Bayesian Methods for Ecological and Environmental Modelling

Spatial Data: Practical 1

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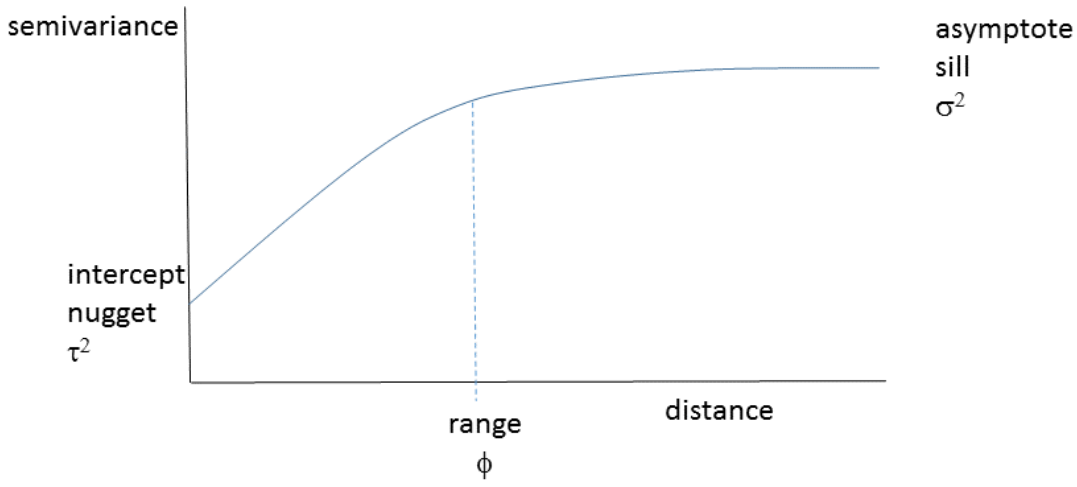
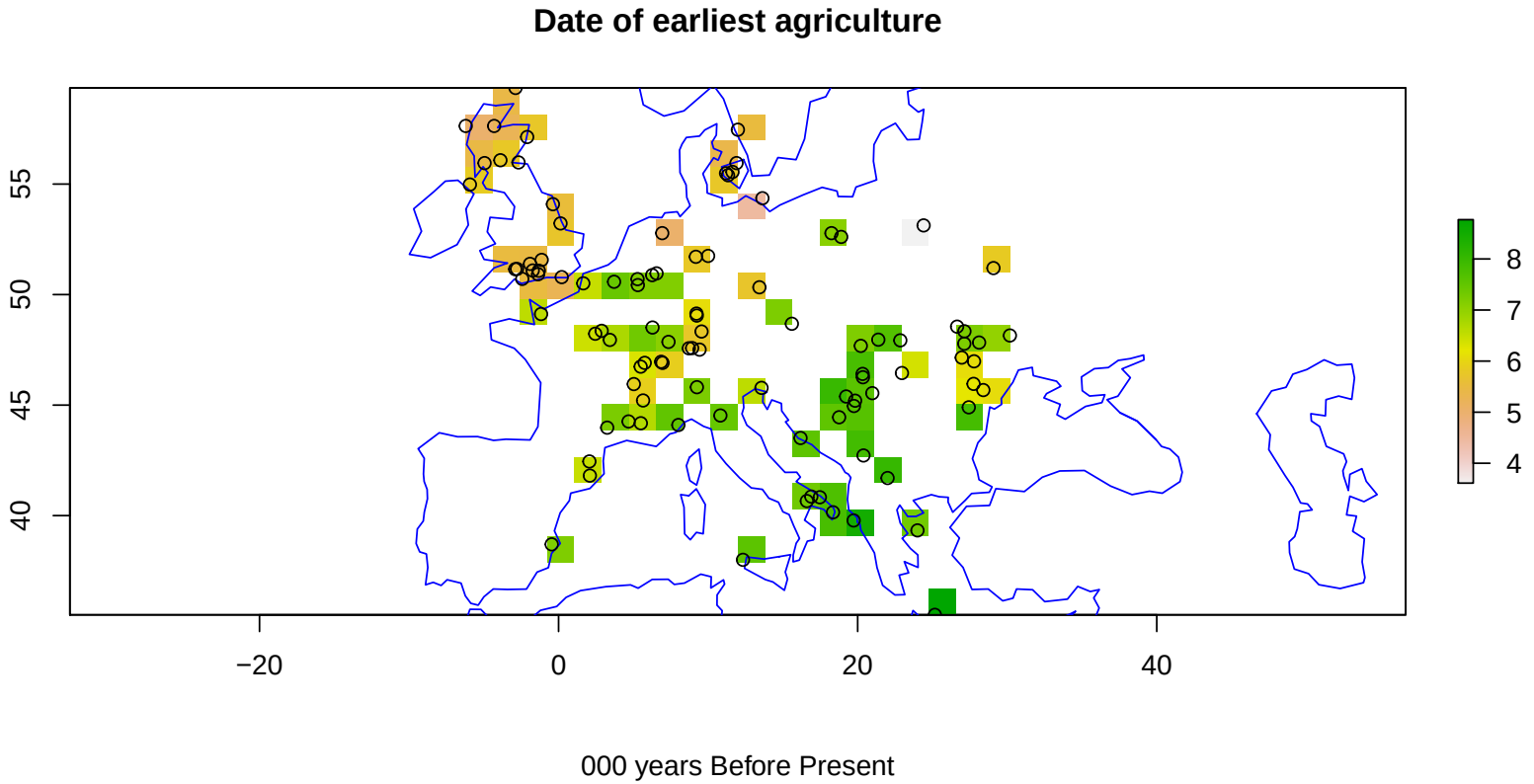
10 September 2019

