Spatial Correlation in Regression

Zuur et al., Chapter 7

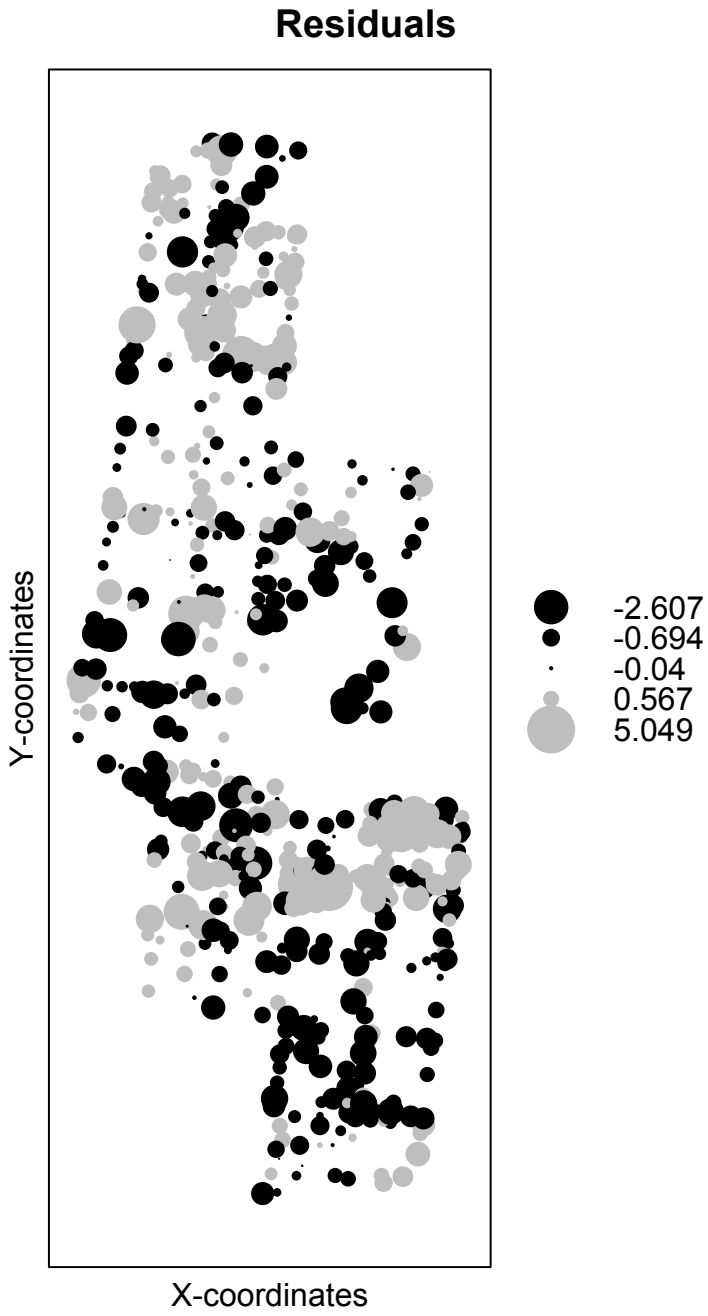
Example concerning the influence of relief, soil, and climatic factors on the forests of the Raifa section of Volzhsko-Kamsky State Nature Biosphere

Response variable is boreal forest index: the number of species that belong to a set of boreal species divided by the total number of species at a site

$$z_i = \alpha + \beta \times \text{Wetness}_i + \varepsilon_i$$

```
> library(AED); data(Boreality)
> Boreality$Bor <- sqrt(1000 * (Boreality$nBor + 1) /
                                (Boreality$nTot))
> B.lm <- lm(Bor ~ Wet, data = Boreality)
> summary(B.lm)
```

