

# Package ‘optimCheck’

October 9, 2019

**Type** Package

**Title** Graphical and Numerical Checks for Mode-Finding Routines

**Version** 1.0

**Date** 2019-10-06

**Author** Martin Lysy

**Maintainer** Martin Lysy <mlysy@uwaterloo.ca>

## Description

Tools for checking that the output of an optimization algorithm is indeed at a local mode of the objective function. This is accomplished graphically by calculating all one-dimensional “projection plots” of the objective function, i.e., varying each input variable one at a time with all other elements of the potential solution being fixed. The numerical values in these plots can be readily extracted for the purpose of automated and systematic unit-testing of optimization routines.

**URL** <https://github.com/mlysy/optimCheck>

**BugReports** <https://github.com/mlysy/optimCheck/issues>

**License** GPL-3

**Imports** stats, graphics

**RoxygenNote** 6.1.1

**Encoding** UTF-8

**Suggests** testthat, quantreg, mclust, knitr, rmarkdown

**VignetteBuilder** knitr

**NeedsCompilation** no

**Repository** CRAN

**Date/Publication** 2019-10-09 08:40:02 UTC

## R topics documented:

diff.optcheck . . . . .	2
optimCheck . . . . .	3
optim_proj . . . . .	4

optim_refit . . . . .	5
plot.optproj . . . . .	6
print.optcheck . . . . .	7
summary.optproj . . . . .	8
summary.optrefit . . . . .	9

<b>Index</b>	<b>10</b>
--------------	-----------

---

diff.optcheck	<i>Elementwise difference between potential and optimal solutions.</i>
---------------	--

---

## Description

Elementwise difference between potential and optimal solutions.

## Usage

```
## S3 method for class 'optcheck'
diff(x, ...)

## S3 method for class 'summary.optcheck'
diff(x, ...)
```

## Arguments

x	Object of class <code>optcheck</code> or <code>summary.optcheck</code> , currently returned by <code>optim_proj</code> , <code>optim_refit</code> , or a summary of either of those calls.
...	Further arguments to be passed to or from other methods.

## Details

This function is simply a wrapper to `summary(x)$xdiff` and `x$xdiff`, for `optcheck` and `summary.optcheck` objects respectively.

## Value

A two-column matrix consisting of the absolute and relative differences between the potential and optimal solutions (`xsol` and `xopt`).

**Description**

Graphical and numerical checks for mode-finding routines.

**Examples**

```
# example: logistic regression
ilogit <- binomial()$linkinv

# generate data
p <- sample(2:10,1) # number of parameters
n <- sample(1000:2000,1) # number of observations
X <- matrix(rnorm(n*p),n,p) # design matrix
beta0 <- rnorm(p, sd = .1) # true parameter values
y <- rbinom(n, size = 1, prob = ilogit(X %*% beta0)) # response

# fit logistic regression
bhat <- coef(glm(y ~ X - 1, family = binomial))

# check convergence

# likelihood function
loglik <- function(beta, y, X) {
  sum(dbinom(y, size = 1, prob = ilogit(X %*% beta), log = TRUE))
}

# projection plots
bnames <- parse(text = paste0("beta[", 1:p, "]"))
system.time({
  oproj <- optim_proj(xsol = bhat,
                    fun = function(beta) loglik(beta, y, X),
                    xnames = bnames,
                    xlab = "Coefficient", ylab = "Loglikelihood")
})

# numerical summary
oproj # see ?summary.optproj for more information

# elementwise differences between potential and optimal solution
diff(oproj) # same as summary(oproj)$xdiff

# refit general purpose optimizer starting from bhat
# often faster than optim_proj, but less stable
system.time({
  orefit <- optim_refit(xsol = bhat,
                      fun = function(beta) loglik(beta, y, X))
})
orefit
```

---

 optim\_proj

*Projection plot test.*


---

### Description

Given the objective function of an optimization problem and a potential solution, calculates "projection plots" along each coordinate of the solution vector, with all other coordinates being fixed at the input values.