Variogram


semivariance
asymptote
sill
σ^2
intercept
nugget
τ^2
range
ϕ
distance

Case study 1: Spread of Agriculture in the Neolithic Period



The z values show the earliest date of agriculture at 100 sites, in 000s of years before present (8 ka BP = 8000 years ago).

Construct a variogram

We can construct a variogram using the geoR `variog()` function. This creates bins for separation distance and calculates the semivariance in each.

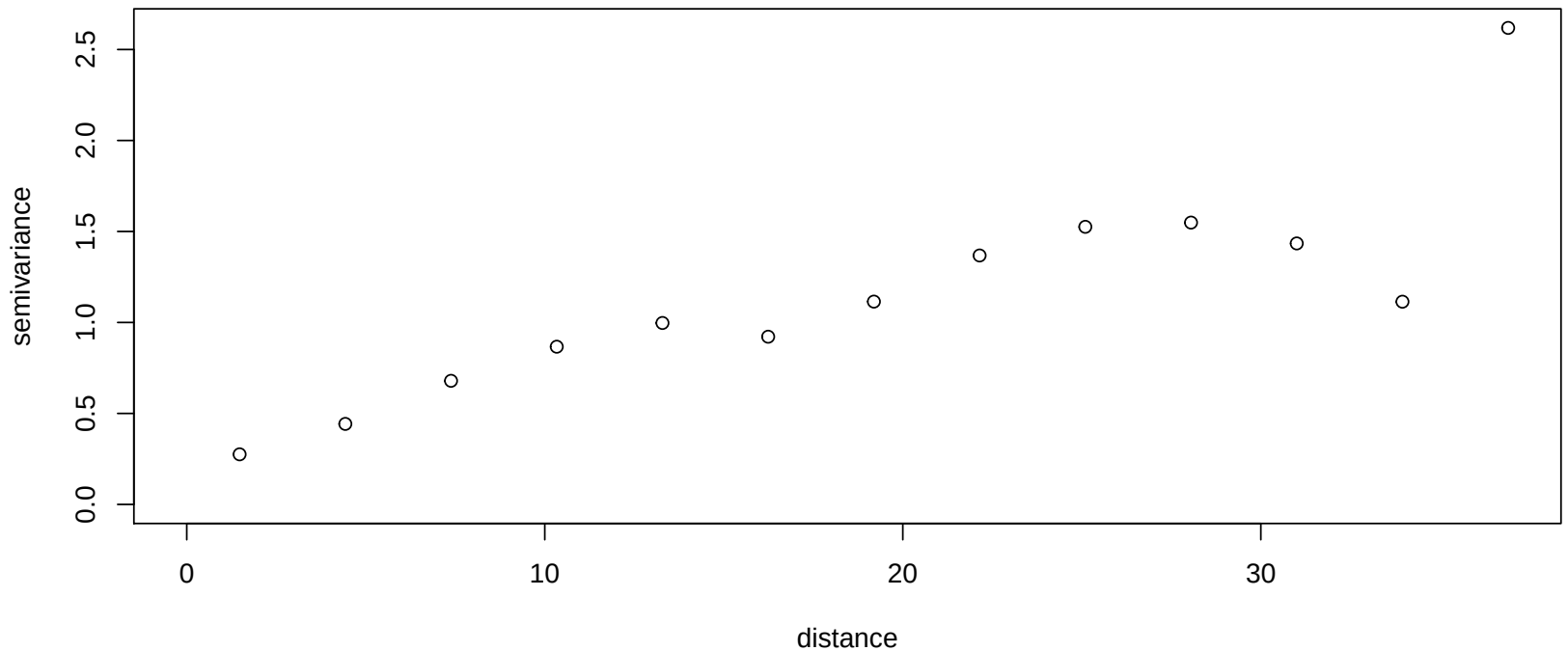
```
## Number of data points: 100
##
## Coordinates summary
##     LONGITUDE LATITUDE
## min     -6.21    35.51
## max     30.18    59.35
##
## Distance summary
##          min          max
##  0.09219544 38.38451901
##
## Data summary
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 3.61100 5.73025 6.49450 6.52259 7.25125 8.76900
```

