RcppGO User Guide

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17 nov 2014

Contents

1 Introduction

RcppGO is a package designed for optimization problems. The code was originally written in *Cpp*. With the use of the *Rcpp* package by (Eddelbuettel et al. 2011) it is now translated into *R*. Newton's laws of gravity and motion are the basis of the algorithm as described in (Kaveh and Talatahari 2010). *RcppGO* is an allusion to the integration of *Rcpp*, the concept of *Gravity* at the core of the algorithm and *Optimization* as the purpose of the package.

2 Installation

RcppGO is hosted at https://github.com/peterkehlerjr/RcppGO. The installation via *github* requires the package *devtools* (Wickham and Chang 2014). Assuming *devtools* is not present in your library, the installation is done via:

```
install.packages("devtools")
library(devtools)
install_github('peterkehlerjr/RcppGO')
```

3 Examples

After installing the required packages, they have to be loaded into *R*.

```
## Loading required package: Rcpp
## Loading required package: RcppArmadillo
## Loading required package: lattice
## Now loading:
## RcppGO: global optimization algorithm using the laws of gravity and motion
## Author: Peter Kehler
## Loosely based on the CSS algorithm described in:
##   A novel heuristic optimization method: charged system search
##   Acta Mechanica 213, p. 267-289 (2010)
##   by A. Kaveh and S. Talatahari
```

Now we can start to play around with the package. Before going into detail, I will present two examples how to use its functionality.

3.1 Example 1

Let's have a look at our first example. Say, we have a cost function defined by the following objective function:

$$f(x) = (x-2)^2 + 3, x \in \mathbf{N}, x \geqq 1$$

The objective is to find the minimum costs given a quantity of our product.

Defining the objective function in *R* is straight forward. We will call it *Fun01*.

```
Fun01 <- function(X)
  {
   (X-3)^2 + 4
  }
```

Let's look at a plot of *Fun01*:

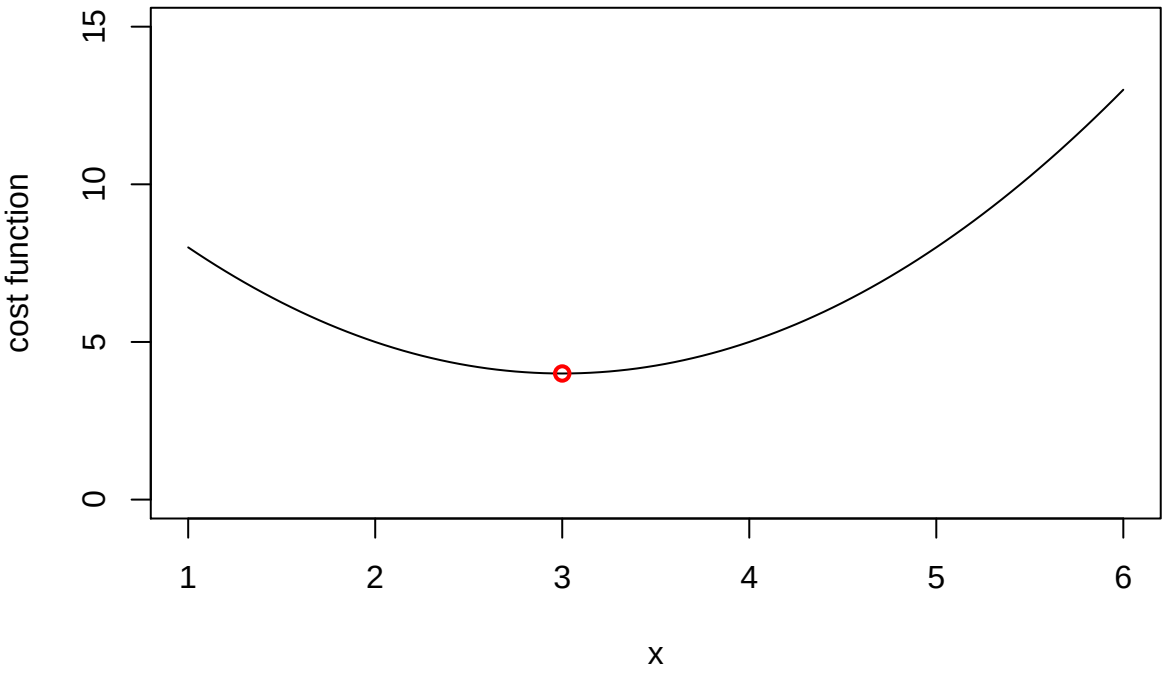
```
plot(Fun01, xlim=c(1,6), ylim = c(0,15),ylab = "cost function")
points(x = 3, y = 4, lwd=2, col="red")
```

