

R demonstrations for the SG and BSP methods

Introduction to EnviRo.stat.1.0.1

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Outline

- Download and install EnviRo.stat.1.0.1 package
- An R demonstration on the SG method for the Southern Ontario Data
- SG method used in the BSP approach
- An Example in R on interpolation the multivariate responses by the BSP approach
- Lab Exercises

EnviRo.stat.1.0.1 package

- Platform: Windows, Unix, & Linux
- Language: Fortran, C, & R
- Freely downloaded at:
<http://enviro.stat.ubc.ca/statisticalanalysis/>
- Download EnviRo.stat.1.0.1 and unzip it at C:/
- Open C:/EnviRo.stat.1.0.1/INSTALL/install.txt and follow the steps to complete its installation in windows

Review the Sampson-Guttorp method

- Construct a 1-1 non-linear smooth mapping from G-space to D-space
- Estimate variogram using the D-distances and the observed dispersion
- Estimate the spatial covariance matrix
- Two-steps on constructing the thin-plate smoothing spline
 - Multidimensional scaling → find a configuration of the monitoring locations
 - Select the smoothing parameter λ to ensure spatially no folding

An R Example on the SG method

- Open C:/EnviRo.stat.1.0.1/DEMO/Example2.txt
- Objective: Use the SG-method to interpolate the variance field in southern Ontario data, given the estimated spatial covariance matrix ("cov7.txt") and locations for the monitoring stations ("crds7.txt")

An R Example on the SG method (Con'd)

- Steps:
 - Find the new configuration in D-space
 - Select a smoothing parameter λ
 - Obtain an optimal thin-plate spline mapping
 - Estimate the dispersion between new and monitoring locations
 - Estimate covariance matrix at all locations

The BSP approach and the SG method

- BSP: Bayesian spatial prediction after pre-filtering (see tomorrow's lecture)
- Goal: Interpolate the responses in the spatio-temporal field
- Univariate or Multivariate responses
- Staircase pattern missing data
- Two-steps to estimate all parameters in the BSP:
 - Use EM algorithm to estimate the parameters at the monitoring stations
 - Use SG method to extend the spatial covariance structures to the other unmonitoring stations

EnviRo.stat.1.0.1: hourly O3 in NY

- Open C:/EnviRo.stat.1.0.1/DEMO/Example1.txt
- Responses: hour 8 - 11 ozone levels
- Read and rearranging data
- Covariates: month and weekday
- EM algorithm: `staircase.EM()` → "cov.est"—estimated marginal spatial correlation matrix
- SG method: extend the spatial covariance to unmonitoring locations
- Interpolate the multivariate response at unmonitoring locations

Summary

- SG method and its R example
- SG method's usage in the BSP approach
- An R example to demonstrate the BSP approach

Reference

- Sampson & Guttorp, 1992
- Le & Zidek, 2006

Lab Exercises

- Run "Example2.txt" and "Example1.txt"
- Experiment:
 - split into small teams
 - each team select one set of data
 - each team first does the simple data analysis: ts plot, data transformation, boxplot, missing value fitting, acf/pacf (R functions: ts.plot(), boxplot(), acf(), pacf(), etc.)
 - each team use the SG method to estimate the covariance matrices for daily, weekly and monthly data: what's the changing in the nonstationarity?

Lab Exercises (Con'd)

- Real data experiment:
 - select one real data set or use your own data
 - interpolate the responses at the unmonitoring stations using the EnviRo.1.0.1 package
 - How to assess your results?