Construct a variogram

```
vgm <- variog(dg)
```

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

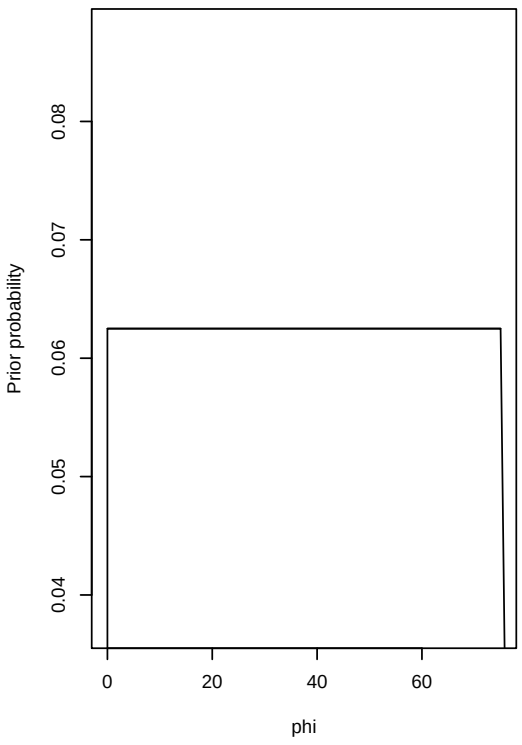
```
plot(vgm)
```

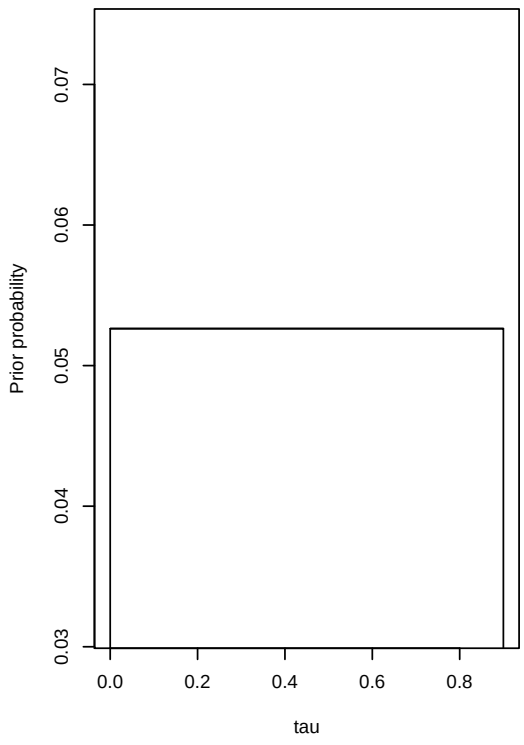


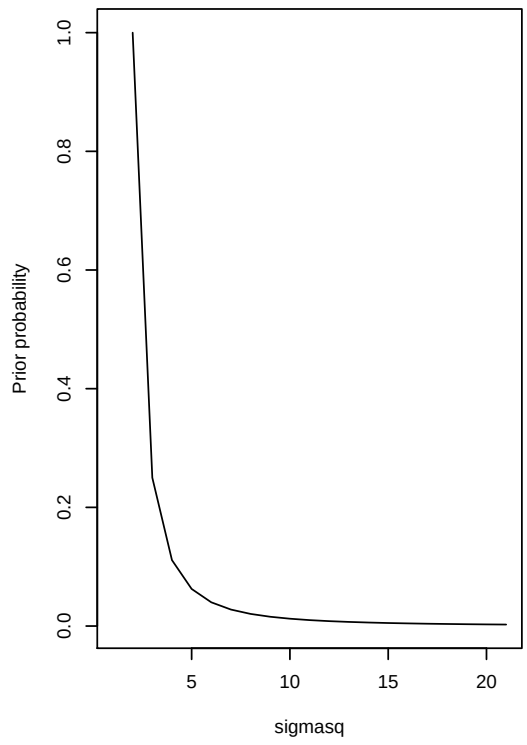
Specifying priors

- range ϕ - we assume a uniform distribution between 0 and twice the maximum in the data
- intercept τ^2 - this is specified as a fraction of the asymptote σ^2, "tausq.rel". We assume a uniform distribution between 0 and 0.9.
- asymtote σ^2 - we assume a "reciprocal" prior, where larger values become diminishingly probable, in inverse proportion to σ^2
