COM ACROSS

Companion Approach for cross-sectoral Collaboration in health risks management in SEA

Institut Pasteur du Cambodge

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Analysis of continuous spatialized data

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Type of data

- **Data on the value of a variable (usually a quantitative variable) measured at different locations**

- **Moreover that variable**
  - can have a value at every possible spatial location
    - Rainfall over the month of October 2018
  - or can have a value only at certain spatial locations
    - The diameter of trees of a particular species

- **However the data always consist in measurements of the varable at discrete (discontinuous) spatial locations**

Exemple of continuous spatialized data

- Data on the proportion of trees in plots of a wildlife park in Tchad damaged by elephants
- Two spatial objects

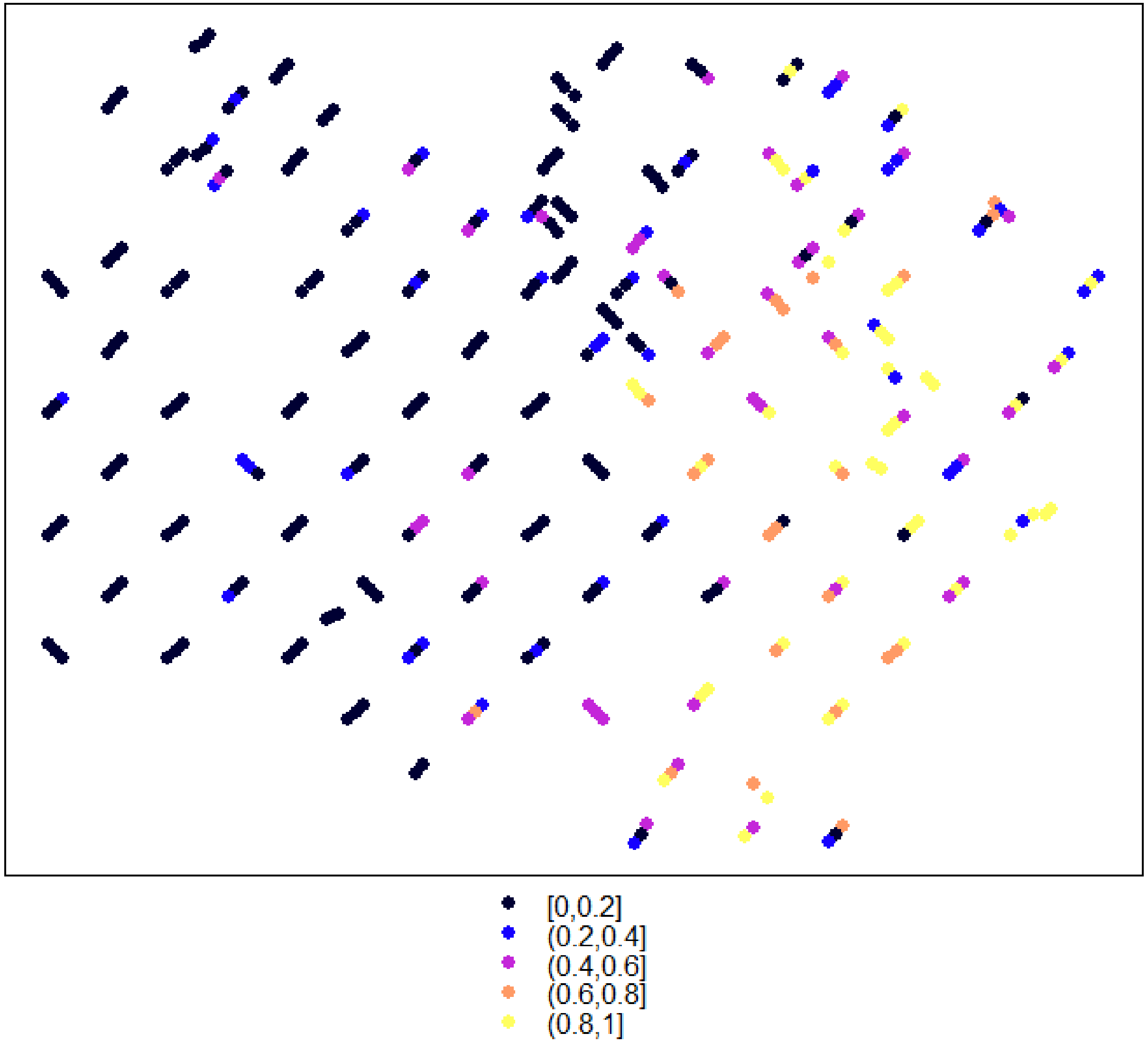
- placette.data is a SpatialPointDataFrame that contains
  - the position of the placettes
  - an attribute reflecting the tree species in the plot
  - an attribute reflecting the proportion of trees damaged

