R package RandomFields

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Random fields

\( Z \): random field on \( \mathbb{R}^d \) = random function in space
= dependent random variables \( Z(x) \) indexed by \( x \in \mathbb{R}^d \)

Applications

spatial data that can be measured at any location, e.g., temperature, moisture, ozon concentration, . . .
but also genetics: each SNP is a coordinate

Characteristics

- Expectation \( \mathbb{E} Z(x) \)
- Covariance function \( C(x, y) = \text{Cov}(Z(x) - Z(y)) \)
- Stationary and isotropic field: \( C(x, y) = \varphi(\|x - y\|) \)
Goal: simulation of and inference on random fields

History

- 1999: starting point for R package geoR;
- split up in geoR and RandomFields
  - geoR: Bayesian; user friendly
  - RandomFields: research and speed oriented
  - future close cooperation reconsidered
- most code in C
- broad range of options
- necessity for own research work to have simulations out of the box
Original features

- Simulation of isotropic, spatial random fields
  ```r
  x <- c(-5, 5, 5 * 2 / lenx)
  model <- list('exp', param=c(0,1,0,1))
  z <- GaussRF(x,x, model=model, gridtriple=TRUE)
  ```

- various methods needed for different models (and parameter settings) and locations
  - automatic choice of the method
  - `RFparameters()` to influence choice and working of the methods

- Parameter estimation (MLE);
  - avoiding bugs in `optim` (parameter range, returned parameter set)
  - user friendly (starting values need not be given)
  - starting point with LSQ

- Kriging (spatial prediction)
Current state

- **Complex model specification**
  
  ```r
  model <- list('+',
    list('whittle', nu =5),
    list('$', var=3, list('gauss')),
    list('$', aniso=matrix(1:4, ncol=2), list('spher'))
  )
  ```

- simulation of space-time random fields
- simulation of multivariate fields
- arbitrary dimensions
- estimation of mixed models with geostatistical component (MLE / REML)
Future work

- extended manual
- customized interfaces
- Graphic card option
- C++