STA5001_Assignment_3

2024-04-29

#a.Produce a sample variogram on the interval [0,1] using 20 bins.

```
library(geoR)

## Warning: package 'geoR' was built under R version 4.3.3

## --------------------------------------------------------------
##  Analysis of Geostatistical Data
##  For an Introduction to geoR go to http://www.leg.ufpr.br/geoR
##  geoR version 1.9-4 (built on 2024-02-14) is now loaded
## --------------------------------------------------------------

library(sp)

## Warning: package 'sp' was built under R version 4.3.3

data(s256i)

bin <- variog(s256i, uvec=seq(0,1,l=20))

## variog: computing omnidirectional variogram
```

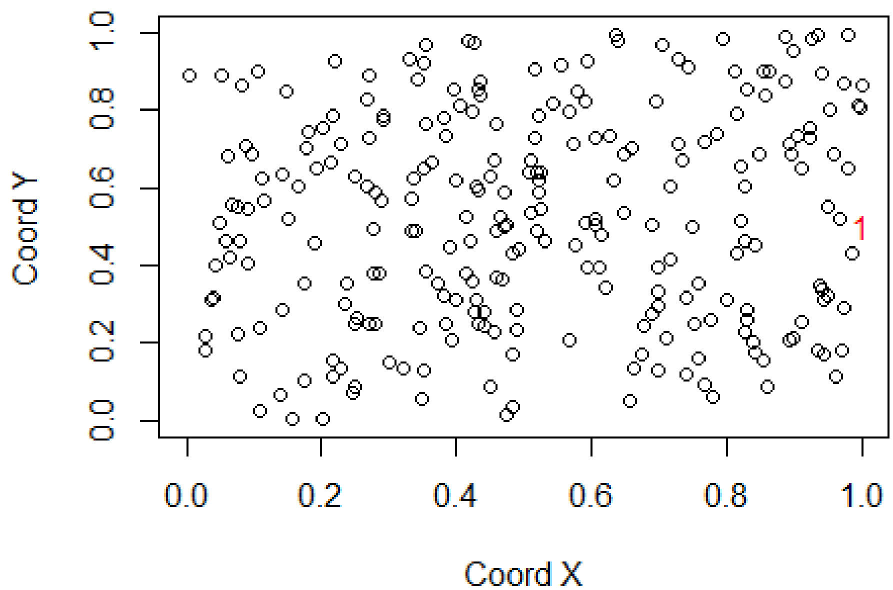
#b.Fit the spherical variogram to the sample variogram by using ordinary least squares. Use the initial values (1, 0.5) and nugget = 0.5

```
ols.n <- variofit(bin, ini = c(1,0.5), nugget=0.5, weights="equal",cov.model
= "sph")

## variofit: covariance model used is spherical
## variofit: weights used: equal
## variofit: minimisation function used: optim

summary(s256i)

## Number of data points: 256
##
## Coordinates summary
##               x           y
## min 0.003999991 0.005934719
## max 0.999277622 0.996592965
##
## Distance summary
##         min         max
## 0.004018807 1.301652573
##
## Data summary
```

```
##        Min.     1st Qu.      Median        Mean     3rd Qu.        Max.
## -3.1835322 -0.9664729 -0.3294795 -0.4056549  0.1531377  1.3515990
```

#c.Consider the location (1, 0.5). Plot locations of the data in black and this location in red in the same image.

```r
plot(s256i$coords,xlab="Coord X", ylab="Coord Y",xlim=c(0,1),ylim=c(0,1))


loci <- matrix(c(1,0.5),ncol=2)
text(loci,as.character(1), col="red")
```



