Assignment 3 Spatial Epidemiology

Ferrara Lorenzo, Lucchini Marco

Task 1: Introduction to Spatial Point Process

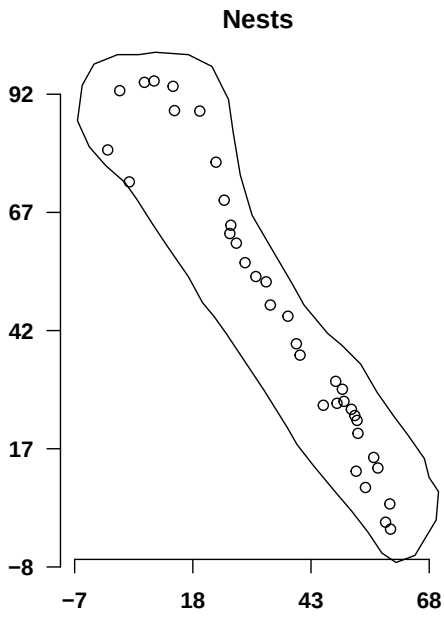
The nest data from islet "nucli 23" is stored in nucli23.txt. Additionally, the coordinates of the islet are in poly23.txt.

1) Build a ppp object using the "poly23" data as a window

```
# the data
nucli.23 = read.delim("T1/nucli23.txt")
min.X = min(nucli.23$X)
min.Y = min(nucli.23$Y)

nucli.23$X = nucli.23$X - min.X
nucli.23$Y = nucli.23$Y - min.Y

max.X = max(nucli.23$X)
max.Y = max(nucli.23$Y)
```

```
# the polygon object for the border
poligon = poly23 <- read.delim("T1/poly23.txt")
poligon$X = poligon$X - min.X
poligon$Y = poligon$Y - min.Y
pol.illa <- list(x = poligon$X, y = poligon$Y)

min.pX = min(poligon$X)
min.pY = min(poligon$Y)
max.pX = max(poligon$X)
max.pY = max(poligon$Y)
```

```
# the final object
n23p = ppp(nucli.23$X, nucli.23$Y, poly = pol.illa)
par(mfrow = c(1, 1), font = 2, font.axis = 2, font.lab = 4, las = 1, mar = c(1, 0,
    1, 0))
plot(n23p, main = "Nests")
axis(1, at = c(floor(seq(min.pX, max.pX, by = 25))), pos = c(min.pX, min.pY - 15))
axis(2, at = c(floor(seq(min.pY, max.pY, by = 25))), pos = c(-10, 0))
```

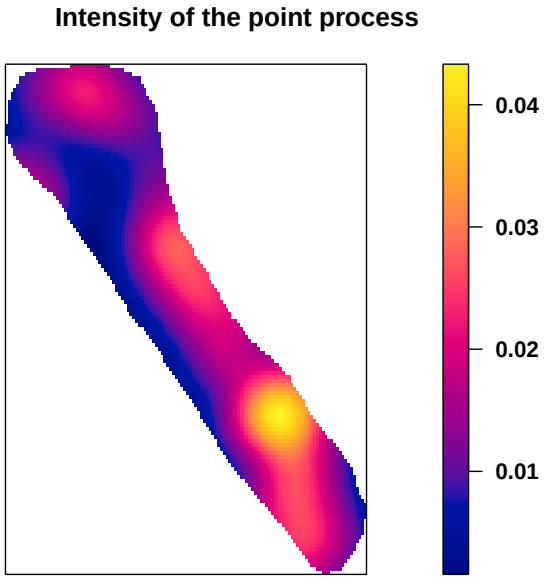


2) Describe the point pattern process and its intensity.

```
summary(n23p)
```

```
## Planar point pattern:  36 points
## Average intensity 0.01451131 points per square unit
##
## Coordinates are given to 6 decimal places
##
## Window: polygonal boundary
## single connected closed polygon with 47 vertices
## enclosing rectangle: [-6.40267, 69.97237] x [-7.06032, 100.8694] units
##                      (76.38 x 107.9 units)
## Window area = 2480.82 square units
## Fraction of frame area: 0.301
```

```
par(mfrow = c(1, 1), font = 2, font.axis = 2, font.lab = 4, las = 1, mar = c(0, 0,
    2, 0))
plot(density(n23p, dimax.Yx = c(256, 256), sigma = 5.5), main = "Intensity of the point process")
```



