

Package: wishartinference (via r-universe)

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Contents

ldet	2
lfafun_improper	2
lfafun_proper	3
lgammap_export	4
mode_alphaEM	4
rejection_sampler	5

rwishart	6
test	7
wishart_inference	7
wishart_stats	8

Index	9
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ldet	<i>Log determinant of a positive definite matrix</i>
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Description

Uses Armadillo’s log_det for numerical stability.

Usage

ldet(X)

Arguments

x Square positive definite matrix

Value

log|X|

lfafun_improper	<i>Log unnormalized marginal posterior of alpha under the improper prior</i>
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Description

The improper prior $p(\alpha, \mu) \propto (\alpha - (p-1)/2)^{-1} * |\mu|^{-(p+1)/2}$, after marginalizing over μ , gives a closed-form log posterior for α . Returns -Inf when $a \leq (p-1)/2$.

Usage

lfafun_improper(a, n, p, xbar, ldetxbarg)

Arguments

a Shape parameter alpha, must be $> (p-1)/2$
n Number of Wishart observations
p Dimension
xbar Sample mean matrix (p x p)
ldetxbarg Log geometric mean of determinants $(1/n) * \sum \log|X_{il}|$

Value

$\log f^*(\alpha)$, or $-\text{Inf}$ if $\alpha \leq (p-1)/2$

lfafun_proper

Log unnormalized marginal posterior of alpha under the proper prior

Description

The proper prior $\alpha \sim \text{Gamma}(\beta, \beta \cdot \eta)$ (truncated at $(p-1)/2$) and $\mu | \alpha \sim \text{inv-Wishart}(2 \cdot \kappa \cdot \alpha, 2 \cdot \kappa \cdot \alpha \cdot \mu_0)$, after marginalizing over μ , gives a closed-form log posterior for α . Returns $-\text{Inf}$ outside the domain $\alpha > (p-1)/2$.

Usage

```
lfafun_proper(a, n, p, ldet_muhat, ldetxbarg, ldet_mu0, beta, eta, kappa)
```

Arguments

a	Shape parameter alpha, must be $> (p-1)/2$
n	Number of Wishart observations
p	Dimension
ldet_muhat	$\log \mu\text{hat} $ where $\mu\text{hat} = (n \cdot \bar{x} + \kappa \cdot \mu_0)/(n + \kappa)$
ldetxbarg	Log geometric mean of determinants $(1/n) \cdot \sum \log X_{:i} $
ldet_mu0	$\log \mu_0 $
beta	Gamma prior shape, must be > 1
eta	Gamma prior rate parameter
kappa	inv-Wishart prior strength, must be ≥ 1

Value

$\log f^*(\alpha)$, or $-\text{Inf}$ if outside domain

lgammap_export	<i>Log of the multivariate Gamma function</i>
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Description

Defined as $\log \Gamma_p(a) = p(p-1)/4 * \log(\pi)$ plus the sum over $i = 1, \dots, p$ of $\log \Gamma(a - (i-1)/2)$. Required for the normalizing constant of the Wishart and inverse-Wishart distributions.

Usage

```
lgammap_export(a, p)
```

Arguments

a	Argument, must be $> (p-1)/2$
p	Dimension

Value

$\log \Gamma_p(a)$

mode_alphaEM	<i>Find the posterior mode of alpha</i>
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Description

Dispatches to the improper- or proper-prior EM mode finder depending on which parameters are supplied. The prior type is auto-detected: omit μ_0 , β , η , κ for the improper prior; supply μ_0 and $\beta > 1$, $\kappa \geq 1$ for the proper prior. Uses a Newton-within-EM algorithm.

Usage

```
mode_alphaEM(
  n,
  p,
  xbar,
  ldetxbarg,
  mu0_ = NULL,
  beta = 0,
  eta = 1,
  kappa = 0,
  tol = 1e-06,
  prnt = FALSE,
  max_em_iter = 1000L,
  max_nr_iter = 100L
)
```

Arguments

n	Number of Wishart observations
p	Dimension
xbar	Sample mean matrix (p x p)
ldetxbarg	Log geometric mean of determinants
mu0_	Prior center matrix (p x p); omit for improper prior
beta	Gamma prior shape, must be > 1 (ignored if improper)
eta	Gamma prior rate (ignored if improper)
kappa	inv-Wishart prior strength, must be >= 1 (ignored if improper)
tol	Convergence tolerance
prnt	If TRUE, print EM iterates and bounds
max_em_iter	Maximum number of EM iterations
max_nr_iter	Maximum number of inner Newton-Raphson iterations

Value

A numeric vector $c(\text{ahat}, \log f^*(\text{ahat}))$

rejection_sampler	<i>Rejection sampler for the joint posterior of (alpha, mu)</i>
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Description

Requires the posterior mode `ahat` and `mxlfa = log f*(ahat)` from `mode_alphaEM()`, plus the covering Gamma parameters `lambda` and `nu_star`. Prior type is auto-detected from parameters, exactly as in `mode_alphaEM()`.