#d.Use the kriging method to compute the predicted value and the variance at the point (1, 0.5). Round the answers with 4 decimal places.

```r
kc <- krige.conv(s256i, locations = loci,krige = krige.control(obj.m =
ols.n))

## krige.conv: model with constant mean
## krige.conv: Kriging performed using global neighbourhood

kc

## $predict
##      data
## 0.8541704
##
## $krige.var
```

```
## [1] 0.2525041
##
## $beta.est
##       beta
## -0.2445487
##
## $distribution
## [1] "normal"
##
## $message
## [1] "krige.conv: Kriging performed using global neighbourhood"
##
## $call
## krige.conv(geodata = s256i, locations = loci, krige = krige.control(obj.m
= ols.n))
##
## attr(,"sp.dim")
## [1] "2d"
## attr(,"prediction.locations")
## loci
## attr(,"parent.env")
## <environment: R_GlobalEnv>
## attr(,"data.locations")
## s256i$coords
## attr(,"class")
## [1] "kriging"
```

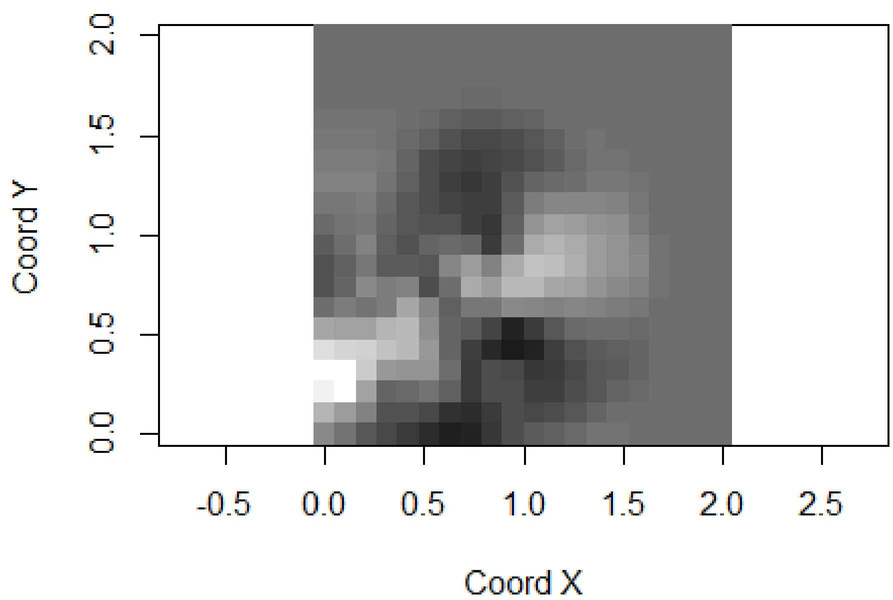
#Answer: #Predicted value:0.8542 #Variance: 0.2525

#e. Perform a prediction(kriging) on a grid covering the area [0,2]x[0,2]. Plot the result.

```
pred.grid <-expand.grid(seq(0,2, l=20), seq(0,2, l=20))
kc <- krige.conv(s256i, loc = pred.grid, krige = krige.control(obj.m =
ols.n))

## krige.conv: model with constant mean
## krige.conv: Kriging performed using global neighbourhood

image(kc, loc = pred.grid, col=gray(seq(1,0.1,l=50)),  xlab="Coord X",
ylab="Coord Y")
```



#f.Explain the obtained plot. #The grey level indicates values of s256i at the corresponding locations.