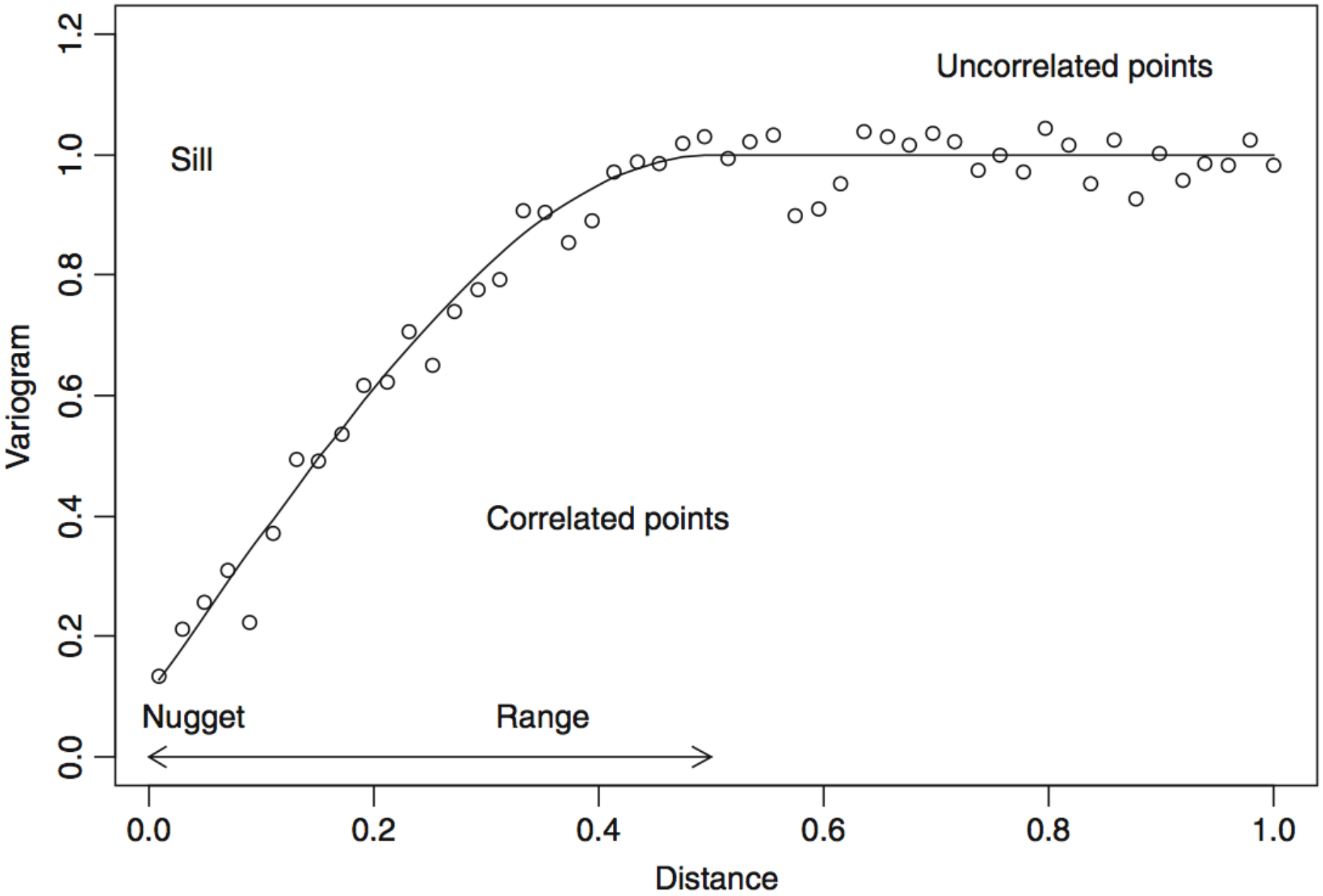
```
> E <- rstandard(B.lm)
> library(gstat)
> mydata <- data.frame(E, Boreality$x, Boreality$y)
> coordinates(mydata) <- c("Boreality.x","Boreality.y")
> bubble(mydata, "E", col = c("black","grey"),
      main = "Residuals", xlab = "X-coordinates",
      ylab = "Y-coordinates")
```


