

# Package ‘ConConPiWiFun’

November 18, 2015

**Type** Package

**Title** Optimisation with Continuous Convex Piecewise (Linear and Quadratic) Functions

**Version** 0.4.6

**Date** 2013-06-05

**Author** Robin Girard

**Maintainer** Robin Girard <robin.girard@mines-paristech.fr>

**Description** Continuous convex piecewise linear (ccpl) resp. quadratic (ccpq) functions can be implemented with sorted breakpoints and slopes. This includes functions that are ccpl (resp. ccpq) on a convex set (i.e. an interval or a point) and infinite out of the domain. These functions can be very useful for a large class of optimisation problems. Efficient manipulation (such as  $\log(N)$  insertion) of such data structure is obtained with map standard template library of C++ (that hides balanced trees). This package is a wrapper on such a class based on Rcpp modules.

**License** GPL ( $\geq 2$ )

**Depends** methods, graphics, Rcpp ( $\geq 0.10.3$ )

**LinkingTo** Rcpp

**RcppModules** mod\_cpfunction,mod\_cpqfunction

**NeedsCompilation** yes

**Repository** CRAN

**Date/Publication** 2015-11-18 09:31:01

## R topics documented:

ConConPiWiFun-package	2
cpfunction	3
cpfunctionvec	4
cpqfunction	5
cpqfunctionvec	7
OptimPriceStorage	8

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

ConConPiWiFun-package *This package contains an implementation of continuous convex piecewise (linear) functions (quadratic coming soon)*

---

## Description

Continuous convex piecewise linear (ccpl) resp. quadratic (ccpq) functions can be implemented with sorted breakpoints and slopes. This includes functions that are ccpl (resp. ccpq) on a convex set (i.e. an interval or a point) and infinite out of the domain. These functions can be very useful for a large class of optimisation problems. Efficient manipulation (such as  $\log(N)$  insertion) of such data structure is obtained with map standard template library of C++ (that hides balanced trees). This package is a wrapper on such a class based on Rcpp modules.

## Details

Package: ConConPiWiFun  
Type: Package  
Version: 0.3.0  
Date: 2013-02-08  
License: GPL

## Author(s)

Robin Girard

Maintainer: <robin.girard@mines-paristech.fr>

## References

Related Papers are

## Examples

```
library(ConConPiWiFun)
#### See
#? cplfunction for continuous convex piecewise functions
#? cplfunctionvec for (optimized) list of continuous convex piecewise functions
```

---

cplfunction

*This class implements continuous convex piecewise linear functions*


---

## Description

This includes functions that are ccpl (resp. ccpq) on a convex set (i.e. an interval or a point) and infinite out of the domain. These functions can be very useful for a large class of optimisation problems. Efficient manipulation (such as  $\log(N)$  insertion) of such data structure is obtained with map standard template library of C++ (that hides balanced trees). This package is a wrapper on such a class based on Rcpp modules.

## Author(s)

Robin Girard

## See Also

to See Also as [cplfunction](#),

## Examples

```
##
#Construction of a piecewise linear function
##

Slopes=c(-1,2,Inf) # increasing ! convexity is required
Breakpoints=c(-Inf,2,4) # increasing. length is number of slopes +1
FirstNonInfBreakpointVal=3
CCPWLfunc1=new(cplfunction,Slopes,Breakpoints,FirstNonInfBreakpointVal)
plot(CCPWLfunc1) #visualisation method

###Etoile transformation (legendre transform of f)
# Changes f no return value
CCPWLfunc1$Etoile()
plot(CCPWLfunc1) #if f = CCPWLfunc1 CCPWLfunc1 becomes is f*(y) =inf_x {xy-f(x)}
CCPWLfunc1$Etoile()
plot(CCPWLfunc1) ## (f^*)^* is f !

###Squeeze function
# Changes f, no return value
left=-Inf; right=3
CCPWLfunc1$Squeeze(left,right) # CCPWLfunc1 is now infinite (or not definite) out of [left,right]
# i.e. all breakpoints out of [left,right] removed

###Swap function
```

```

# Changes f no return value !
y=2;
CCPWLfunc1$Swap(y)
plot(CCPWLfunc1); #now f = CCPWLfunc1 is replaced by x -> f(y-x)

### Sum function (uses fast insertion) do not affect operands
CCPWLfunc1=new(cplfunction,c(-1,2,Inf) ,c(-Inf,2,4),0)
CCPWLfunc2=new(cplfunction,c(-1,2,Inf),c(-Inf,1,3),0)
CCPWLfunc1plus2=Sum1(CCPWLfunc1,CCPWLfunc2)
CCPWLfunc1plus2

par(mfrow=c(1,3))
plot(CCPWLfunc2,col='red');
plot(CCPWLfunc1,col='blue');
plot(CCPWLfunc1plus2);

rm(list=ls())
gc()