#g. To prepare your data for cross-validation, use the R commands ##where ols.n is the variogram fitted by the ordinary least squares method.

```
library(gstat)

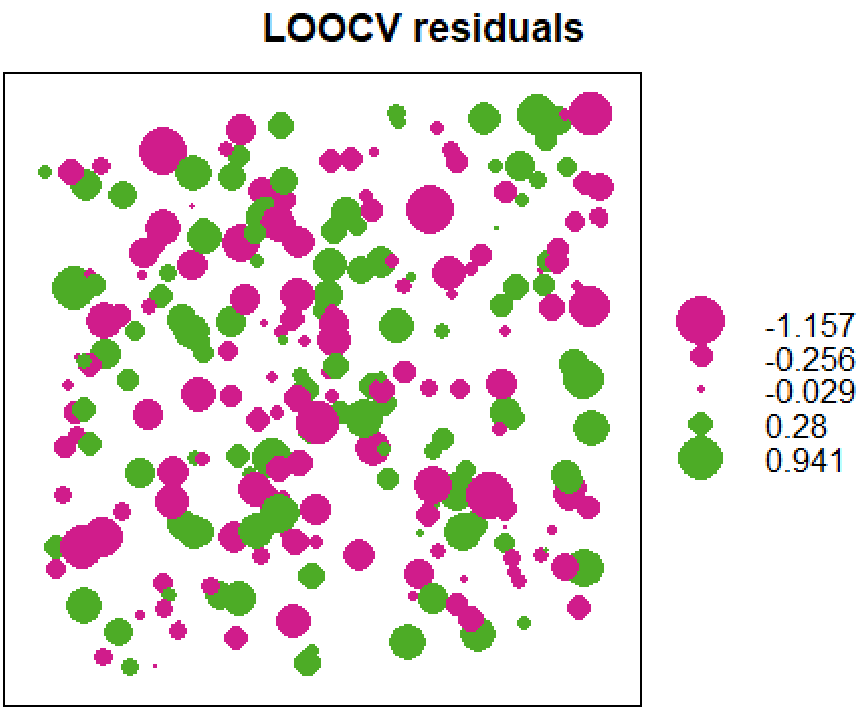
## Warning: package 'gstat' was built under R version 4.3.3

a <- as.data.frame(s256i$data)
s <- SpatialPointsDataFrame(s256i$coords, a,
proj4string=CRS(projargs=as.character(NA)), match.ID=TRUE)
v.fit <- as.vgm.variomodel(ols.n)
```

#Cross-validate your model by using leave-one-out cross-validation and a bubble plot of the result.

```
#Cross-validate your model
cvLOOCV <- krige.cv(s256i.data~1, s, v.fit, nfold=nrow(s))

#Bubble plot of the result
bubble(cvLOOCV, "residual", main = "LOOCV residuals")
```

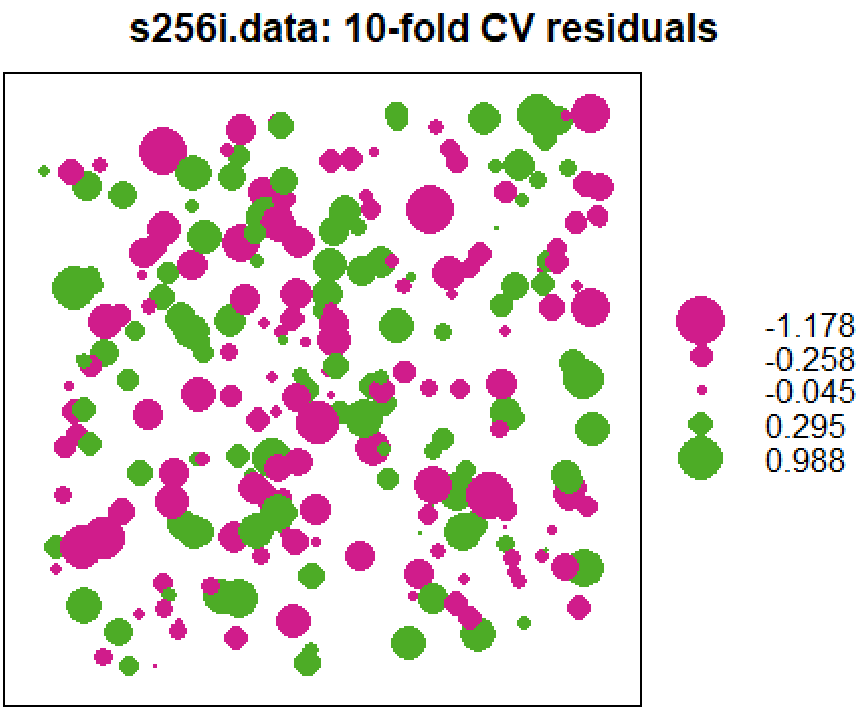


#h.Explain the obtained plot. #By definition: visits a data point,and predicts the value at that location by leaving out the observed value, and proceeds with the next data point. #COME BACK LATER!