Usage

```
rejection_sampler(
  ahat,
  mxlfa,
  lambda,
  nu_star,
  p,
  n,
  xbar,
  ldetxbarg,
  mu0_ = NULL,
  beta = 0,
  eta = 1,
  kappa = 0,
  nsamp = 10000L
)
```

Arguments

ahat	Posterior mode from mode_alphaEM()[1]
mxlfa	log f*(ahat) from mode_alphaEM()[2]
lambda	Covering Gamma rate
nu_star	Covering Gamma shape (= ahat*lambda + 1)
p	Dimension
n	Number of Wishart observations
xbar	Sample mean matrix (p x p)
ldetxbarg	Log geometric mean of determinants
mu0_	Prior center matrix; omit for improper prior
beta	Gamma prior shape; 0 = improper, must be > 1 if proper
eta	Gamma prior rate; default 1.0
kappa	inv-Wishart prior strength; 0 = improper, must be >= 1 if proper
nsamp	Number of posterior samples (default 10000)

Value

A list with alpha_sample, mu_sample, empirical_acpt_rate, theoretical_acpt_rate

rwishart	<i>Generate draws from a Wishart distribution</i>
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Description

Uses the Bartlett decomposition: if L is the lower Cholesky factor of Sigma, then $A = L * T$ satisfies $W = A * A^T \sim \text{Wishart}_p(\text{nu}, \text{Sigma})$, where T is lower triangular with $T(i,i) \sim \sqrt{\text{Chi}^2(\text{nu} - i)}$ and $T(i,j) \sim N(0,1)$ for $i > j$.

Usage

```
rwishart(n, p, nu, Sigma)
```

Arguments

n	Number of draws
p	Dimension of the matrix, must be >= 2
nu	Degrees of freedom, must be > p - 1
Sigma	Scale matrix (p x p), must be positive definite

Value

A cube of size (p, p, n) containing the Wishart draws

test	<i>Hello-world test to verify the library loaded correctly</i>
------	--

Description

Hello-world test to verify the library loaded correctly

Usage

```
test()
```

Value

Always returns 0. Also prints "Hello from C++" as a side effect.

wishart_inference	<i>Bayesian inference for the Wishart shape parameter</i>
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Description

Given $X_1, \dots, X_n \sim \text{iid Wishart}_p(2\alpha, \Sigma)$, computes the posterior of (α, μ) where $\mu = \alpha \Sigma$, under either an improper or proper prior. Runs the full pipeline: sufficient statistics, EM mode finding, and rejection sampling.

Usage

```
wishart_inference(
  X,
  mu0_ = NULL,
  beta = 0,
  eta = 1,
  kappa = 0,
  nsamp = 10000L,
  tol = 1e-06,
  prnt = FALSE,
  max_em_iter = 1000L,
  max_nr_iter = 100L
)
```

Arguments

X	Cube of n Wishart observations, dimensions (p, p, n)
mu0_	Prior center matrix (p x p); omit for improper prior
beta	Gamma prior shape, must be > 1 (ignored if improper)
eta	Gamma prior rate parameter (ignored if improper)

kappa	inv-Wishart prior strength, must be ≥ 1 (ignored if improper)
nsamp	Number of posterior samples
tol	Convergence tolerance for the EM mode finder
prnt	If TRUE, print EM iterates
max_em_iter	Maximum number of EM iterations
max_nr_iter	Maximum number of inner Newton-Raphson iterations

Value

A list with results (alpha_samples, mu_samples, ahat, theoretical_acpt_rate, empirical_acpt_rate) and statistics (xbar, muhat, log_det_geometric_mean, cover_shape, cover_rate, elapsed_seconds). If a convergence failure is caught internally, returns list(error = "...") instead.

wishart_stats	<i>Compute sufficient statistics for Wishart observations</i>
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Description

Returns the sample mean matrix xbar and the log geometric mean of determinants ldetxbarg, the sufficient statistics for (alpha, Sigma) under $X_i \sim \text{Wishart}_p(2*\alpha, \text{Sigma})$.

Usage

```
wishart_stats(X)
```

Arguments

X Cube of n Wishart draws, dimensions (p, p, n)

Value

A list with xbar (p x p sample mean matrix) and ldetxbarg (log geometric mean of determinants)

Index

ldet, [2](#)
lfafun_improper, [2](#)
lfafun_proper, [3](#)
lgammap_export, [4](#)

mode_alphaEM, [4](#)

rejection_sampler, [5](#)
rwishart, [6](#)

test, [7](#)

wishart_inference, [7](#)
wishart_stats, [8](#)