```

---

cplfunctionvec

*This class implements "optimized list" of continuous convex piecewise linear functions*

---

### Description

This is a wrapper to stl vector of convex piecewise linear functions. Allows to loop efficiently on such list.

### Author(s)

Robin Girard

### See Also

to See Also as [cplfunction](#), [cpqfunctionvec](#)

### Examples

```

####
# construction of a vector of
# continuous convex piecewise linear functions

CCPWLfuncList=new(cplfunctionvec)

```

```

CCPWLfuncList$push_back(new(cplfunction,c(-1,1) ,c(-Inf,0),0))
CCPWLfuncList$push_back(new(cplfunction,c(-1,1) ,c(-Inf,0),0))

CCPWLfuncList=new(cplfunctionvec)
n=1000; Y=rnorm(n); S1=array(-1,n);S2=array(1,n); B0=array(-Inf,n); B1=rnorm(n);
for (i in 1:n){
  CCPWLfuncList$push_back(new(cplfunction,c(S1[i],S2[i]) ,c(B0[i],B1[i]),0))
}
CCPWLfuncList$size() ## gives the size
## The same but faster
CCPWLfuncList=new(cplfunctionvec)
CCPWLfuncList$SerialPush_2Breaks_Functions(S1,S2,B0,B1);

#### method OptimMargInt solves
#      min_x sum_i=1^n C_i(x_i)
#      Pmoins_i<= x_i <=Pplus_i  i=1,...,n
# Cmoins_i<= sum_j=1^i x_j <=Cplus_i  i=1,...,n

Pmoins=array(-1,n);Pplus=array(1,n);Cmoins=array(0,n);Cplus=array(5,n);
res=CCPWLfuncList$OptimMargInt(Pmoins,Pplus,Cmoins,Cplus)

par(mfrow=c(1,2))
plot(Y,type='l',ylim=range(res$xEtoile))
lines(y=Pmoins,x=1:n,col='blue'); lines(y=Pplus,x=1:n,col='blue');
lines(y=res$xEtoile,x=1:n,col='red')
text(x=800,y=3,paste("Optimum=",signif(sum(abs(res$xEtoile-Y)),digits=6)))
plot(Y,type='l',ylim=c(min(Y),max(diffinv(res$xEtoile)[1:n+1])))
lines(y=Cmoins,x=1:n,col='blue'); lines(y=Cplus,x=1:n,col='blue');
lines(y=diffinv(res$xEtoile)[1:n+1],x=1:n,col='red')

rm(list=ls())
gc()

```

---

cpqfunction

*This class implements continuous convex piecewise quadratic functions*


---

### Description

This includes functions that are ccpq on a convex set (i.e. an interval or a point) and infinite out of the domain. These functions can be very useful for a large class of optimisation problems. Efficient manipulation (such as  $\log(N)$  insertion) of such data structure is obtained with map standard template library of C++ (that hides balanced trees). This package is a wrapper on such a class based on Rcpp modules.

