Basic Beamer

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Table of Contents

A list of cool things

- Here is the first thing
- and now the second
  - look I have a subitem!
  - and it says more things
    - and now I have a subsubitem!

Theorems and definitions

Theorem

Hopkins biostat is the best!

Proof by contradiction.

1. Suppose Hopkins biostat was not the best

□

Definition (biostat)

Working hard and being awesome

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4. But Karen is at Hopkins

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1. Suppose Hopkins biostat was not the best
2. Then there would be a better place than Hopkins biostat
3. Then that place would have Karen as chair
4. But Karen is at Hopkins
5. We have reached a contradiction, therefore Hopkins is the best

□

Definition (biostat)

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A figure

Figure: This is a picture of biostat camping!

Camping reference

This slide's only purpose is to reference the camping picture in figure **??**

Table: collocated monitors

- 313 monitors throughout continental United States; 289 unique locations

City	# Monitors	# Collocated
New York	8	2
Houston	7	2
Phoenix	7	3
Seattle	7	2/2
Chicago	5	2
Philadelphia	5	3

Figure: Number of Collocated Monitors

Spatial-temporal model

Gaussian Process, specific to region ($r(s)$) and constituent:

$$x_{r(s)}(s,t) = \mu_{r(s)} + w_{r(s)}(s,t) + \epsilon_{r(s)}(s,t)$$

$x_{r(s)}(s,t)$ Gaussian process for a constituent at time t and space s

$\mu_{r(s)}$ Region-specific mean for a constituent

$\epsilon_{r(s)}(s,t)$ Mean zero, white noise process with variance $\tau^2_{r(s)}$

- Exposure measurement error
- Microscale variation (Paciorek and Schervish, 2006)

$w_{r(s)}(s,t)$ Gaussian process, mean zero with covariance

$$Cov\Big(w_{r(s)}(s,t), w_{r(s')}(s',t')\Big) = \begin{cases} \sigma^2_{r(s)}\rho\big(\|s-s'\|; \phi_{r(s)}, \kappa_{r(s)}\big) & t = t' \\ 0 & t \neq t' \end{cases}$$

where ρ is the Matèrn covariance function with Bessel function of the third kind

Likelihood for spatial-temporal model

$$L(\boldsymbol{\Theta}_{r(s)}; \mathbf{m}_{r(s)}) \propto \prod_{t=1}^{T} |\mathbf{M}_{r(s)}|^{-1/2} \exp\left(-\frac{1}{2}[\mathbf{m}_{r(s)}(t) - \mu_{r(s)}\mathbf{1}]'\mathbf{M}_{r(s)}^{-1}[\mathbf{m}_{r(s)}(t) - \mu_{r(s)}\mathbf{1}]\right)$$

$\boldsymbol{\Theta}_{r(s)}$ $(\sigma_{r(s)},\ \phi_{r(s)},\ \kappa_{r(s)},\ \mu_{r(s)},\ \tau_{r(s)})$

$\mathbf{m}_{r(s)}(t)$ observed, log-transformed monitor levels for region $r(s)$ for day t

$\mu_{r(s)}$ region-specific mean

where $\mathbf{M}_{r(s)}$ is the appropriate covariance matrix with (i, k) element equal to

$$\sigma^2_{r(s)}\rho(\|s_i - s_k\|; \phi_{r(s)}, \kappa_{r(s)}) + \tau^2_{r(s)} \cdot \mathsf{I}_{\{s_i = s_k\}}$$

Citations

Now I will cite some important papers. The following are really important [**?**, **?**, **?**]

Thanks!

The End

Luna, X. D. and Genton, M. G. (2005), "Predictive spatio-temporal models for spatially sparse environmental data," *Statistica Sinica*, URL http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.6.5621.

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