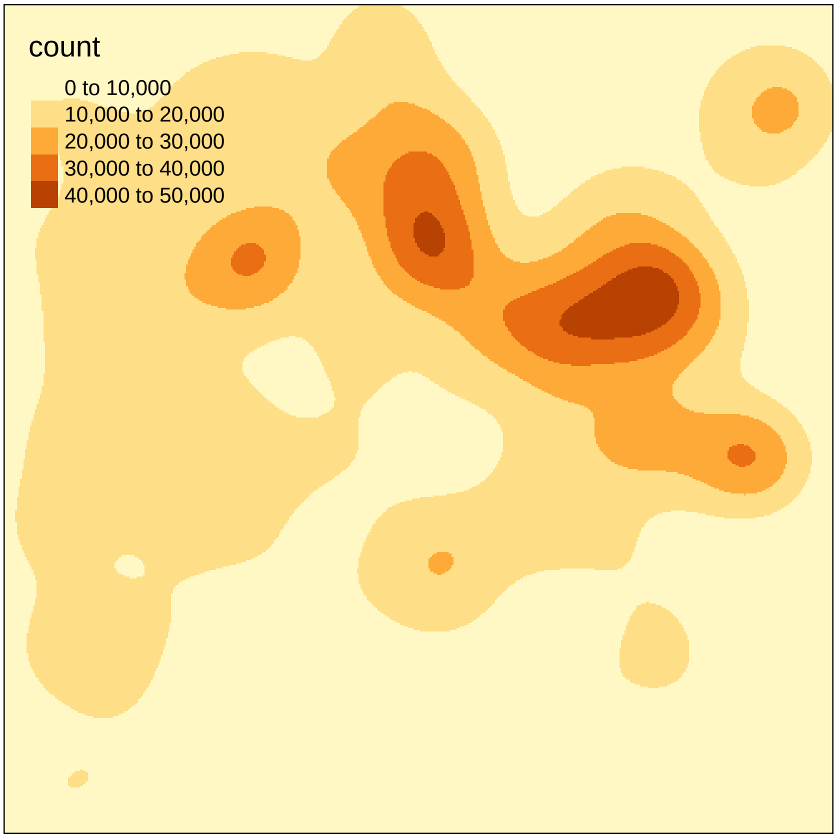


```r
# c) Construct a kernel density and display it with a heat map
trees_sp = as.SpatialPoints.ppp(trees_ppp)
proj4string(trees_sp) <- CRS('+init=epsg:26978')

sp_dens = smooth_map(trees_sp,
                     breaks = seq(0, 50000, by = 5000),
                     style="fixed",
                     bandwidth = c(0.01, 0.01))
```

```
## Warning: This function is deprecated and has been migrated to github.com/
## mtennekes/oldtmaptools
```

```
##   |                                                                          |
```

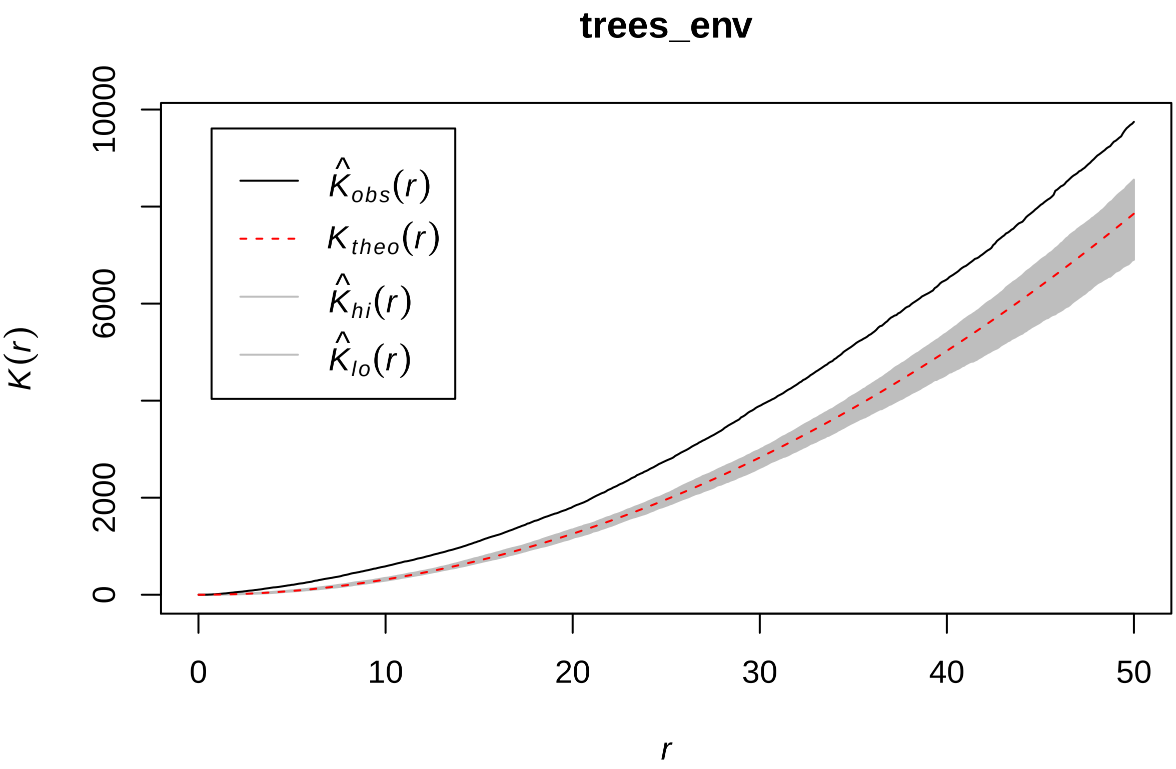
```r
tm_shape(sp_dens$raster) +
  tm_raster()
```



```
# e) Estimate the K function and plot it along with the envelope for testing CSR.
trees_env = envelope(trees_ppp, Kest, correction = "border")
```

```
## Generating 99 simulations of CSR  ...
## 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28
## 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 6
## 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98,  99.
##
## Done.
```