### Usage

```
optim_proj(xsol, fun, maximize = TRUE, xrng = 0.1, npts = 100,
           plot = TRUE, ...)
```

### Arguments

xsol	Potential solution vector of length nx.
fun	Objective function to be maximized (or minimized), with first argument the length-nx parameter vector over which optimization is to take place. Should return a scalar result.
maximize	Logical, whether a maximum or a minimum of the objective function is sought.
xrng	Optional specification of the range of each projection plot. Can be: (i) a 2 x nx matrix giving the endpoints of the range, (ii) a scalar or vector of length nx, such that the range in each plot is $\text{theta} \pm \text{xrng} * \text{abs}(\text{theta})$ .
npts	Number of points in each projection plot.
plot	Logical, whether or not to display the projection plots or just return their contents.
...	Further arguments to pass to the plot method (see <a href="#">plot.optproj</a> ).

### Value

An object of class `optproj` inheriting from `optcheck` (returned invisibly if `plot = TRUE`, with elements:

`xsol` The potential solution.

`ysol` The value of `fun(xsol)`.

`maximize` Logical indicating whether the potential solution should maximize or minimize the objective function.

`xproj` An `npts x nx` matrix where each column is the x-axis of the projection plot along the given component of `theta`.

`yproj` An `npts x nx` matrix where each column is the y-axis of the corresponding projection plot.

### See Also

`plot`, `summary`, `print`, and `diff` methods for projection plots are available; see `plot.optproj`, `summary.optproj`, `print.optproj`, and `diff.optproj`.

---

optim_refit	<i>Refined optimization test.</i>
-------------	-----------------------------------

---

### Description

If the potential solution is indeed a local optimum of the objective function, and if it is used to initialize a second optimization, then original and "refined" solutions ought to be close.

### Usage

```
optim_refit(xsol, fun, maximize = TRUE, maxit = 5000, reltol = 1e-08,
            xopt)
```

### Arguments

xsol	Potential solution vector of length nx.
fun	Objective function to be maximized (or minimized), with first argument the length-nx parameter vector over which optimization is to take place. Should return a scalar result.
maximize	Logical, whether a maximum or a minimum of the objective function is sought.
maxit	Maximum number of iterations for <code>optim</code> refit (see Details).
reltol	Relative tolerance for convergence of <code>optim</code> refit (see Details).
xopt	Optional refit solution calculated externally from an optimization algorithm of choice (see Details).

### Details

By default, a so-called *refined optimization* (or refit) test is performed by running the default Nelder-Mead simplex method provided by `optim`, initialized by the potential solution `xsol`. Only a simplified interface to `optim`'s control parameters are provided here.

Alternatively, the refit test can be performed with any optimization algorithm of choice. This is done externally, with the refined solution passed to `optim_refit` via the argument `xopt`.

### Value

An object of class `optrefit` inheriting from `optcheck`, with elements:

xsol	The potential solution.
ysol	The value of <code>fun(xsol)</code> .
maximize	Logical indicating whether the potential solution should maximize or minimize the objective function.
xopt	The solution found by the general-purpose optimizer.
yopt	The function value at the optimal solution, i.e., <code>fun(xopt)</code> .

**See Also**

summary, print, and diff for optrefit objects are available; see [summary.optrefit](#), [print.optrefit](#), and [diff.optrefit](#).

---

plot.optproj	<i>Projection plots for optimization routines.</i>
--------------	--

---

**Description**

Projection plots for optimization routines.

**Usage**

```
## S3 method for class 'optproj'
plot(x, xnames, xind, equalize = FALSE, layout, xlab,
     ylab, ...)
```

**Arguments**

x	An optproj object, i.e., output from function <a href="#">optim_proj</a> .
xnames	Optional vector of element names of potential solution for plot titles.
xind	Integer or logical vector of indices indicating which projections should be plotted. Defaults to all projection plots.
equalize	If TRUE, narrows the range in each projection plot such that the y-value is more or less the same at either endpoint.
layout	Optional vector giving the number of rows and columns in the plot layout. For nx plots, defaults to <code>c(nr, nc)</code> , where <code>nr = floor(nx)</code> and <code>nc = ceiling(nx/nr)</code> .
xlab, ylab	Outer x-axis and y-axis labels.
...	Further arguments to be passed to or from other methods.

**Value**

A grid of projection plots, with vertical lines at the potential solution.

---

print.optcheck	<i>Print method for optcheck and summary.optcheck objects.</i>
----------------	--

---

## Description

Print method for optcheck and summary.optcheck objects.

