el Far'ah South

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Tel el-Far'ah South, Israel

A little background on work done on the tel may prove helpful.

Information of the mapping of the tel can be found at http://facweb1.redlands.edu/fac/jim_bentley/talks/elFaraSMap.ppt

Information of the surface survey can be found at http://facweb1.redlands.edu/fac/jim_bentley/talks/elFaraSSurvey.ppt

Read the Data

Get the sherds data from the web.

```
circles = read.csv("http://facweb1.redlands.edu/facultyfolder/jim_bentley/downloads/math312/circles981
names(circles)
```

```
##  [1] "EFT"      "EM"       "NFT"      "NM"       "HFT"      "HM"
##  [7] "SESSION"  "ESTEM"    "ESTNM"    "ESTHM"    "THEOCODE" "DATE"
## [13] "AREA"     "COLUNIT"  "RADIUS"   "MB"       "LB"       "IAI"
## [19] "IAII"     "IAIII"    "PERS"     "HELL"     "ROM"      "BYZ"
## [25] "MA"       "OTT"      "UNIDENT"  "TOTAL"    "PH"       "HR"
## [31] "PR"       "NOTE"
```

```
dim(circles)
```

```
## [1] 70 32
```

From the above we can see that there are 32 variables and 70 observations. Two of the variables contain information on the number of iron age II sherds found in each circle and the easting of the center of the circle in meters.

```
circles$IAII
```

```
##  [1]  0  3  0  0  0  2  0  1  6  0  0  2  0  0  0  0  0  1  0  1  3  2  1
## [24]  2  2  0  0  0  0  0  5  5  2  0  0  0  0  0  0  0 16  8  0  7  0  2
## [47]  0  8  2  0  0  1  0  7  5  3  5  1  0  1  0  7  4 12  3  0  0  1  1
## [70]  3
```

```
circles$ESTEM
```

```
##  [1]       NA       NA 100703.6 100704.3 100693.1 100682.7 100698.8
##  [8] 100678.4 100669.1 100686.2 100668.4 100692.6 100689.6 100678.1
## [15] 100683.0 100671.8 100670.4 100695.5 100688.4 100660.5 100648.8
## [22] 100672.0 100675.7 100663.4 100639.2 100641.6 100625.3 100624.9
## [29] 100630.4 100635.5 100628.1 100613.9 100609.7 100594.4 100598.3
## [36] 100654.4 100643.1 100647.0 100630.3 100634.8 100624.3 100675.1
## [43] 100667.0 100681.8 100676.2 100665.8 100652.0 100655.1 100688.0
## [50] 100656.2 100696.5 100702.3 100674.6 100636.6 100640.9 100597.7
## [57] 100606.6 100594.6 100590.3 100598.5 100585.5 100596.0 100610.9
## [64] 100627.0 100637.2 100642.0 100608.6 100628.5 100641.7 100618.0
```

```
length(circles$IAII)
```

```
## [1] 70
```

```
length(circles$ESTEM)
```

```
## [1] 70
```

The first two rows are trash. We can remove them.

```
circles=circles[-c(1:2),]
dim(circles)
```

```
## [1] 68 32
```

Test the Distribution of the Iron Age II Sherds

We can let our X_i represent the Iron Age II sherds.

```
x = circles$IAII
table(x)
```

```
## x
##  0  1  2  3  4  5  6  7  8 12 16
## 34  9  8  4  1  4  1  3  2  1  1
```

The circles with no sherds are meaningless as they do not affect the sum. We remove them.

```
x.no0 = x[x != 0]
length(x.no0)
```

```
## [1] 34
```

```
x.no0
```

```
##  [1]  2  1  6  2  1  1  3  2  1  2  2  5  5  2 16  8  7  2  8  2  1  7  5
## [24]  3  5  1  1  7  4 12  3  1  1  3
```

We can now compute Λ and the associated p-values.

```
(n <- length(x))
```

```
## [1] 68
```

```
(df <- n-1)
```

```
## [1] 67
```

```
(Lambda <- 2*t(x.no0)%*%log(x.no0/mean(x)))
```

```
##          [,1]
## [1,] 267.0377
```

```
1-pchisq(Lambda,df)
```

```
##      [,1]
## [1,]    0
```

```
(test.stat <- (n-1)*sqrt(var(x))/mean(x))
```

```
## [1] 107.3201
```

```
1-pchisq(test.stat,df)
```

```
## [1] 0.001288988
```