Now let us

```
Example01 <- RcppGO(ObjectiveFunction = Fun01,
                    Args = 1,
                    Lower = -10,
                    Upper = 10
                    )
```

```
str(Example01)
```

```
## List of 12
##  $ GravityParticles : num [1:20, 1:4, 1:201] -10 -10 -10 -10 -10 ...
##   ..- attr(*, "dimnames")=List of 3
##   .. ..$ : chr [1:20] "1" "2" "3" "4" ...
```



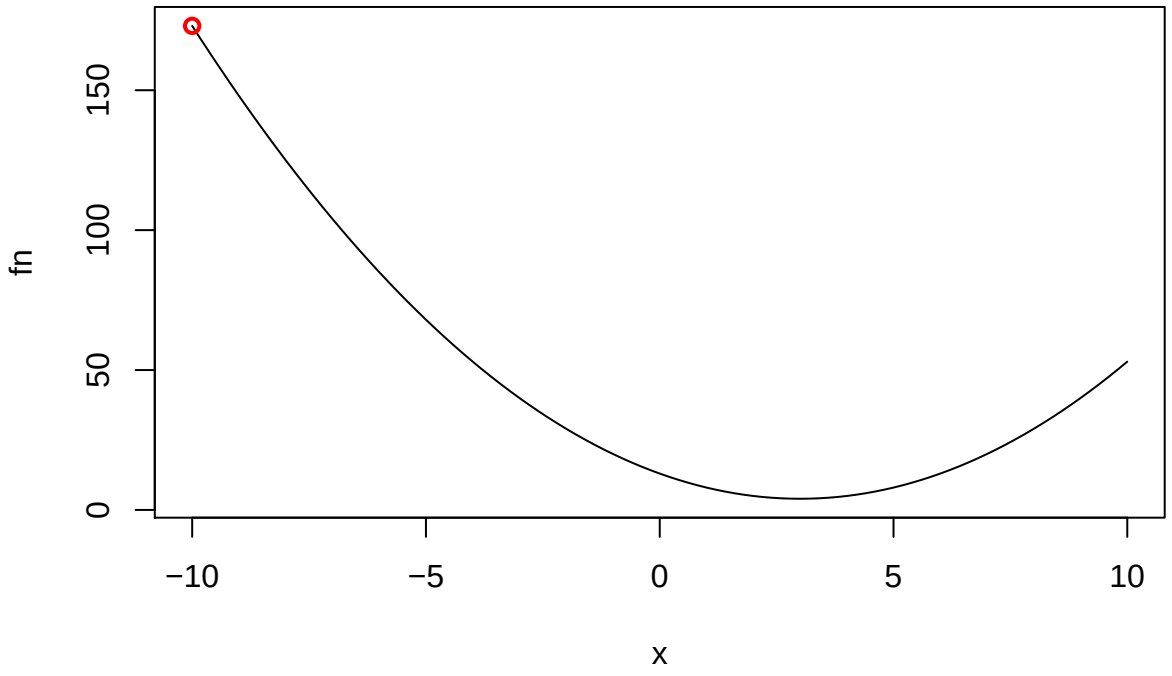

```
##   .. ..$ : chr [1:4] "x1" "fn_x" "v_x1" "F_x1"
##   .. ..$ : NULL
##  $ ObjectiveFunction:function (X)
##   ..- attr(*, "srcref")=Class 'srcref'  atomic [1:8] 1 10 4 3 10 3 1 4
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x7f93aa3cb740>
##  $ GMemory          : num [1:20, 1:2] -10 -10 -10 -10 -10 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:20] "1" "2" "3" "4" ...
##   .. ..$ : chr [1:2] "x1" "fn_x"
##  $ Iterations       : num 201
##  $ Args             : int 1
##  $ n                : int 20
##  $ g                : int 20
##  $ Lower            : num -10
##  $ Upper            : num 10
##  $ Scale            : num 0.1
##  $ User             : logi FALSE
##  $ Maximize         : logi FALSE
##  - attr(*, "class")= chr "RcppGO"
```

```
Example01$GMemory
```

```
##     x1 fn_x
## 1  -10  173
## 2  -10  173
## 3  -10  173
## 4  -10  173
## 5  -10  173
## 6  -10  173
## 7  -10  173
## 8  -10  173
```

```
## 9  -10  173
## 10 -10  173
## 11 -10  173
## 12 -10  173
## 13 -10  173
## 14 -10  173
## 15 -10  173
## 16 -10  173
## 17 -10  173
## 18 -10  173
## 19 -10  173
## 20 -10  173
```

