

# Package ‘Homework1’

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**Type** Package

**Title** Advanced Statistics Computing HW1 Fast Algorithm

**Version** 1.0

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**Author** Yu Du<ydu@jhsph.edu>

**Maintainer** Yu Du<ydu@jhsph.edu>

**Description**

Homework 1 in Advanced Statistics Computing Class which includes two functions. One function is to fit a fast linear model and the other function is to calculate multivariate normal densities.

**License** GPL

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**Description**

Advanced Statistics Computing Homework 1 which includes fastlm() and dmvnorm() two functions.

**Details**

Package: Homework1  
Type: Package  
Version: 1.0  
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License: GPL

run `fastlm()` to fit a linear model and `dmvnorm()` to evaluate mvn density.

### Author(s)

Yu Du

Maintainer: Yu Du<ydu@jhsph.edu>

### References

Advanced Statistics Computing Class. Dr. Peng.

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dmvnorm

*Fast Multivariate Normal Density*

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### Description

Evaluates the k-dimensional multivariate Normal density with mean  $\mu$  and covariance matrix  $S$ .

### Usage

```
dmvnorm(x, mu, S, log = TRUE)
```

### Arguments

<code>x</code>	<code>x</code> is a n-by-k matrix with each row is a sample from a k-dimensional multivariate normal distribution
<code>mu</code>	<code>mu</code> is the mean vector of length k for the given multivariate normal distribution.
<code>S</code>	<code>S</code> is the p-by-p variance covariance matrix for the given multivariate normal distribution.
<code>log</code>	if <code>log=TRUE</code> which is the default value, the logged density values will be returned otherwise the original density value will be returned.

### Details

This function evaluates the k-dimensional multivariate Normal density with mean  $\mu$  and covariance matrix  $S$ .

### Value

A vector of length n of density values will be returned. n is the number of rows of input matrix `x`.

### Author(s)

Yu Du

### References

Advanced Statistics Computing Class, Dr. Peng.

## Examples

```
## Create the covariance matrix
n <- 100
n2 <- n^2
xg <- seq(0, 1, length = n)
yg <- xg
g <- data.matrix(expand.grid(xg, yg))
D <- as.matrix(dist(g))
phi <- 5

S <- exp(-phi * D)
mu <- rep(0, n2)
set.seed(1)
x <- matrix(rnorm(n2), byrow = TRUE, ncol = n2)
dmvnorm(x, mu, S, log = TRUE)

## The function is currently defined as
function (x, mu, S, log = TRUE)
{
  k = length(mu)
  n = nrow(x)
  R = tryCatch({
    chol(S)
  }, error = function(e) {
    message("S is not positive definite")
  })
  logdetS = 2 * sum(log(diag(R)))
  T = x - rep(1, n) %*% t(mu)
  C = forwardsolve(t(R), t(T))
  term3 = diag(crossprod(C))
  fx = (-k/2) * log(2 * pi) - (1/2) * logdetS - (1/2) * term3
  if (log == TRUE) {
    fx = fx
  }
  else {
    fx = exp(fx)
  }
  return(fx)
}
```

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fastlm

*Fast Linear Model Fitting*


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## Description

fit a linear regression model to outcome data  $y$  and predictor data in a matrix  $X$ .

## Usage

```
fastlm(X, y, na.rm = FALSE)
```

**Arguments**

<code>X</code>	<code>X</code> is a design matrix including predictor data and intercept.
<code>y</code>	<code>y</code> is a vector of outcome data.
<code>na.rm</code>	<code>na.rm=TRUE</code> to remove NA values otherwise the default value is <code>FALSE</code> .

**Details**

This function fits a linear regression model to outcome data `y` and predictor data in a matrix `X`. Matrix `X` also includes the intercept, i.e. the design matrix. This is faster than `lm.fit()`.

**Value**

<code>coefficients</code>	The coefficients returned are the fitted regression coefficient to the input dataset.
<code>vcov</code>	The <code>vcov</code> returned is the variance-covariance matrix of the estimated coefficients.

**Author(s)**

Yu Du

**References**

Advanced Statistics Computing Class, Dr. Peng.

**Examples**

```
set.seed(2)
## Generate predictor matrix
n <- 100000
p <- 500
X <- cbind(1, matrix(rnorm(n * (p - 1)), n, p - 1))

## Coefficients
b <- rnorm(p)

## Response
y <- X %*% b + rnorm(n)

fit <- fastlm(X, y)
str(fit)

## The function is currently defined as
function (X, y, na.rm = FALSE)
{
  if (na.rm == TRUE) {
    r = cbind(X, y)
    X = X[complete.cases(r), ]
    y = as.matrix(y[complete.cases(r), ])
  }
  A = crossprod(X)
  B = crossprod(X, y)
  R = chol(A)
  Rbeta = forwardsolve(t(R), B)
  coefficients = backsolve(R, Rbeta)
```

```
    n = length(y)
    p = ncol(X)
    sigmahat2 = crossprod(y - X %*% coefficients)/(n - p)
    Ainv = chol2inv(R)
    vcov = as.numeric(sigmahat2) * Ainv
    return(list(coefficients = coefficients, vcov = vcov))
}
```

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