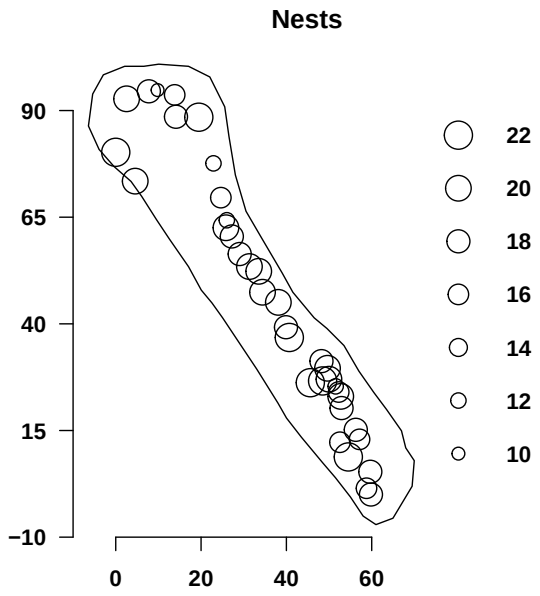
The density plot reveals that the majority of the nests are located in the center and south, along the north coast. There is a notable concentration, indicated by the yellow peak, in which a large number of nests were found.

This distribution does not appear to be completely random and appears to have a pattern.

3) Create a multi-type mark indicating the order of the nesting according to the nesting time, Using the time intervals: [10,16], [17,19], [20,22].

```
n23T = ppp(nucli.23$X, nucli.23$Y, poly = pol.illa, marks = nucli.23$data_pos)
```

```
par(mfrow = c(1, 1), font = 2, font.axis = 2, font.lab = 4, las = 1, mar = c(2, 0,
    2, 0))
plot(n23T, main = "Nests", markscale = 0.3, leg.side = "right")
axis(1, at = c(seq(0, max.pX, by = 20)), pos = c(-10, 0))
axis(2, at = c(seq(-10, max.pY, by = 25)), pos = c(-10, 0))
```




```
DPOScat = cut(nucli.23$data_pos, breaks = c(9, 16, 19, 22), labels = c("10-16", "17-19",
    "20-22"))
table(DPOScat)
```

```
## DPOScat
## 10-16 17-19 20-22
##    10    10    16
```

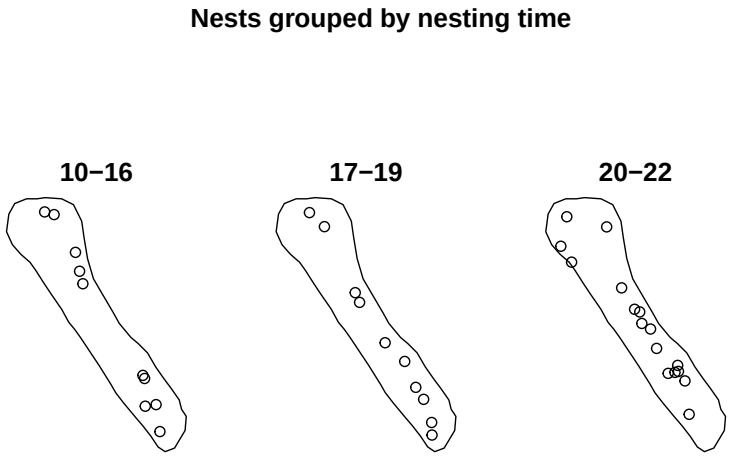
The suddivision of the nests in the 3 temporal groups seems homogeneous

```
n23Tcat = ppp(nucli.23$X, nucli.23$Y, poly = pol.illa, marks = DPOScat)
summary(n23Tcat)
```