- parc.sp is SpatialPixelDataFrame that
  - divides the park in pixels
  - each pixel has as an attribute the dominant tree species

Exemple of continuous spatialized data

```
summary(placette.data)
Object of class SpatialPointsDataFrame
Coordinates:
            min      max
coords.x1 19.36569 19.99069
coords.x2 10.57639 11.04764
Is projected: FALSE
proj4string :
[+proj=longlat +ellps=WGS84 +towgs84=0,0,0,0,0,0,0 +no_defs]
Number of points: 329
Data attributes:
     PLOT       DAMAGE                zone
 1      : 1   Min.   :0.00000   Acacia      :114
 2      : 1   1st Qu.:0.03571   Combretaceae:215
 3      : 1   Median :0.16667
 4      : 1   Mean   :0.30800
 5      : 1   3rd Qu.:0.50000
 6      : 1   Max.   :1.00000
```

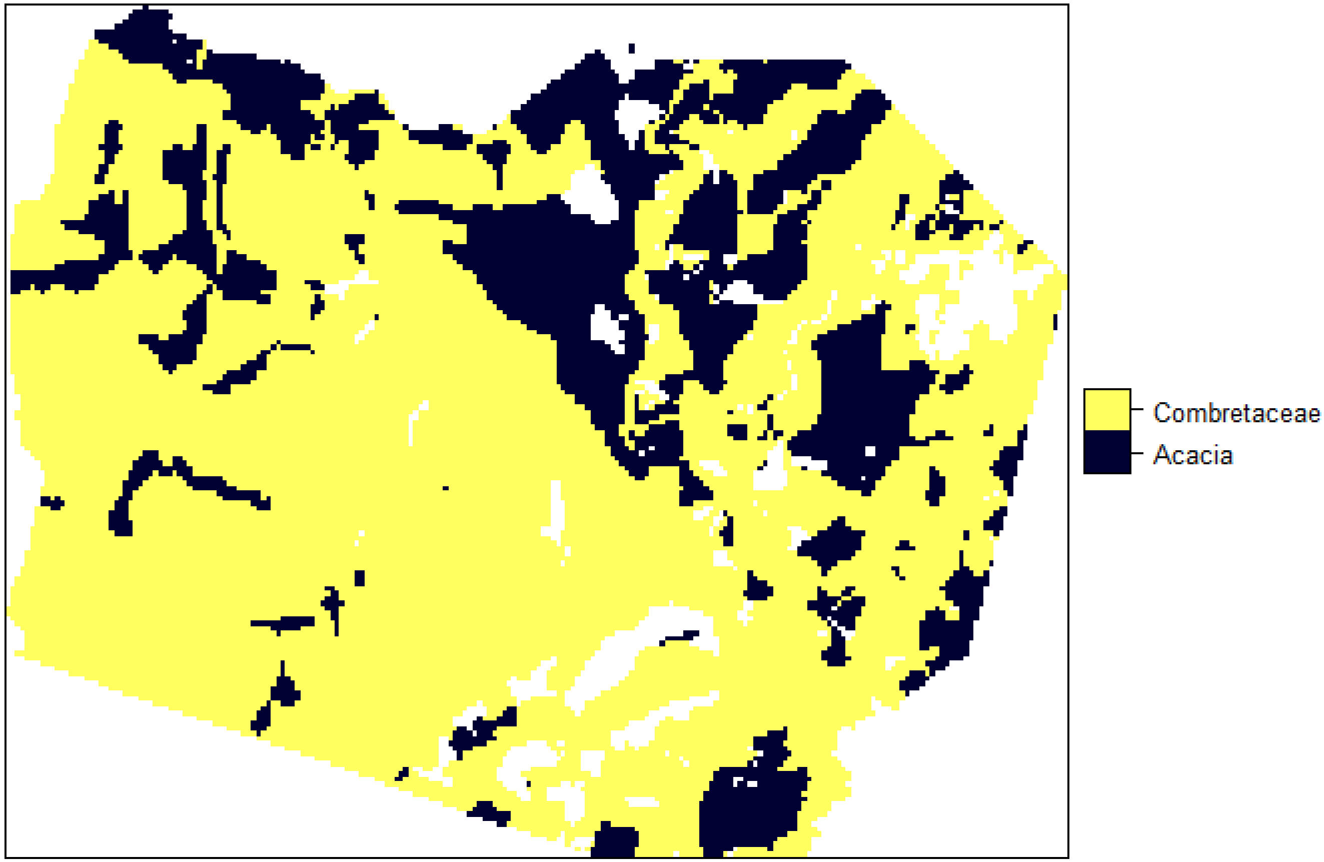
```
spplot(placette.data)
```



Exemple of continuous spatialized data

```
summary(parc.sp)
Object of class SpatialPixelsDataFrame
Coordinates:
      min      max
x 19.35056 19.99856
y 10.56806 11.07806
Is projected: FALSE
proj4string :
[+proj=longlat +ellps=WGS84 +towgs84=0,0,0,0,0,0,0 +no_defs]
Number of points: 26006
Grid attributes:
  cellcentre.offset cellsize cells.dim
x          19.35206    0.003       216
