

Selection of Lambda in Rho Prior

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 $\mathbb{P}(\rho \leq \frac{1}{2}) \approx \frac{2}{3}$.

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>.