#i.Cross-validate your model by using 10-fold cross-validation and a bubble plot of the result.

```
library(gstat)
cv256 <- krige.cv(s256i.data~1, s, v.fit, nfold=10)

bubble(cv256, "residual", main = "s256i.data: 10-fold CV residuals")
```



#Main Question: Explain the obtained plot. and differences with leave-one-out cross-validation from f and g.

#N-fold cross validation, as i understand it, means we partition our data in N random equal sized subsamples. A single subsample is retained as validation for testing and the remaining N-1 subsamples are used for training. #More to add!

#j. Optimize the monitoring network using the criterion of minimum mean kriging variances. Which data point has the maximum mean kriging variance?

```
m1 <- sapply(1:256, function(x) mean(krige(s256i.data~1, s[-x,], s,
v.fit)$var1.var))

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```r
which(m1 == max(m1))
```

```
## [1] 51
```

```r
#Answer: 51
```

#k. Which data point has the second maximal mean kriging variance?

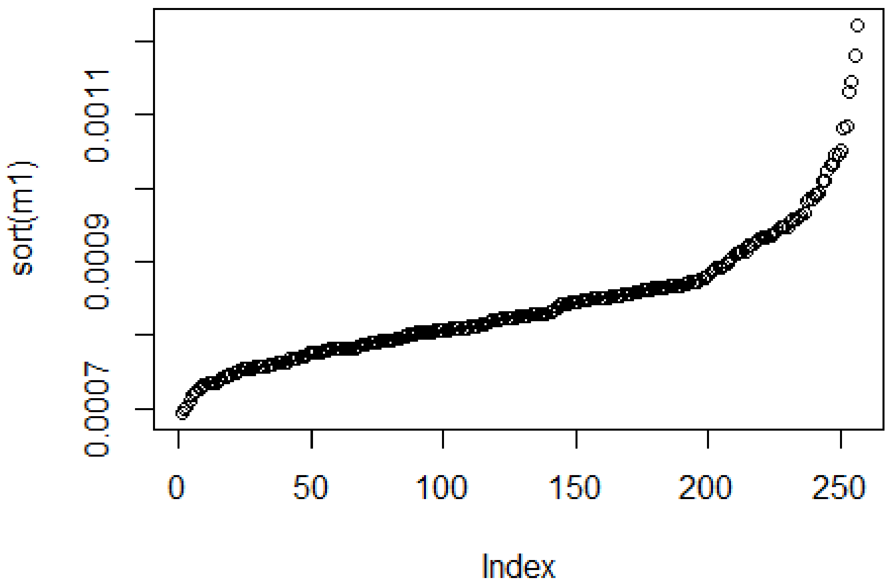
```
which(m1 %in% sort(m1)[255])

## [1] 254

#Answer: 254
```

#l. Plot the sorted mean kriging variances. Explain the obtained plot.

```
plot(sort(m1))
```




```
#First 5 candidate points for removal.
which(m1 %in% sort(m1)[1:5])

## [1]   5  11  16  79 139
```

#Explaination: #From the obtained plot, It points to observation 139 as the first candidate for removal.Where 79, 16, 11 and 5 for example are the next candidates for removal.

#m.Plot points with top and bottom 5% mean kriging variance (use different point shapes for top and bottom points).

```
#To compare the obtained results we plot top and bottom 5% candidate points
for removal for both criteria:
cutoff <- 0.1
x <- seq(0,1,by=0.001)
y <- seq(0,1,by=0.001)
sgrid <- data.frame(x,y)
coordinates(sgrid) <- ~x+y
```

```
f <- function(x){
 kr =krige(s256i.data~1, s[-x,], sgrid, v.fit)
 mean(abs(pnorm((kr$var1.pred-log(cutoff))/sqrt(abs(kr$var1.var))) - 0.5))}

m2 <- sapply(1:256, f)
```