y          10.56956    0.003       170
Data attributes:
          zone
 Acacia      : 6353
 Combretaceae:19653
```

```
spplot(parc.sp)
```



Spatial dependency in spatialized data

- **Spatial dependency: the values of the variable measured at spatially close points are more similar than the values of the same variable measured at spatially remote points**
  - Stationnariy: when spatial dependency is similat at all point in a study area.
  - Non stationnarity : when spatial dependency varies within a study area

  - Isotropy: when the intensity of spatial dependency is not affected by the direction
  - Anisotropy: when the intensity of spatial dependency is affected by the direction

Statistics used to assess spatial dependency

- Variogram: representation of the variance within pairs of values of variable as a function of distance.

- The Variogram can be modelled.

Variogram for elephant damages

- The variogram function plots the variance as a function of distance computed from the data

```
library(gstat)
damage.var0<-
variogram(DAMAGE~1,placette.data,boundaries=seq(1,40,1))
```

A model formula

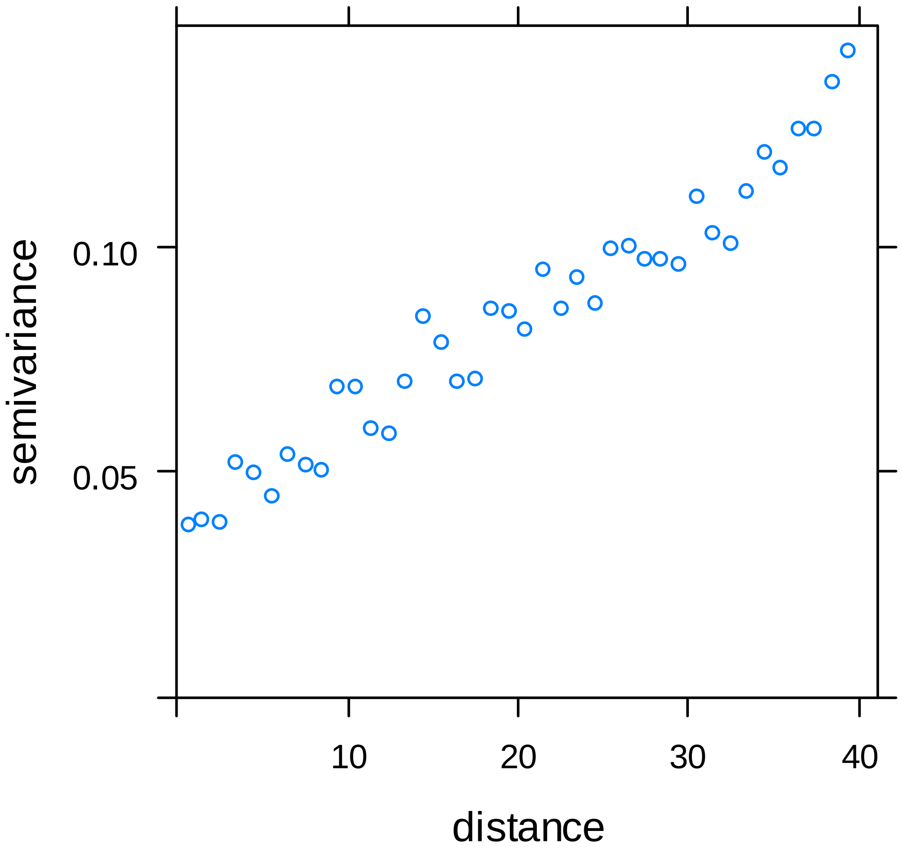
The SpatialDataFrame object including the data