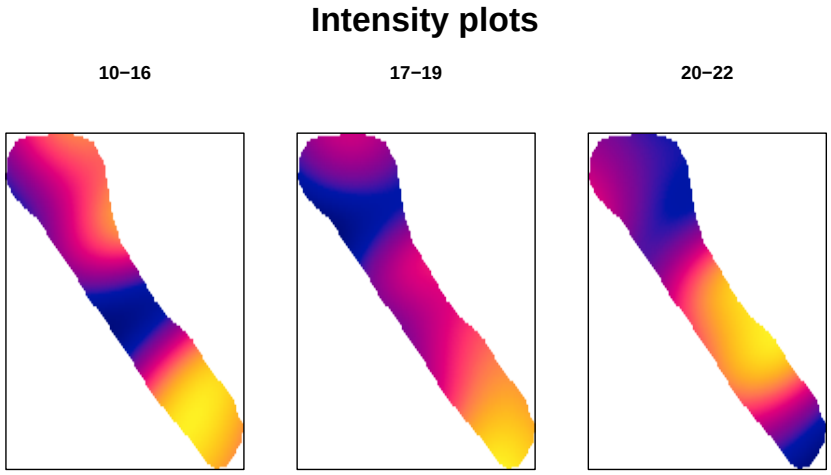
```
## Marked planar point pattern:  36 points
## Average intensity 0.01451131 points per square unit
##
## Coordinates are given to 6 decimal places
##
## Multitype:
##       frequency proportion   intensity
## 10-16        10  0.2777778 0.004030920
## 17-19        10  0.2777778 0.004030920
## 20-22        16  0.4444444 0.006449472
##
## Window: polygonal boundary
## single connected closed polygon with 47 vertices
## enclosing rectangle: [-6.40267, 69.97237] x [-7.06032, 100.8694] units
##                      (76.38 x 107.9 units)
## Window area = 2480.82 square units
## Fraction of frame area: 0.301
```

4) Describe the marked point process and its intensity

```
par(mfrow = c(1, 1), font = 2, font.axis = 2, font.lab = 4, las = 1, mar = c(0, 0,
    1, 0))
plot(split(n23Tcat), main = "Nests grouped by nesting time")
```



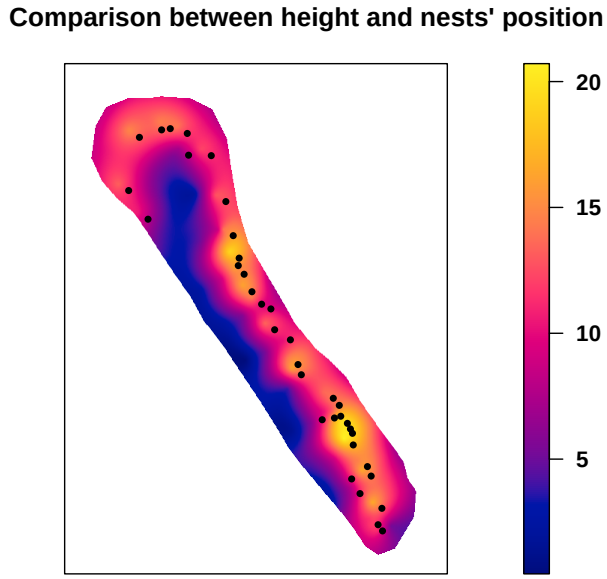

```
par(mfrow = c(1, 1), font = 2, font.axis = 2, font.lab = 4, las = 1, mar = c(0, 0,
    1, 0))
plot(density(split(n23Tcat), sigma = 12), ribbon = FALSE, main = "Intensity plots")
```



Different patterns can be observed in the three time intervals, with a distribution initially located in the extreme south that gradually moves towards the center.

5) Add to the analysis the height of the islet.

```
grid <- read.csv("T1/grid_height_23.txt", sep = "")
mat <- as.matrix(read.table("T1/height_23.txt"))
mat[mat == 0] = NA
height <- im(mat, grid$x, grid$y)
par(mfrow = c(1, 1), font = 2, font.axis = 2, font.lab = 4, las = 1, mar = c(0, 0,
    2, 0))
plot(height, axis = T, main = "Comparison between height and nests' position")
plot(n23p, add = T, cex = 0.7, pch = 16)
```



This plot allows us to observe a correlation between the positions of the nest and the elevation of the islet. It appears that the nests are concentrated in areas with higher elevation. Therefore, we can conclude that the point process is not completely random and the assumption of a Homogeneous Poisson Process can be rejected.