- mean β - we assume a uniform distribution between 0 and infinity i.e. completely uninformative; "flat" in the geoR syntax.

Specifying priors







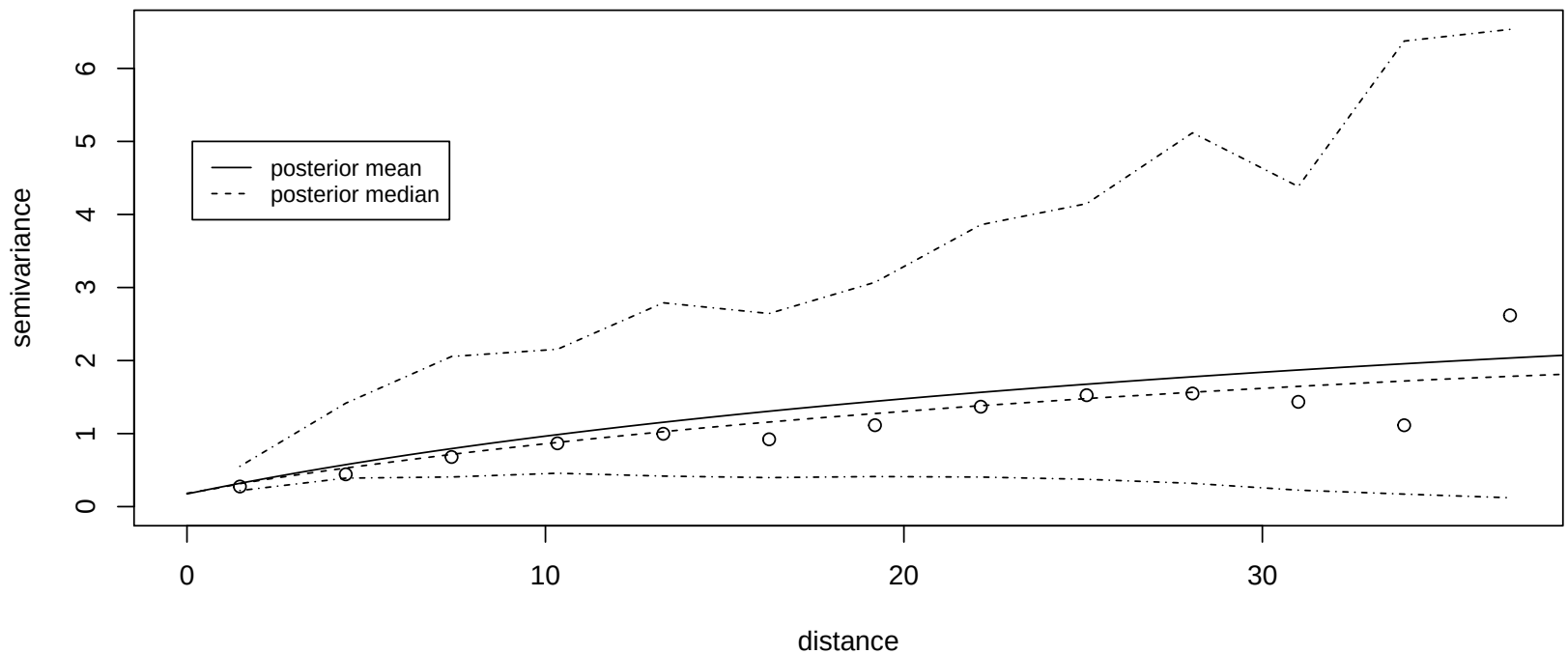
Estimate the vargiogram model parameters

```
system.time(
bsp <- krige.bayes(
  dg,
  loc="no",
  prior=prior.control(
    beta.prior="flat",
    sigmasq.prior="reciprocal",
    phi.prior="uniform",
    phi.discrete=seqphi_sparse,
    tausq.rel.discrete = seqtau_sparse,
    tausq.rel.prior="uniform"),
  output=output.control( n.posterior=10000, messages=FALSE)
  )
)
```