The limits of the distance categories for which variance will be computed

Variogram for elephant damages

- The variogram function plots the variance as a function of distance computed from the data

```
plot(damage.var0)
```



Variogram for elephant damages

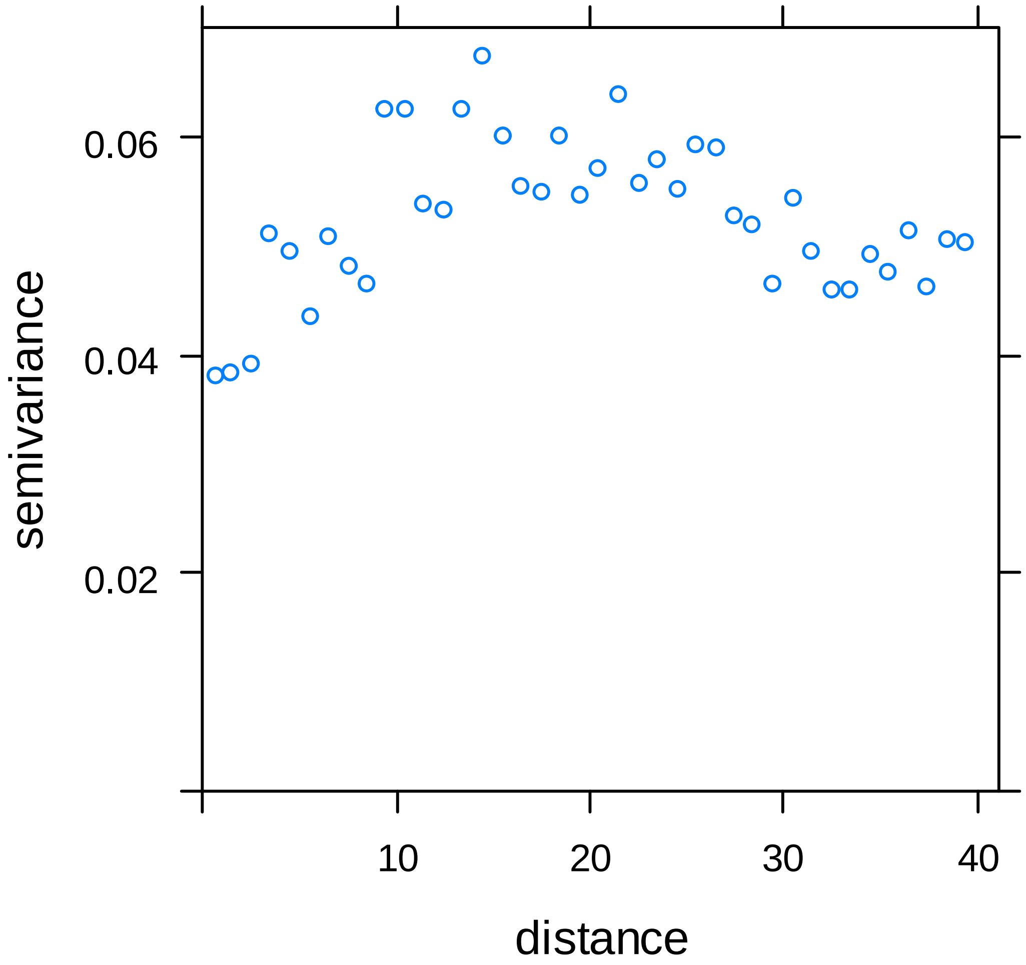
- The variogram function can produce variograms that account for the effect of covariates.
- The covariate effects are declared in the model formula

```
damage.var1<-
variogram(DAMAGE~zone+I(x^2)+I(y^2)+I(x*y)+x+y,
placette.data,boundaries=seq(1,40,1)
```