Residuals
Y-coordinates
X-coordinates
-2.607
-0.694
-0.04
0.567
5.049

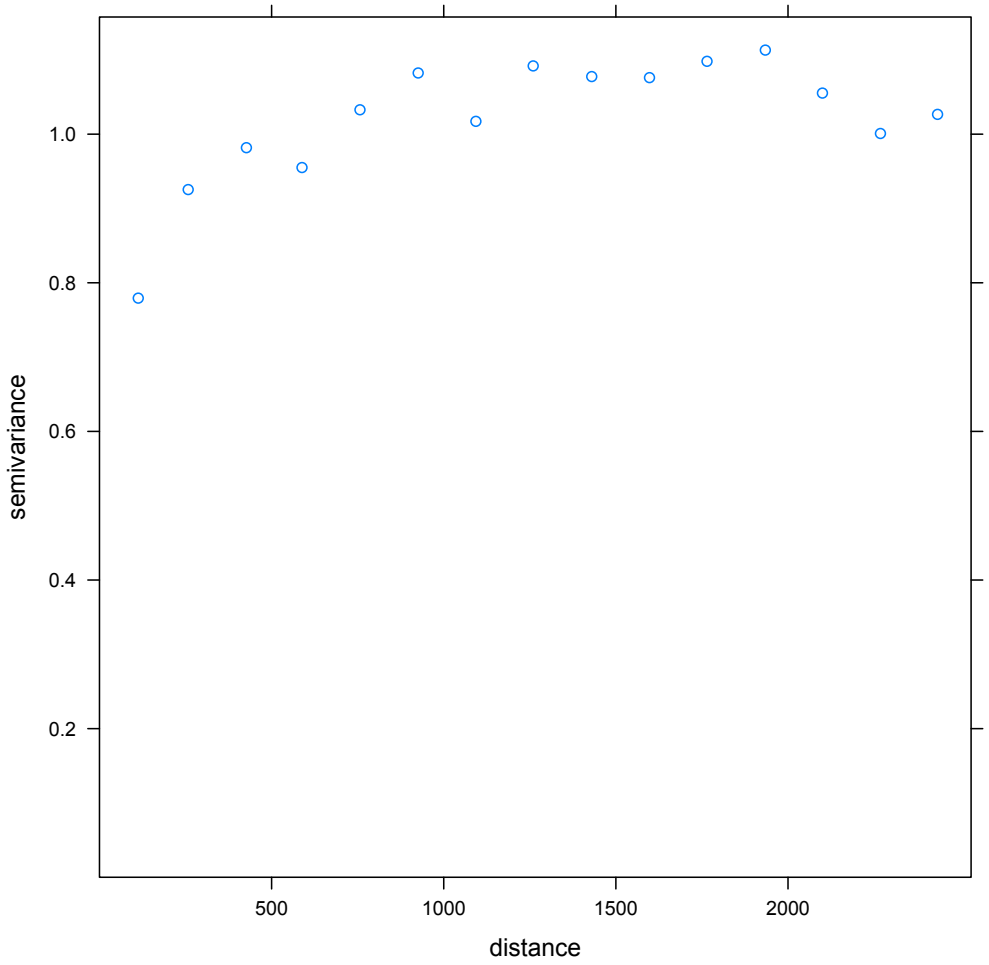
Sample Variogram

$$\hat{\gamma}(\mathbf{h}) = \frac{1}{2\,N(\mathbf{h})} \sum_{i=1}^{N(\mathbf{h})} [z(\mathbf{x}_i + \mathbf{h}) - z(\mathbf{x}_i)]^2$$

- simple tool for assessing spatial correlation
- spatial generalization of the acf
- no spatial dependence => value is 1 for all h
- assumes isotropy