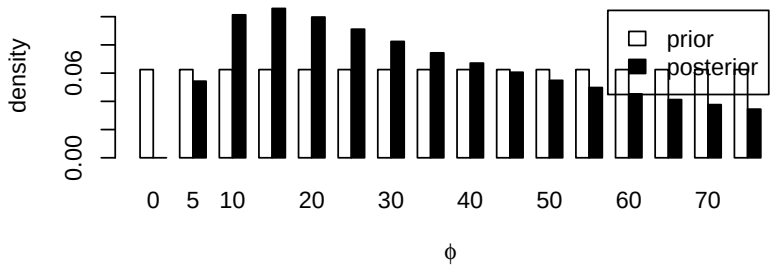
```
##    user  system elapsed
##    0.91    0.01    0.95
```

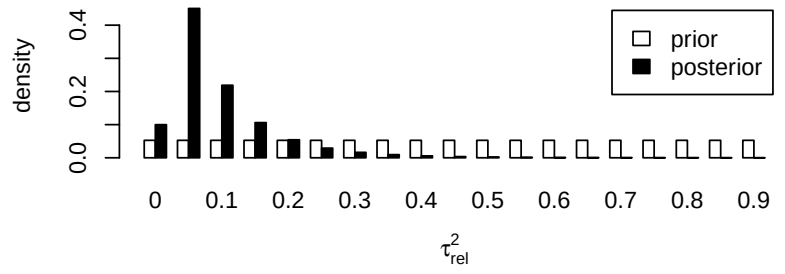
Plot estimated variogram

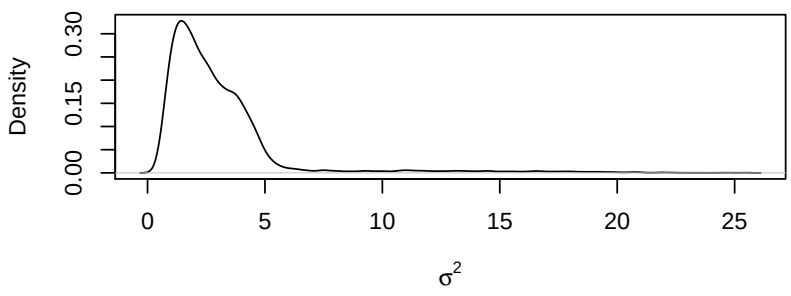
```
## variog: computing omnidirectional variogram

## variog.env: generating 99 simulations (with  100 points
## variog.env: adding the mean or trend
## variog.env: computing the empirical variogram for the 99
## variog.env: computing the envelops
```

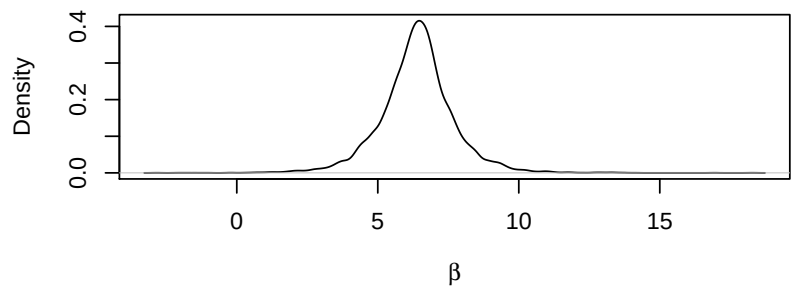


Posterior distributions of parameters









References