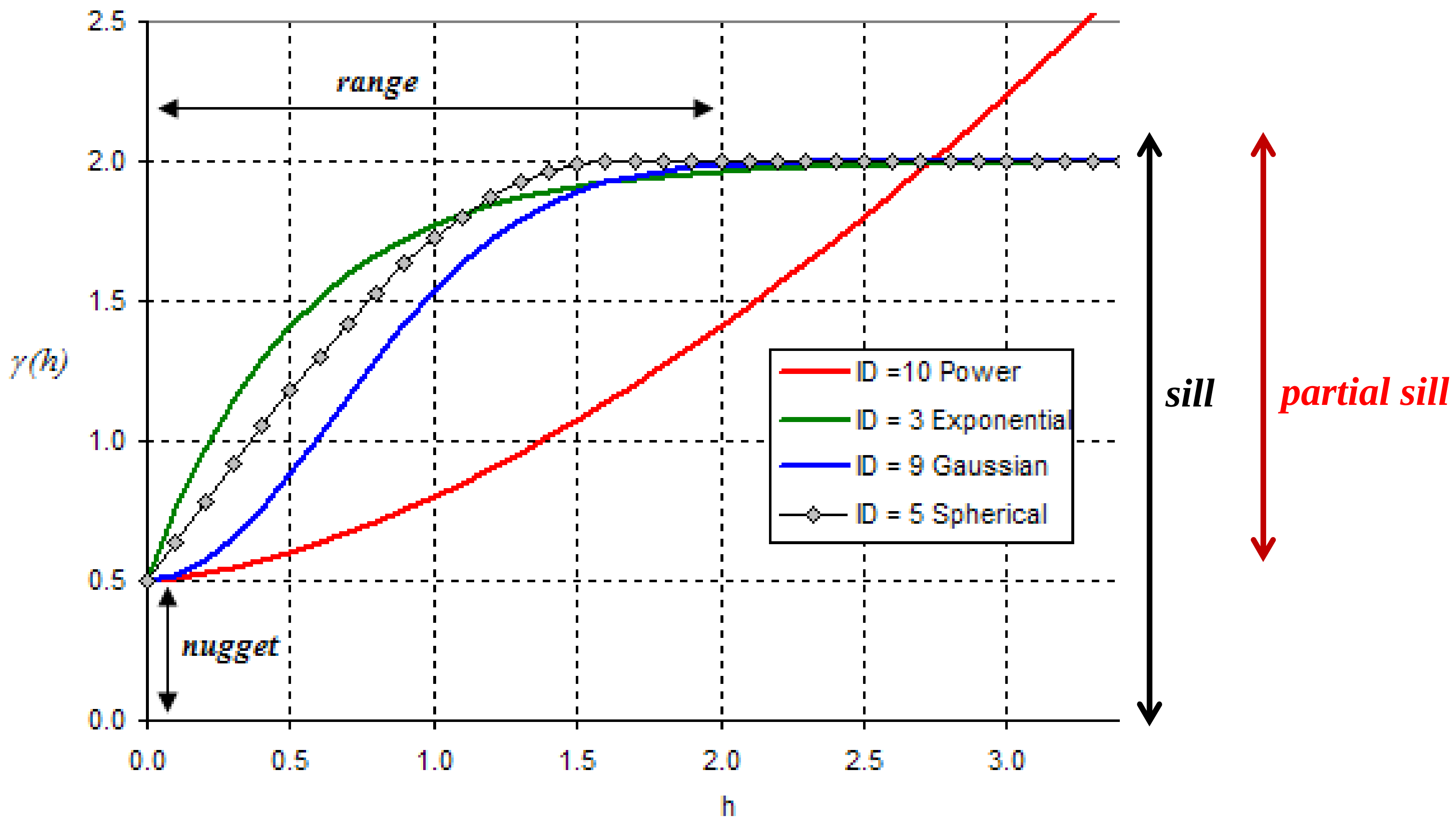
In this formula, we account for the effects of zone (type of vegetation and of a second degree polynomial effect of the coordinates