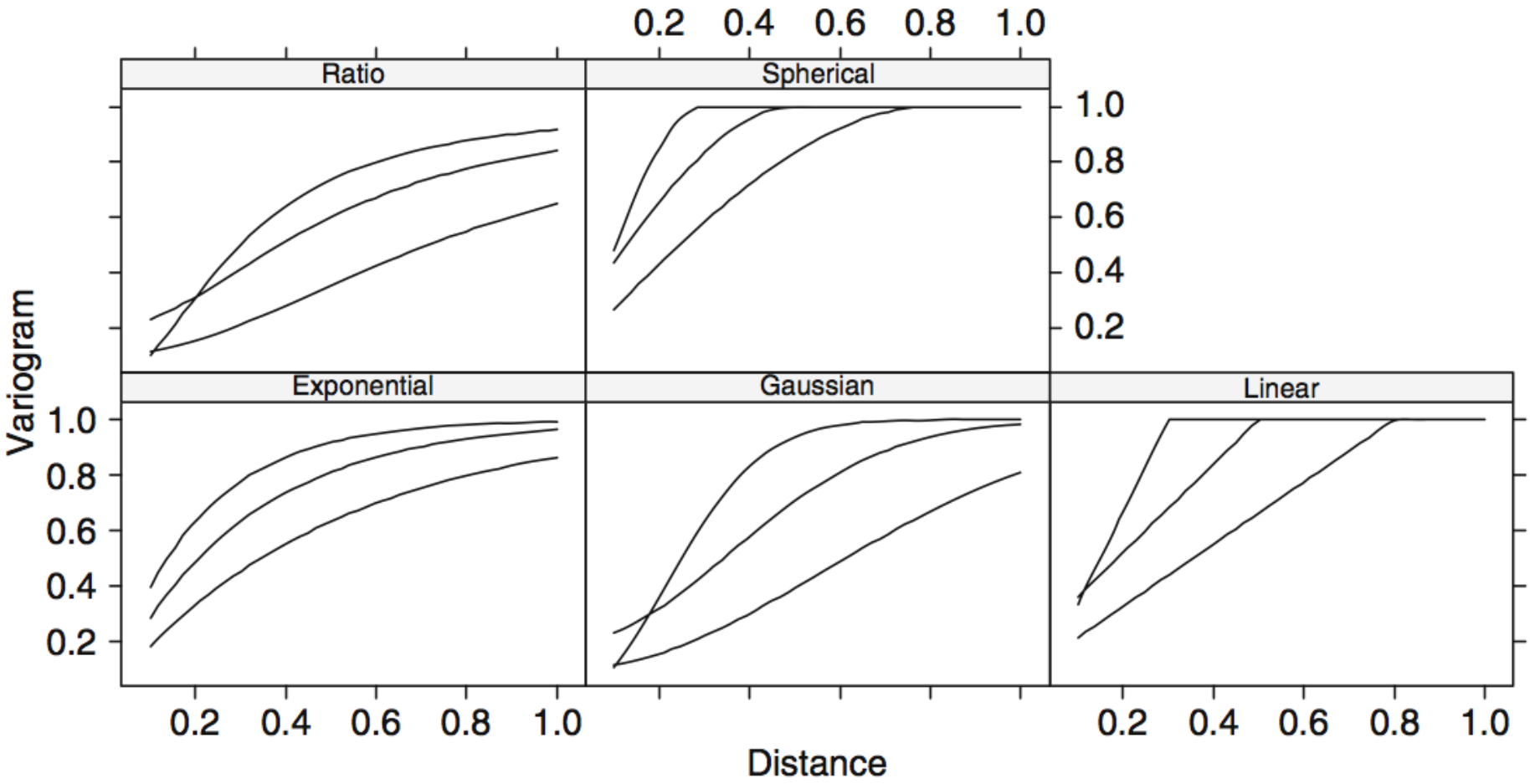

Uncorrelated points
Sill
Correlated points
Nugget
Range
Variogram
Distance
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0

```
> Vario1 <- variogram(E ~ 1, mydata)
> plot(Vario1)
```



different mathematical forms for the spatial correlation

- Exponential correlation using the function `corExp`.
- Gaussian correlation using the function `corGaus`.
- Linear correlation using the function `corLin`.
- Rational quadratic correlation using the function `corRatio`.
- Spherical correlation using the function `corSpher`.


Ratio
Spherical
Exponential
Gaussian
Linear
Variogram
Distance
0.2
0.4
0.6
0.8
1.0

```
> B1A <- gls(f1, correlation = corSpher(form =~ x + y,
              nugget = TRUE), data = Boreality)
> B1B <- gls(f1, correlation = corLin(form =~ x + y,
              nugget = TRUE), data = Boreality)
> B1C <- gls(f1, correlation = corRatio(form =~ x + y,
              nugget = TRUE), data = Boreality)
> B1D <- gls(f1, correlation = corGaus(form =~ x + y,
              nugget = TRUE), data = Boreality)
> B1E <- gls(f1, correlation = corExp(form =~ x + y,
              nugget = TRUE), data = Boreality)
> AIC(B1, B1A, B1B, B1C, B1D, B1E)
```

Model	Object	df	AIC
No correlation	B1	3	2844.54
corSpher	B1A	5	2737.01
corLin	B1B	5	2848.51
corRatio	B1C	5	2732.93
corGaus	B1D	5	2736.29
corExp	B1E	5	2732.22