### Author(s)

Robin Girard

**See Also**

to See Also as [cplfunction](#),

**Examples**

```
##
#Construction of a piecewise quadratic function
##
Slopes1=c(-1,2)
Slopes0=c(-2,0)# increasing ! convexity is required
Breakpoints=c(-Inf,2,4) # increasing. length is number of slopes +1
FirstNonInfBreakpointVal=3
CCPWLfunc1=new(cpqfunction,Slopes0,Slopes1,Breakpoints,FirstNonInfBreakpointVal)
CCPWLfunc1$get_BreakPoints_() ## return Breaks AND Slopes
plot(CCPWLfunc1)

###Etoile transformation (legendre transform of f)
# Changes f no return value
CCPWLfunc1$Etoile()
CCPWLfunc1$get_BreakPoints_()
CCPWLfunc1$Etoile()
CCPWLfunc1$get_BreakPoints_() ## (f^*)^* is f !

###Squeeze function
# Changes f, no return value
left=-1; right=4
CCPWLfunc1$Squeeze(left,right) # CCPWLfunc1 is now infinite (or not definite) out of [left,right]
# i.e. all breakpoints out of [left,right] removed
CCPWLfunc1$get_BreakPoints_()

###Swap function
# Changes f no return value !
y=2;
CCPWLfunc1$Swap(y)
CCPWLfunc1$get_BreakPoints_() #now f = CCPWLfunc1 is replaced by x -> f(y-x)

### Sum function (uses fast insertion) do not affect operands
CCPWLfunc1=new(cpqfunction,Slopes0,Slopes1,Breakpoints,FirstNonInfBreakpointVal)
CCPWLfunc2=new(cpqfunction,Slopes0,Slopes1+1,Breakpoints,FirstNonInfBreakpointVal)
CCPWLfunc1plus2=Sumq(CCPWLfunc1,CCPWLfunc2)
CCPWLfunc1plus2$get_BreakPoints_()

rm(list=ls())
gc()
```

---

cpqfunctionvec	<i>This class implements "optimized list" of continuous convex piecewise quadratic functions</i>
----------------	--

---

## Description

This is a wrapper to stl vector of convex piecewise quadratic functions. Allows to loop efficiently on such list.

## Author(s)

Robin Girard

## See Also

to See Also as [cpqfunction](#), [cplfunctionvec](#)

## Examples

```
CCPWLfuncList=new(cpqfunctionvec)
CCPWLfuncList$push_back(new(cpqfunction,c(0),c(1),c(-2, 2),0))
CCPWLfuncList$push_back(new(cpqfunction,c(0),c(1),c(-2, 2),0))

CCPWLfuncList=new(cpqfunctionvec)
n=1000; Y=rnorm(n); S0=array(0,n)+Y;S1=array(1,n)+Y; B0=array(-Inf,n); B1=array(Inf,n);
for (i in 1:n){
  CCPWLfuncList$push_back(new(cpqfunction,S0[i],S1[i] ,c(B0[i],B1[i]),0))
}
CCPWLfuncList$size() ## gives the size
## The same but faster
CCPWLfuncList=new(cpqfunctionvec)
CCPWLfuncList$SerialPush_0Breaks_Functions(S0,S1);

##### method OptimMargInt solves
#      min_x sum_i=1^n C_i(x_i)
#      Pmoins_i<= x_i <=Pplus_i  i=1,...,n
# Cmoins_i<= sum_j=1^i x_j <=Cplus_i  i=1,...,n

Pmoins=array(-1,n);Pplus=array(1,n);Cmoins=array(0,n);Cplus=array(5,n);
res=CCPWLfuncList$OptimMargInt(Pmoins,Pplus,Cmoins,Cplus)

par(mfrow=c(1,2))
plot(Y,type='l')
lines(y=Pmoins,x=1:n,col='blue'); lines(y=Pplus,x=1:n,col='blue');
lines(y=res$xEtoile,x=1:n,col='red')
text(x=800,y=3,paste("Optimum=", signif(sum(abs(res$xEtoile-Y)),digits=6)))
plot(Y,type='l',ylim=c(min(Y),max(diffinv(res$xEtoile)[1:n+1])))
lines(y=Cmoins,x=1:n,col='blue'); lines(y=Cplus,x=1:n,col='blue');
lines(y=diffinv(res$xEtoile)[1:n+1],x=1:n,col='red')
```

```
rm(list=ls())
gc()
```

---

OptimPriceStorage	<i>Optimisation of storage operation with market prices taking into account storage efficiency and network taxes.</i>
-------------------	---

---

### Description

Optimisation of storage operation with market prices taking into account storage efficiency and network taxes.