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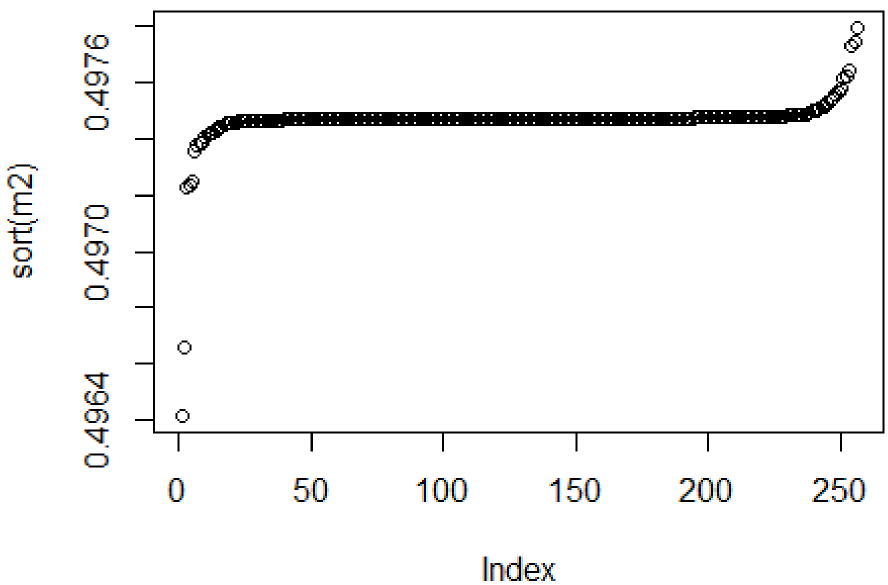
```r
plot(sort(m2))
```

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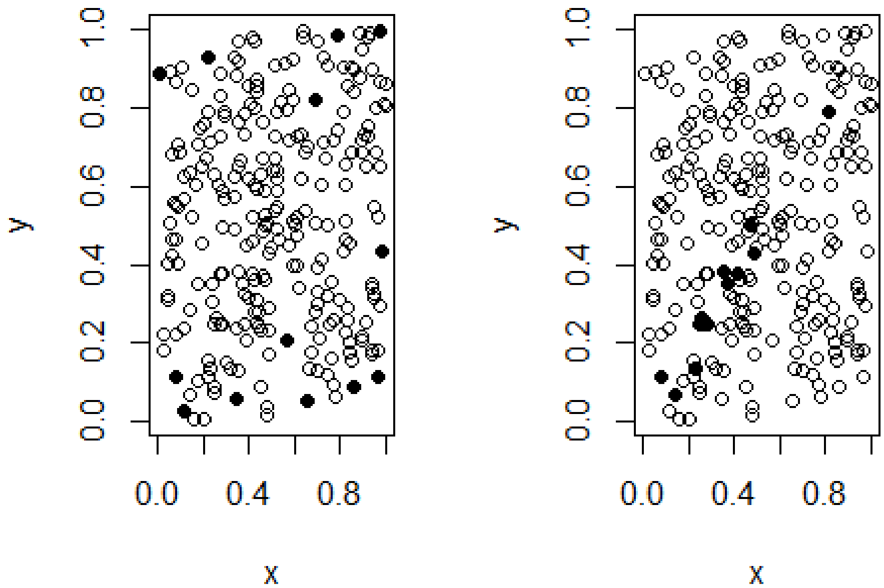
 layout(matrix(1:2,1,2))

#Left for m1
 plot(s256i$coords)
 points(s256i$coords[m1<quantile(m1,.05),],pch=1)
 points(s256i$coords[m1>quantile(m1,.95),],pch=16)


 #Right for m2
 plot(s256i$coords)
 points(s256i$coords[m2<quantile(m2,.05),],pch=16)
 points(s256i$coords[m2>quantile(m2,.95),],pch=1)
```



y
x
0.0
0.2
0.4
0.6
0.8
1.0
y
x