M.S. Writing Project

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Schedule

Week of	Tasks
Jan 23	Review Ch.2 Banerjee, Carlin, & Gelfand Look at R software for simulating and fitting variograms.
Jan 30	Simulate data with known covariance structure Fit Bayesian spatial model to simulated data Start annotated bibliography
Feb 6	
Feb 13	
Feb 20	
Feb 27	
Mar 6	
Mar 13	
Mar 20	
Mar 27	
Apr 3	
Apr 10	
Apr 17	
Apr 24	
Apr 31	Writing Project Due:

Table 1: Writing Project Schedule

Package Exploration

GeoR

Future Research Ideas

- Modeling how the SE moves through the lake; extensions to generally modeling how things move (blood flow through body, mineral deposits change in a mine, modeling tumor growth- somewhat inspired by Margaret's abstract)
-

Annotated Bibliography

[inline, color=red!50]Andy add more papers to this list

Bayesian Geospatial Design, Peter Diggle and Soren Lophaven

In [?] the authors specify design criteria as the minimum posterior predictive variance for both prospective and retrospective designs. Univariate response case.

An Introduction to Model-based Geostatistics

The authors describe a method for calculating posterior predictive variance in both prospective and retrospectie case. [?]

Optimal Spatio-temporal Hybrid Sampling Designs for Ecological Monitoring

The authors in [?] specified a method for optimal designs for dynamic spatial temporal processes. Dynamic is in the sense that the process changes over time. Compared designs for hybrid and fixed designs. Hybrid designs combine fixed sites to sample each year and random sites which vary each year. Fixed (static) sites are more convenient while dynamic sites show how the process changes over time and the "inherent spatial autocorrelation". Criteria specified was the minumum average prediction variance. Favored sites have the most spatial variation and are least correlated with other sites (Wikle and Royle, 1999).

Process: 1) Leave out observation t and use all other observations to predict y_t.

2) Compute $Var(Y_t|Y_{t-1,...1})$ for all t.

3) Average (2).

4) Retain minimum (3).

Method handles multivariate response model through m_t:

$$\mathbf{Y_t} = \mathbf{K_t}\alpha_\mathbf{t}\mathbf{\Phi_t^T} + \epsilon_\mathbf{t}\phi_\mathbf{t}^\mathbf{T}$$

$\mathbf{Y_t}$ = $m_t Xn$ multivariate response vector $\mathbf{K_t}$ = $m_t Xn$ maps observations to process vector α_t = true latent process $\mathbf{\Phi_t}$ = matrix to transform to univariate spatial observation

Criteria was using Kalman filtering. Benfits of Kalman filtering include allowing estimatation of latent process (α) as well as it's uncertainty. *check is this similar to incorproating bayes in diggle's paper to min estimation and pred. var?*

Kalman filter reference http://www.cs.unc.edu/~welch/kalman/

Heirarchial Modeling - Analysis for Spatial Data

Chapter 2

- **Stationarity**:

  1) Strong - distribution constant over entire domain

  2) Weak - $Cov(y_t, y_{t+h})$ = C(h) - the covariance between two observations depends only on the separation vector between them, can also state that the mean is constant over the entire domain, but not necessary

3) Intrinsic - **Semi-variogram** = $\gamma(h) = \frac{Var(y_t - y_{t+h})}{2}$ = $Var(y) + Cov(y_t, y_{t+h})$ = c(0) + c(h) - the average variance between two observations depends only on the separation vector between them

   - Gaussian response $\rightarrow weakstationarityimplesstrongstationarity$

- Weak stationarity $\rightarrow intrinsicstationarity$
- **Ergodic** - if c(h) $\rightarrow 0as||h|| \rightarrow \inf, thenintrinsicstationarity \rightarrow weakstationarity$
- $\gamma(h)$ == **Variogram**, and must be negative defninte
  - **Isotrophic** - $\gamma(h)$ depends only on the separation vector through its length (vs. direction, etc.) - likely Benton Lake data are not isotrophic - *How to deal with this?*
  - **Homogenous** = intrinsic + isotrophic
  - **Semivariogram** - plot of the semivariogram vs. ||h||, can also have directional where multiple "lines", one for each direction considered
  - Notation
    - τ^2 = nugget = "non-spatial" variance component
    - σ^2 = partial sill = "spatial" variance component
    - $\tau^2 + \sigma^2$ = sill
    - $\gamma(h)$ = $\tau^2 + \sigma^2$*Correlation Structrure
    - R = range = distance at which $\gamma(h)$ = $\tau^2 + \sigma^2$, responses are no longer correlated
    - If R = $\inf, thencreate$**effectiverange**

Options for choosing the correlation function:

1. Empirical compared to theoretical, but make sure valid - Gaussian, exponential, and cauchy always valid
2. Criteria penalizing complexity and rewarding parsimony
3. Theoretical foundations
4. Matern class

The correlation structure informs smoothness.

Explain difference between intrinsic and weak stationarity.

Odd Matern τ^2

Project Outline:

6 Latex / Overleaf code

6.1 How to include Figures

Figure 1: This frog was uploaded via the project menu.

First you have to upload the image file from your computer using the upload link the project menu. Then use the includegraphics command to include it in your document. Use the figure environment and the caption command to add a number and a caption to your figure. See the code for Figure **??** in this section for an example.

6.2 How to add Comments

Comments can be added to your project by clicking on the comment icon in the toolbar above. To reply to a comment, simply click the reply button in the lower right corner of the comment, and you can close them when you're done.

Comments can also be added to the margins of the compiled PDF using the todo commandHere's a comment in the margin!, as shown in the example on the right. You can also add inline comments:

[inline, color=green!40]This is an inline comment.

6.3 How to add Tables

Use the table and tabular commands for basic tables — see Table **??**, for example.

Item	Quantity
Widgets	42
Gadgets	13

Table 2: An example table.

References

[Diggle and Lophaven, 2006] Diggle, P. and Lophaven, S. (2006). Bayesian geostatistical design. *Scandinavian Journal of Statistics*, 33(1):53–64.

[et al., 2003] et al., D. (2003). An introduction to model-based geostatistics. *Spatial statistics and computational methods*.

[Hooten and Rushin, 2009] Hooten, Wikle, S. and Rushin (2009). Optimal spatio-temporal hybrid sampling designs for ecological monitoring. *Journal of Vegetarian Science*, 20:639–649.