Selection of Lambda in Rho Prior

Kyle Lin Wu

In this RMD file, we select an appropriate value for the λ hyperparameter of the penalized complexity prior for both the simulation example in Section 4 and the data analysis in Section 5. The penalized complexity prior was introduced in Simpson et al. (2017), and we place this prior on ρ, which controls the spatial proportion of total variance in the BYM2 model. We select λ from a dense sequence such that $\mathbb{P}\left(\rho \leq \frac{1}{2}\right) \approx \frac{2}{3}$.

1 Load Packages and Helper Functions

```
library(data.table)
library(Rcpp)
library(RcppArmadillo)
library(ggplot2)
rm(list = ls())

# helper functions to sample from PC prior given spatial variance structure
source(file.path(getwd(), "src", "R", "pc_selection_helper_functions.R"))
```

2 Simulation Selection

```
# simulation selection of lambda_rho
source(file.path(getwd(), "src", "R", "simulation", "US_data_generation.R"))
Q_eigen <- eigen(Q_scaled)
Lambda <- Q_eigen$values
```

```
set.seed(1130)
alpha <- 2/3
U <- 0.5
l_seq <- seq(0.02, 0.05, by = .0015)
# alpha = P(rho <= U)
alphas <- vapply(l_seq, function(target_l) {
  mean(samplePCPrior(10000, Lambda, target_l) <= U)
}, numeric(1))
# select lambda such that P(rho <= U) is about alpha
min(l_seq[alphas >= alpha])
```

```
## [1] 0.0335
```

3 Lung Cancer Analysis Selection

```
# US lung mortality RDA selection of lambda_rho
# Read in and setup lung + smoking data
source(file.path(getwd(), "src", "R", "RDA", "US_data_setup.R"))
Q_eigen <- eigen(Q_scaled)
Lambda <- Q_eigen$values
```

```
set.seed(1130)
alpha <- 2/3
U <- 0.5
l_seq <- seq(0.02, 0.05, by = .0015)
# alpha = P(rho <= U)
alphas <- vapply(l_seq, function(target_l) {
  mean(samplePCPrior(10000, Lambda, target_l) <= U)
}, numeric(1))
# select lambda such that P(rho <= U) is about alpha
min(l_seq[alphas >= alpha])
```

```
## [1] 0.0335
```

4 References

Simpson, Daniel, Håvard Rue, Andrea Riebler, Thiago G. Martins, and Sigrunn H. Sørbye. 2017. "Penalising Model Component Complexity: A Principled, Practical Approach to Constructing Priors." *Statistical Science* 32 (1): 1–28. https://www.jstor.org/stable/26408114.