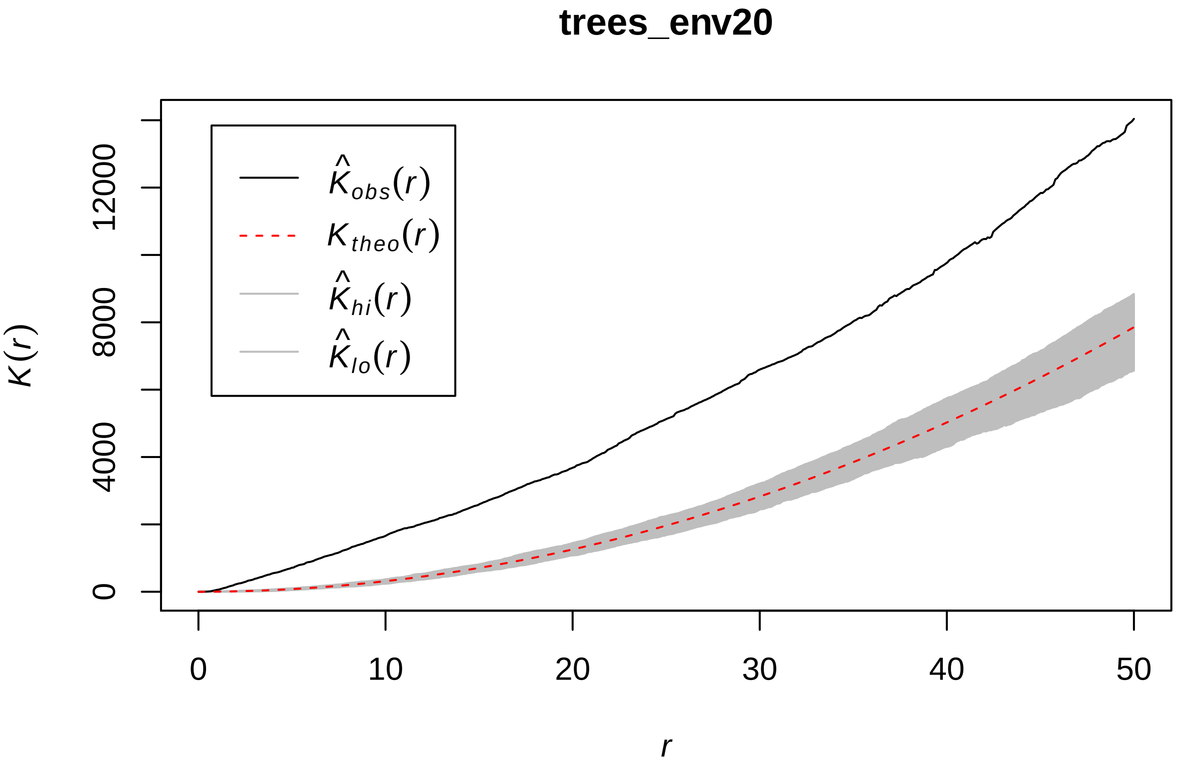
```
plot(trees_env)
```



```r
# f) Consider only the trees with diameter less than or equal to 20. Repeat part (e)
trees = data.table::fread("homework/trees.csv")
trees_ppp20 = trees[dia <= 20, ppp(x, y, xrange = c(0, 200), yrange = c(0, 200))]
trees_env20 = envelope(trees_ppp20, Kest, correction = "border")
```

```
## Generating 99 simulations of CSR  ...
## 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28
## 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 6
## 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98,  99.
## 
## Done.
```

```r
plot(trees_env20)
```


trees_env20
$\hat{K}_{obs}(r)$
$K_{theo}(r)$
$\hat{K}_{hi}(r)$
$\hat{K}_{lo}(r)$
$K(r)$
0
4000
8000
12000
0
10
20
30
40
50
r