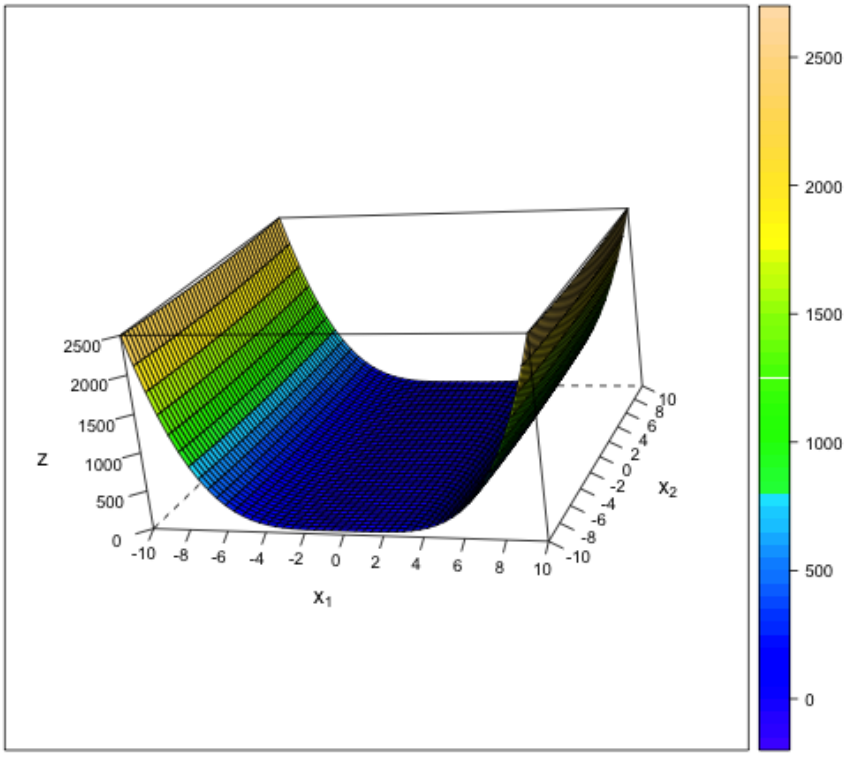
```
plot(x=Example01, xlim = c(-10,10), bestsolution = TRUE)
```



3.2 Example 2

to bit more complicated objective function.

$$f(x,y) = \frac{1}{4}x^4 - \frac{1}{2}x^2 + \frac{1}{10}x + \frac{1}{2}y^2$$



Let's look for the minimum of the function.

```
# defining a benchmark function min at -0.352386, X in [-10,10]^2
AluffiPentiny <- function(X) {
    1/4 * X[, 1]^4 - 1/2 * X[, 1]^2 + 1/10 * X[, 1] + 1/2 * X[, 2]^2
}
```

