

# Package ‘dcurver’

May 8, 2026

**Version** 0.9.3

**Date** 2025-10-24

**Title** Utility Functions for Davidian Curves

**Description** A Davidian curve defines a seminonparametric density, whose shape and flexibility can be tuned by easy to estimate parameters. Since a special case of a Davidian curve is the standard normal density, Davidian curves can be used for relaxing normality assumption in statistical applications (Zhang & Davidian, 2001)  [<doi:10.1111/j.0006-341X.2001.00795.x>](https://doi.org/10.1111/j.0006-341X.2001.00795.x). This package provides the density function, the gradient of the loglikelihood and a random generator for Davidian curves.

**License** GPL-3

**URL** <https://github.com/oguzhanogreden/dcurver>

**BugReports** <https://github.com/oguzhanogreden/dcurver/issues>

**Imports** Rcpp (>= 0.12.14)

**LinkingTo** Rcpp, RcppArmadillo

**RoxygenNote** 7.3.2

**Encoding** UTF-8

**Suggests** testthat

**Language** en-US

**NeedsCompilation** yes

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**Repository** CRAN

**Date/Publication** 2025-10-24 16:10:09 UTC

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dc_grad	<i>Gradient of the log-likelihood of univariate Davidian curves</i>
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### Description

Provides the gradient for use in estimation.

### Usage

```
dc_grad(x, phi)
```

### Arguments

x	A vector of observations.
phi	phi Davidian curve parameters. A maximum of 10 parameters is allowed.

### Details

Woods & Lin (2009) provide the gradient (Equations 17 and 18). Note that the gradient is not defined for  $\phi = 0.0$ .

### References

Woods, C. M., & Lin, N. (2009). Item response theory with estimation of the latent density using Davidian curves. *Applied Psychological Measurement*, 33(2), 102-117. doi:10.1177/0146621608319512

### Examples

```
# The loglikelihood of a univariate Davidian curve is given by,
dc_LL <- function(phi, dat) {
  sum(log(ddc(dat, phi)))
}

# dc_grad can be used for obtaining the gradient of this loglikelihood as follows:
dc_LL_GR <- function(phi, dat) {
  colSums(dc_grad(dat, phi))
}

# This can be verified by numerical approximation.
# For instance, using numDeriv package:
## Not run:
phi <- c(-5, 2.5, 10)
```

```
d <- runif(10, -5, 5)
dc_LL_GR(phi, d)
numDeriv::grad(dc_LL, x = phi, dat = d)

phi <- c(-5, 0, 10)
dc_LL_GR(phi, d)

## End(Not run)
```

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ddc

*Density function for univariate Davidian curves*

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### Description

Returns the density for a vector of x.

### Usage

```
ddc(x, phi)
```

### Arguments

x                    vector of quantiles.  
phi                  Davidian curve parameters. A maximum of 10 parameters is allowed.

### Examples

```
curve(ddc(x, 1.570789), -6, 6) # Approximately normal.

phi <- c(77.32, 78.51, 76.33, 77.16)
curve(ddc(x, phi), -6, 6) # A bimodal density.
integrate(ddc, phi = phi, lower = -Inf, upper = Inf) # Integrates to 1.
```

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rdc

*Random samples from univariate Davidian curves*

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### Description

Returns n samples from a univariate Davidian curve.

### Usage

```
rdc(n, phi)
```

**Arguments**

`n`                    Number of observations to be sampled.  
`phi`                  Davidian curve parameters. A maximum of 10 parameters is allowed.

**Examples**

```
# Sample from the standard normal Davidian curve:  
hist(rdc(1000, 1.570789), xlim = c(-6, 6), ylim = c(0, 0.5), freq = FALSE, breaks = 20)  
curve(dnorm(x), -6, 6, col = "blue", lwd = 1, add = TRUE)  
curve(ddc(x, 1.570789), -6, 6, col = "red", lwd = 2, lty = 3, add = TRUE)
```

```
# Sample from a bimodal density:  
phi <- c(77.32, 78.51, 76.33, 77.16)  
hist(rdc(1000, phi), xlim = c(-6, 6), ylim = c(0, 0.4), freq = FALSE, breaks = "fd")  
curve(ddc(x, phi), -6, 6, col = "red", lwd = 2, lty = 3, add = TRUE)
```

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