Introduction in Geostatistics
Homework

19.07.2016

Exercise 4 b : Simple and Ordinary Kriging using R

In this exercise you will use Ordinary Kriging to predict intensity values for un-sampled locations for a very small dataset.

Data: olea.dat – small dataset copied from the book from Ricardo Olea, containing measurements at 4 sample locations

1. **Ordinary Kriging for a small dataset**
(exercise taken from R. Olea: Geostatistics for engineers and earth scientists)

The following sample is given:

Index	Easting	Northing	Measurement
1	10	20	40
2	30	280	130
3	250	130	90
4	360	120	160

Covariance defined as $Cov(h) = 2000e^{-\frac{h}{250}}$

Estimation location: x_0 = (180,120)

Please do the following:

Make a plot, showing the sample locations and the estimation location

b) Write a function call Cov() that returns a covariance for lag h that is equivalent to the given exponential function:

Create a plot of the associated covariance model:#

```
hs = (0:20)
plot(hs,Cov(hs),xlab="lag/distance",ylab="covariance")
```

Create the associated point-to-point covariance matrix as follows.

```
Dist = matrix(NA, nrow=4 , ncol=4)
for( i in 1: 4 ) {
for( j in 1:4 ) {
Dist[i,j] = ( (ex[i,1]-ex[j,1])^2.0 + (ex[i,2]-ex[j,2])^2.0 )^0.5
}
}
C = matrix(1,nrow=5,ncol=5)
Ct = Cov(Dist)
C[1:4,1:4] = Ct
C[5,5] = 0
```

d) Examine the matrix (print(round(C,2))). What values are on the diagonal? What is the meaning and import of the values in row and column 5?

e) Load the library MASS, and use **ginv()** to invert the **C** matrix (**Ci=ginv(C)**). Use the matrix multiplication operator (**%*%**) to create an identity matrix. Look at the values of **Ci** and interpret them.

f)Compute the distances between the unknown point and the sampled points (similar as point c) and use the **Cov()** function you wrote to calculate the **D** vector. The D vector show have n+1 values, where n is the number of samples (4). Set the 5th value of D to 1.

g) Interpret the values of **D**. Where are they high and low? What does this represent?
h) Calculate the weight vector **(w=Ci %*% D).** What are the weight values? What do these numbers represent? What is the total of the 1st four values in w? What is the meaning of this total?

i) Calculate the kriging estimate at 180°E and 120°N. What is the value?

$$z_0 = W^t Z$$

W contains only the first 4 values of w

j) Calculate the kriging standard error at 180°E and 120°N. What is the value?

$$\sigma_{ok}{}^2 = \sigma_0{}^2 - (W^t D - \mu)$$

Where:

$\sigma_0{}^2$ = the nugget effect (Cov(h=0))

μ = the lagrange paramater, the term on the last position of the vector w

Due: 22.08.2016