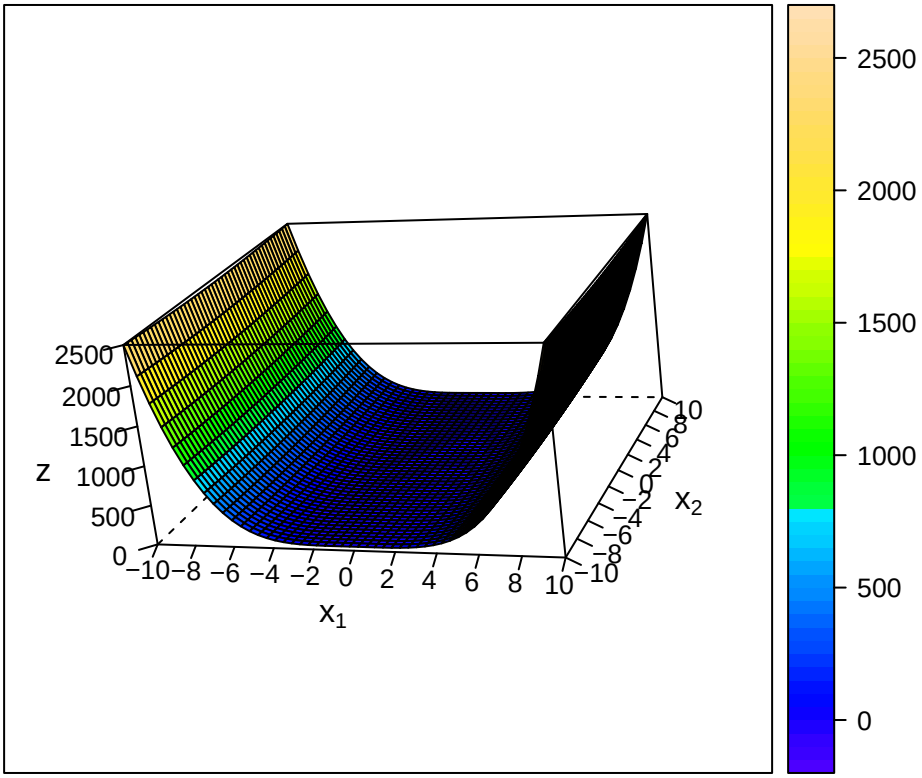
```
# call and save the optimization process in 'demo01''
demo01 <- RcppGO(ObjectiveFunction=AluffiPentiny,
                 Args=2,
                 Lower = -10,
                 Upper = 10,
                 User=FALSE,
                 Scale=0.1)

# show the best solutions found
demo01$GMemory
```

```
##     x1  x2 fn_x
## 1  -10 -10 2499
## 2  -10 -10 2499
## 3  -10 -10 2499
## 4  -10 -10 2499
## 5  -10 -10 2499
## 6  -10 -10 2499
## 7  -10 -10 2499
## 8  -10 -10 2499
## 9  -10 -10 2499
```

```
## 10 -10 -10 2499
## 11 -10 -10 2499
## 12 -10 -10 2499
## 13 -10 -10 2499
## 14 -10 -10 2499
## 15 -10 -10 2499
## 16 -10 -10 2499
## 17 -10 -10 2499
## 18 -10 -10 2499
## 19 -10 -10 2499
## 20 -10 -10 2499
```

```
plot(x=demo01, plot.type = "wireframe", bestsolution = TRUE)
```



4 The two main functions

5 The RcppGO function

5.1 Parameters

6 The plot.RcppGO method

6.1 Parameters

7 Session Info

```
## R version 3.1.2 (2014-10-31)
## Platform: x86_64-apple-darwin13.4.0 (64-bit)
##
## locale:
## [1] en_GB.UTF-8/en_GB.UTF-8/en_GB.UTF-8/C/en_GB.UTF-8/en_GB.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] RcppGO_0.1              lattice_0.20-29         RcppArmadillo_0.4.500.0
## [4] Rcpp_0.11.3
##
## loaded via a namespace (and not attached):
##  [1] digest_0.6.4     evaluate_0.5.5   formatR_1.0      grid_3.1.2
##  [5] htmltools_0.2.6  knitr_1.8        rmarkdown_0.3.10 stringr_0.6.2
##  [9] tools_3.1.2      yaml_2.1.13
```

References

Eddelbuettel, Dirk, Romain François, J Allaire, John Chambers, Douglas Bates, and Kevin Ushey. 2011. "Rcpp: Seamless R and C++ Integration." *Journal of Statistical Software* 40 (8): 1–18.

Kaveh, A, and S Talatahari. 2010. "A Novel Heuristic Optimization Method: Charged System Search." *Acta Mechanica* 213 (3-4): 267–89. doi:10.1007/s00707-009-0270-4.

Wickham, Hadley, and Winston Chang. 2014. *devtools: Tools to Make Developing R Code Easier*. http://CRAN.R-project.org/package=devtools.