Variogram for elephant damages

```
plot(damage.var1)
```



Variogram characterization and modelling

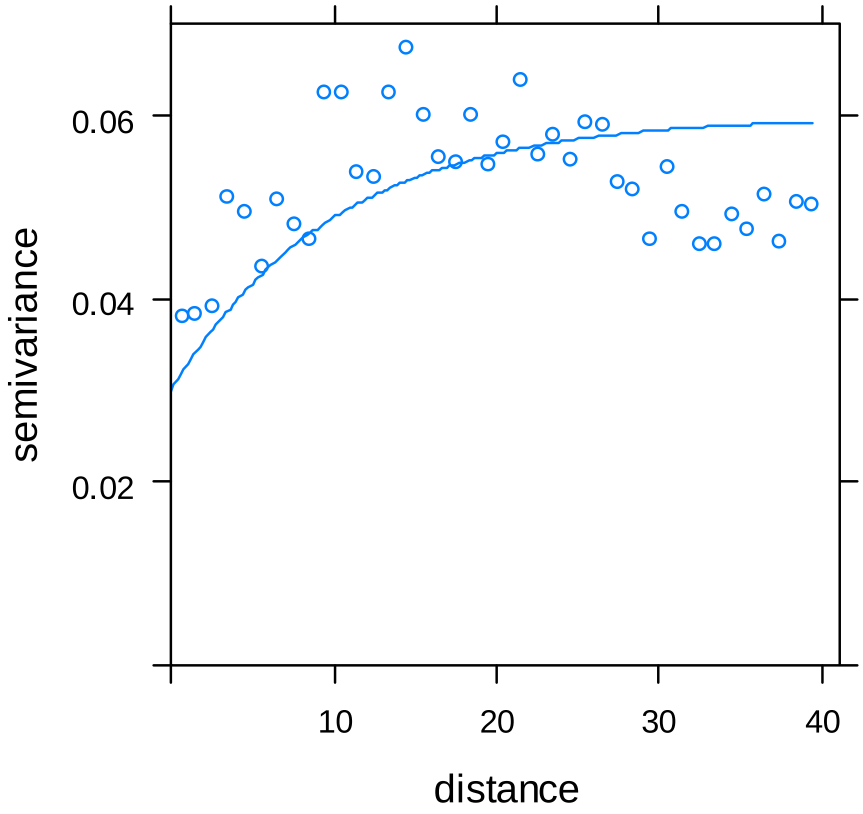


Variogram modelling

- The function vgm generates a variogram model
- For doing so, we have to declare the characteristics of the variogram

```
vgmod0<-vgm(psill=0.03,model="Exp",range=10,nugget=0.03)
```

```
plot(damage.var1,vgmod0)
```

