Package ‘elhmc’

July 4, 2017

Type Package

Title Sampling from a Empirical Likelihood Bayesian Posterior of Parameters Using Hamiltonian Monte Carlo

Version 1.1.0

Date 2017-07-03

Author Dang Trung Kien <kien.dang@nus.edu.sg>, Sanjay Chaudhuri <stasc@nus.edu.sg>, Neo Han Wei <a0086731@u.nus.edu>,

Maintainer Sanjay Chaudhuri <stasc@nus.edu.sg>

Description A tool to draw samples from a Empirical Likelihood Bayesian posterior of parameters using Hamiltonian Monte Carlo.

Imports emplik, plyr, stats, MASS, utils

License GPL-2

LazyData TRUE

RoxygenNote 5.0.1

NeedsCompilation no

Repository CRAN

Date/Publication 2017-07-04 04:44:14 UTC

R topics documented:

ELHMC ................................................................. 2

Index 5
Empirical Likelihood Hamiltonian Monte Carlo Sampling

Description

This function draws samples from an Empirical Likelihood Bayesian posterior distribution of parameters using Hamiltonian Monte Carlo.

Usage

```r
ELHMC(initial, data, fun, dfun, prior, dprior, n.samples = 100,
       lf.steps = 10, epsilon = 0.05, p.variance = 1, tol = 10^-5, 
detailed = FALSE, FUN, DFUN)
```

Arguments

- **initial**: a vector containing the initial values of the parameters
- **data**: a matrix containing the data
- **fun**: the estimating function \( g \). It takes in a parameter vector \( \text{params} \) as the first argument and a data point vector \( x \) as the second parameter. This function returns a vector.
- **dfun**: a function that calculates the gradient of the estimating function \( g \). It takes in a parameter vector \( \text{params} \) as the first argument and a data point vector \( x \) as the second argument. This function returns a matrix.
- **prior**: a function with one argument \( x \) that returns the prior densities of the parameters of interest
- **dprior**: a function with one argument \( x \) that returns the gradients of the log densities of the parameters of interest
- **n.samples**: number of samples to draw
- **lf.steps**: number of leap frog steps in each Hamiltonian Monte Carlo update
- **epsilon**: the leap frog step size(s). This has to be a single numeric value or a vector of the same length as \( \text{initial} \).
- **p.variance**: the covariance matrix of a multivariate normal distribution used to generate the initial values of momentum \( p \) in Hamiltonian Monte Carlo. This can also be a single numeric value or a vector. See Details.
- **tol**: EL tolerance
- **detailed**: If this is set to TRUE, the function will return a list with extra information.
- **FUN**: the same as \( \text{fun} \) but takes in a matrix \( X \) instead of a vector \( x \) and returns a matrix so that \( \text{FUN}(\text{params}, X)[i, ] \) is the same as \( \text{fun}(\text{params}, X[i, ]) \). Only one of \( \text{FUN} \) and \( \text{fun} \) should be provided. If both are then \( \text{fun} \) is ignored.
- **DFUN**: the same as \( \text{dfun} \) but takes in a matrix \( X \) instead of a vector \( x \) and returns an array so that \( \text{DFUN}(\text{params}, X)[, , i] \) is the same as \( \text{dfun}(\text{params}, X[i, ]) \). Only one of \( \text{DFUN} \) and \( \text{dfun} \) should be provided. If both are then \( \text{dfun} \) is ignored.
Details

Suppose there are data \( x = (x_1, x_2, \ldots, x_n) \) where \( x_i \) takes values in \( \mathbb{R}^p \) and follow probability distribution \( F \). Also, \( F \) comes from a family of distributions that depends on a parameter \( \theta = (\theta_1, \ldots, \theta_d) \) and there is a smooth function \( g(x_i, \theta) = (g_1(x_i, \theta), \ldots, g_q(x_i, \theta))^T \) that satisfies \( E_F[g(x_i, \theta)] = 0 \) for \( i = 1, \ldots, n \).

ELHMC draws samples from a Empirical Likelihood Bayesian posterior distribution of the parameter \( \theta \), given the data \( x \) as data, the smoothing function \( g \) as \( \text{fun} \), and the gradient of \( g \) as \( \text{dfun} \) or \( G(X) = (g(x_1), g(x_2), \ldots, g(x_n))^T \) as \( \text{FUN} \) and the gradient of \( G \) as \( \text{DFUN} \).

Value

The function returns a list with the following elements:

- samples: A matrix containing the parameter samples
- acceptance.rate: The acceptance rate
- call: The matched call

If \( \text{detailed} = \text{TRUE} \), the list contains these extra elements:

- proposed: A matrix containing the proposed values at \( n \) samples - 1 Hamiltonian Monte Carlo updates
- acceptance: A vector of \( \text{TRUE}/\text{FALSE} \) values indicates whether each proposed value is accepted
- trajectory: A list with 2 elements \( \text{trajectory.q} \) and \( \text{trajectory.p} \). These are lists of matrices containing position and momentum values along trajectory in each Hamiltonian Monte Carlo update.

References


Examples

```r
## Not run:
## Suppose there are four data points (1, 1), (1, -1), (-1, -1), (-1, 1)
x = rbind(c(1, 1), c(1, -1), c(-1, -1), c(-1, 1))
## If the parameter of interest is the mean, the smoothing function and
## its gradient would be
f <- function(params, x) {
    x - params
}
df <- function(params, x) {
    rbind(c(-1, 0), c(0, -1))
}
```
## Draw 50 samples from the Empirical Likelihood Bayesian posterior distribution
## of the mean, using initial values (0.96, 0.97) and standard normal distributions
## as priors:

```r
normal_prior <- function(x) {
  exp(-0.5 * x[1] ^ 2) / sqrt(2 * pi) * exp(-0.5 * x[2] ^ 2) / sqrt(2 * pi)
}

normal_prior_log_gradient <- function(x) {
  -x
}

set.seed(1234)
mean.samples <- ELHMC(initial = c(0.96, 0.97), data = x, fun = f, dfun = df,
                      n.samples = 50, prior = normal_prior,
                      dprior = normal_prior_log_gradient)
plot(mean.samples$samples, type = "l", xlab = "", ylab = "")
```

## End(Not run)
Index

ELHMC, 2