Spatial Analysis

A variogram helps us see how the sherd counts vary across the tel.

```
dists=dist(circles[,c("ESTEM","ESTNM")])
summary(dists)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   8.113  45.916  74.171  77.921 105.964 188.652
```

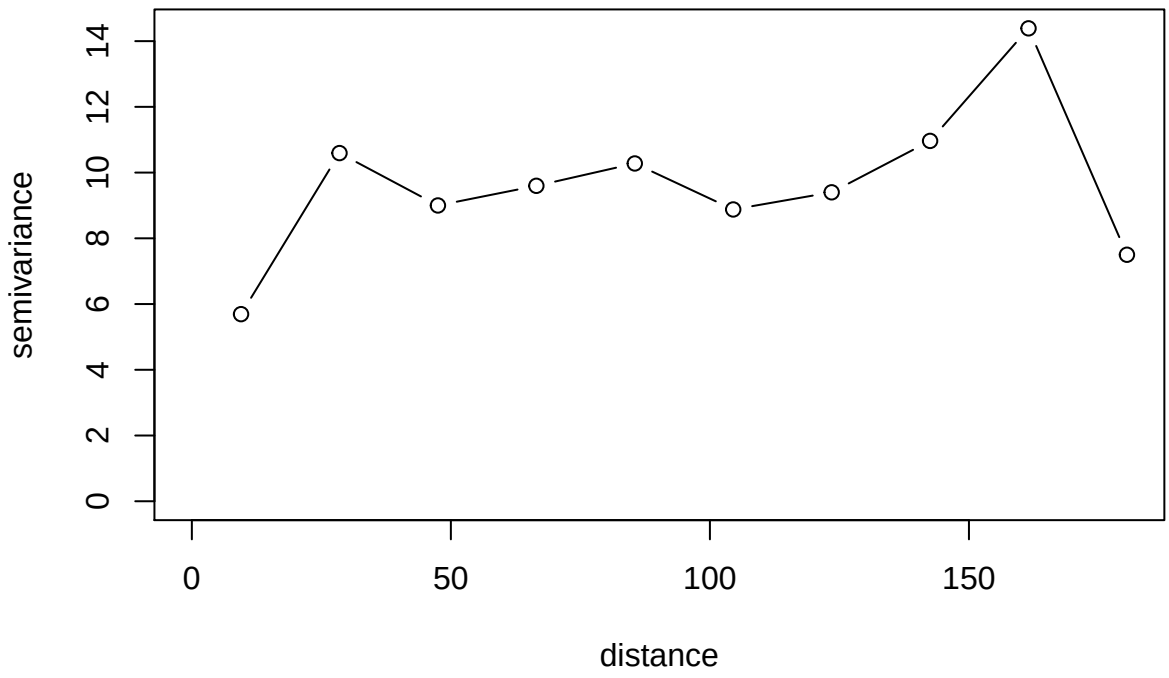
```
breaks=seq(0,190,l=11)
vl = variog(coords=circles[,c("ESTEM","ESTNM")],data=circles$IAII,breaks=breaks)
```

```
## variog: computing omnidirectional variogram
```

```
vl.summary = cbind(c(1:10),vl$v,vl$n)
colnames(vl.summary) = c("lag","semi-variance","# of pairs")
vl.summary
```

```
##       lag semi-variance # of pairs
##  [1,]   1      5.692661        109
##  [2,]   2     10.593220        295
##  [3,]   3      9.000000        373
##  [4,]   4      9.597744        399
##  [5,]   5     10.277778        351
##  [6,]   6      8.878333        300
##  [7,]   7      9.400000        210
##  [8,]   8     10.964029        139
##  [9,]   9     14.388889         81
## [10,]  10      7.500000         21
```

```
plot(vl,type="b")
```


semivariance
0
2
4
6
8
10
12
14
0
50
100
150
distance