## Usage

```
## S3 method for class 'optcheck'  
print(x, digits = max(3L, getOption("digits") - 3L),  
      n = 5L, ...)  
  
## S3 method for class 'summary.optcheck'  
print(x, digits = max(3L, getOption("digits")  
      - 3L), n = 5L, ...)
```

## Arguments

x	Object of class optcheck or summary.optcheck, currently returned by <a href="#">optim_proj</a> , <a href="#">optim_refit</a> , or a summary of either of those calls.
digits	Number of digits to display.
n	Number of elements of solution vector to display (see Details).
...	Further arguments to be passed to or from other methods.

## Details

The print methods for optcheck and summary.optcheck objects both display three-column matrix, consisting of the potential solution (xsol), the absolute difference between it and the optimal solution (xopt) return by either [optim\\_proj](#) and [optim\\_refit](#), and the relative difference ( $R = (xopt - xsol) / |xsol|$ ). Only the elements corresponding to the top-n relative differences are displayed.

## Value

Invisibly x itself.

---

summary.optproj      *summary method for projection plots.*

---

### Description

summary method for projection plots.

### Usage

```
## S3 method for class 'optproj'
summary(object, xnames, ...)
```

### Arguments

object	An optproj object, i.e., output from the function <code>optim_proj</code> .
xnames	Optional vector of names for the elements of the potential solution.
...	Further arguments to be passed to or from other methods.

### Details

The print methods for `summary.optproj` and `optproj` objects themselves both return a three-column matrix, consisting of the potential solution (`xsol`), the optimal solution in each projection plot (`xopt`), and the relative difference between the two ( $R = (xopt - xsol) / |xsol|$ ).

### Value

An object of class `summary.optproj` inheriting from `summary.optcheck`, with elements:

`xsol` The potential solution vector.

`ysol` The value of the objective function at `xsol`.

`maximize` Logical indicating whether the potential solution should maximize or minimize the objective function.

`xopt` A vector containing the argmax/argmin in each projection plot.

`yopt` A vector containing the max/min in each projection plot.

`xdiff` A two-column matrix containing the differences between `xsol` and `xopt`. The first column is the absolute difference  $D = xopt - xsol$ , the second is the relative difference  $R = D / |xsol|$ .

`ydiff` Same thing, but between `ysol` and `yopt`.

### See Also

`print.summary.optproj` for print method.



---

summary.optrefit	summary method for optrefit objects.
------------------	--------------------------------------

---

**Description**

summary method for optrefit objects.

**Usage**

```
## S3 method for class 'optrefit'
summary(object, xnames, ...)
```

**Arguments**

object	An optrefit object, i.e., output from the function <a href="#">optim_refit</a> .
xnames	Optional vector of names for the elements of the potential solution.
...	Further arguments to be passed to or from other methods.

**Value**

An object of class `summary.optrefit` inheriting from `summary.optcheck`, with elements:

`xsol` The potential solution vector.

`ysol` The value of the objective function at `xsol`.

`maximize` Logical indicating whether the potential solution should maximize or minimize the objective function.

`xopt` A vector containing the argmax/argmin in each projection plot.

`yopt` The scalar value of the max/min found by `optim_refit`.

`xdiff` A two-column matrix containing the differences between `xsol` and `xopt`. The first column is the absolute difference  $D = xopt - xsol$ , the second is the relative difference  $R = D / |xsol|$ .

`ydiff` A length-two vector containing the absolute and relative difference between `ysol` and `yopt`.

**See Also**

[print.summary.optcheck](#) for print method.

# Index

diff.optcheck, 2  
diff.optproj, 4  
diff.optproj (diff.optcheck), 2  
diff.optrefit, 6  
diff.optrefit (diff.optcheck), 2  
diff.summary.optcheck (diff.optcheck), 2  
diff.summary.optproj (diff.optcheck), 2  
diff.summary.optrefit (diff.optcheck), 2

optim, 5  
optim\_proj, 2, 4, 6–8  
optim\_refit, 2, 5, 7, 9  
optimCheck, 3  
optimCheck-package (optimCheck), 3

plot.optproj, 4, 6  
print.optcheck, 7  
print.optproj, 4  
print.optproj (print.optcheck), 7  
print.optrefit, 6  
print.optrefit (print.optcheck), 7  
print.summary.optcheck, 9  
print.summary.optcheck  
    (print.optcheck), 7  
print.summary.optproj, 8  
print.summary.optproj (print.optcheck),  
    7  
print.summary.optrefit  
    (print.optcheck), 7

summary.optproj, 4, 8  
summary.optrefit, 6, 9