### Usage

```
OptimPriceStorage(Prices,Pplus,Pmoins,Cplus,Cmoins=0,
                  efficiencyS=0,efficiencyP=efficiencyS,networkTax=0)
```

### Arguments

Prices	A vector of prices
Pplus	A value for the upper power constraint or a vector of values with the same size as Prices
Pmoins	A value for the lower power constraint or a vector of values with the same size as Prices
Cplus	A value for the upper capacity constraint or a vector of values with the same size as Prices
Cmoins	A value for the lower capacity constraint or a vector of values with the same size as Prices
efficiencyS	storage efficiency when storing electricity
efficiencyP	storage efficiency when producing electricity
networkTax	networkTax

### Details

function OptimPriceStorage solves  $\# \min_x \sum_{i=1}^n Y_i \text{efficiencyP} x_i (x_i < 0) + (\sum_{i=1}^n Y_i \text{efficiencyS} + \text{networkTax}) x_i (x_i > 0)$   $\# P_{\text{moins}_i} \leq x_i \leq P_{\text{plus}_i} \ i=1, \dots, n$   $\# C_{\text{moins}_i} \leq \sum_{j=1}^i x_j \leq C_{\text{plus}_i} \ i=1, \dots, n$

when efficiency=1 and networkTax=0 this gives  $\# \min_x \sum_{i=1}^n Y_i x_i$   $\# P_{\text{moins}_i} \leq x_i \leq P_{\text{plus}_i} \ i=1, \dots, n$   $\# C_{\text{moins}_i} \leq \sum_{j=1}^i x_j \leq C_{\text{plus}_i} \ i=1, \dots, n$

**Value**

A list with

Operation	the optimal operation for each time step
Revenue	the revenue for each time step

**Note**

TODO

**Author(s)**

Robin Girard

**References**

TODO

**See Also**

to See Also [cplfunction](#) (method `OptimMargInt` that is more general)

**Examples**

```
n=8760
Prices=runif(n,1,100) ##uniform random prices in [1;100] in Euro/MWh
Pmax=1; Pmin=-1; Cmax=5; ## 1MW maximum during 5 hours.
res=OptimPriceStorage(Prices,Pmax,Pmin,Cmax) # solving the optimization problem
sum(res$Revenue)## Revenue
res=OptimPriceStorage(Prices,Pmax,Pmin,Cmax,efficiencyS=0.8) # solving the optimization problem
sum(res$Revenue)## Revenue
```

# Index

## \*Topic **Optimisation, Dynamic programming**

ConConPiWiFun-package, 2

## \*Topic **\textasciitildekw1**

cplfunction, 3

cplfunctionvec, 4

cpqfunction, 5

cpqfunctionvec, 7

OptimPriceStorage, 8

## \*Topic **\textasciitildekw2**

cplfunction, 3

cplfunctionvec, 4

cpqfunction, 5

cpqfunctionvec, 7

OptimPriceStorage, 8

ComputeMarketPrices

(OptimPriceStorage), 8

ConConPiWiFun (ConConPiWiFun-package), 2

ConConPiWiFun-package, 2

cplfunction, 3, 3, 4, 6, 9

cplfunctionvec, 4, 7

cpqfunction, 5, 7

cpqfunctionvec, 4, 7

InfConv1 (cplfunction), 3

InfConvq (cpqfunction), 5

OptimPriceMarket\_l (OptimPriceStorage),  
8

OptimPriceMarket\_q (OptimPriceStorage),  
8

OptimPriceStorage, 8

OptimPriceStorage\_ (OptimPriceStorage),  
8

plot, ANY-method (cplfunction), 3

plot, Rcpp\_cplfunction-method  
(cplfunction), 3

plot-methods (cplfunction), 3

Rcpp\_cplfunction-class (cplfunction), 3

Rcpp\_cplfunctionvec-class  
(cplfunctionvec), 4

Rcpp\_cpqfunction-class (cpqfunction), 5

Rcpp\_cpqfunctionvec-class  
(cpqfunctionvec), 7

SerialOptimPriceStorage  
(cplfunctionvec), 4

show, ANY-method (cpqfunction), 5

show, Rcpp\_cplfunction-method  
(cplfunction), 3

show, Rcpp\_cplfunctionvec-method  
(cplfunctionvec), 4

show, Rcpp\_cpqfunction-method  
(cpqfunction), 5

show, Rcpp\_cpqfunctionvec-method  
(cpqfunctionvec), 7

show-methods (cpqfunction), 5

Sum1 (cplfunction), 3

Sumq (cpqfunction), 5