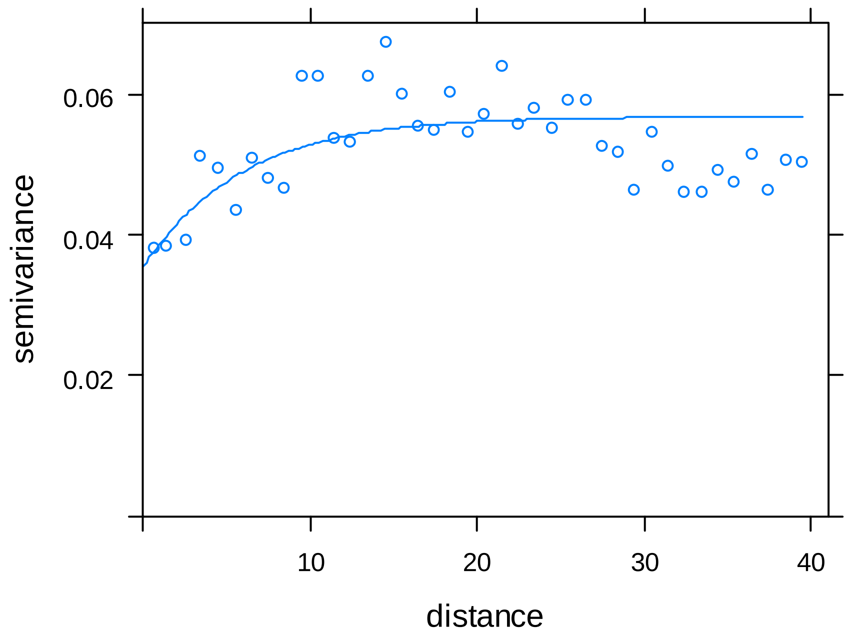


Variogram modelling

- The function fitvariogram, fits a variogram model to the data variogram model
- It requires a baseline variogram model (here we use vgm0) which will be updated to fit as well as possible the observed variogram

```
vgmod1<-fit.variogram(damage.var1,vgmod0)
```

```
plot(damage.var1,vgmod1)
```



Spatial interpolation

- To obtain a continuous spatial representation of a variable from discrete data

- Example:
  - A network of meteorological station records rainfall in a region
  - We wish to obtain a continuous representation of rainfall in that region

Spatial kriging

- A method for spatial interpolation: spatial kriging

  - It produces predictions of the value of the variable at locations where it has not been measured. The prediction is a weighted average of the values of the variable at the locations where it has been measured.

  - The weights are functions of the distance between the location where we wish to predict the value of the variable and the locations where the variable has been measured.

  - Effects of covariates can also be accounted for to derive the predictions

  - It is necessary to have previously characterized the spatial dependency structure: semi-variogram

Spatial kriging for the elephant damages

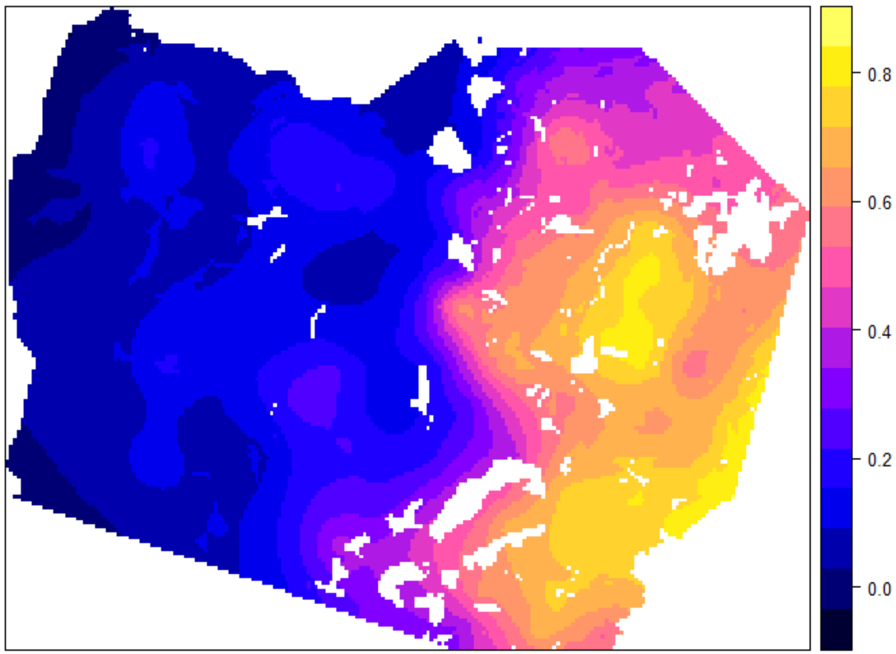
We use the krige function

```
degmoy.kr<-krige
(DAMAGE~zone+I(x^2)+I(y^2)+I(x*y)+x+y,
placette.data,parc.sp,
vgmod1)
```

In the krige function,

- the formula account for covariate effects
- a variogram model is required to characterize spatial dependency (vgmod1)

`spplot(degmoy.kr[1])`



`spplot(placette.data,"DAMAGE")`