

# Package ‘Rcsdp’

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**Version** 0.1.57.5

**Title** R Interface to the CSDP Semidefinite Programming Library

**Description** R interface to the CSDP semidefinite programming library. Installs version 6.1.1 of CSDP from the COIN-OR website if required. An existing installation of CSDP may be used by passing the proper configure arguments to the installation command. See the INSTALL file for further details.

**LazyLoad** yes

**Imports** methods

**Enhances** Matrix

**License** CPL-1.0

**URL** <https://github.com/coin-or/Csdp/>

**RoxygenNote** 7.0.2

**BugReports** <https://github.com/hcorrada/rcsdp/issues>

**NeedsCompilation** yes

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 csdp

 Solve semidefinite program with CSDP
 

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### Description

Interface to CSDP semidefinite programming library. The general statement of the primal problem is

$$\begin{aligned} \max \quad & \text{tr}(CX) \\ \text{s.t.} \quad & A(X) = b \\ & X \succeq 0 \end{aligned}$$

with  $A(X)_i = \text{tr}(A_i X)$  where  $X \succeq 0$  means  $X$  is positive semidefinite,  $C$  and all  $A_i$  are symmetric matrices of the same size and  $b$  is a vector of length  $m$ .

The dual of the problem is

$$\begin{aligned} \min \quad & b'y \\ \text{s.t.} \quad & A'(y) - C = Z \\ & Z \succeq 0 \end{aligned}$$

where  $A'(y) = \sum_{i=1}^m y_i A_i$ .

Matrices  $C$  and  $A_i$  are assumed to be block diagonal structured, and must be specified that way (see Details).

### Usage

```
csdp(C, A, b, K, control=csdp.control())
```

### Arguments

C	A list defining the block diagonal cost matrix $C$ .
A	A list of length $m$ containing block diagonal constraint matrices $A_i$ . Each constraint matrix $A_i$ is specified by a list of blocks as explained in the Details section.
b	A numeric vector of length $m$ containing the right hand side of the constraints.
K	Describes the domain of each block of the sdp problem. It is a list with the following elements:  <b>type:</b> A character vector with entries "s" or "1" indicating the type of each block. If the $j$ th entry is "s", then the $j$ th block is a positive semidefinite matrix. otherwise, it is a vector with non-negative entries. <b>size:</b> A vector of integers indicating the dimension of each block.
control	Control parameters passed to csdp. See CSDP documentation.

## Details

All problem matrices are assumed to be of block diagonal structure, and must be specified as follows:

1. If there are `nblocks` blocks specified by `K`, then the matrix must be a list with `nblocks` components.
2. If `K$type == "s"` then the `j`th element of the list must define a symmetric matrix of size `K$size`. It can be an object of class `"matrix"`, `"simple_triplet_sym_matrix"`, or a valid class from the class hierarchy in the `"Matrix"` package.
3. If `K$type == "l"` then the `j`th element of the list must be a numeric vector of length `K$size`.

This function checks that the blocks in arguments `C` and `A` agree with the sizes given in argument `K`. It also checks that the lengths of arguments `b` and `A` are equal. It does not check for symmetry in the problem data.

`csdp_minimal` is a minimal wrapper to the C code underlying `csdp`. It assumes that the arguments `sum.block.sizes`, `nconstraints`, `nblocks`, `block.types`, and `block.sizes` are provided as if they were created by `Rcsdp:::prob.info` and that the arguments `C`, `A`, and `b` are provided as if they were created by `Rcsdp:::prepare.data`. This function may be useful when calling the `csdp` functionality iteratively and most of the optimization details stays the same. For example, when the control file created by `Rcsdp:::write.control.file` stays the same across iterations, but it would be recreated on each iteration by `csdp`.

## Value

<code>X</code>	Optimal primal solution $X$ . A list containing blocks in the same structure as explained above. Each element is of class <code>"matrix"</code> or a numeric vector as appropriate.
<code>Z</code>	Optimal dual solution $Z$ . A list containing blocks in the same structure as explained above. Each element is of class <code>"matrix"</code> or a numeric vector as appropriate.
<code>y</code>	Optimal dual solution $y$ . A vector of the same length as argument <code>b</code>
<code>pobj</code>	Optimal primal objective value
<code>dobj</code>	Optimal dual objective value
<code>status</code>	Status of returned solution. <ul style="list-style-type: none"> <li><b>0:</b> Success. Problem solved to full accuracy</li> <li><b>1:</b> Success. Problem is primal infeasible</li> <li><b>2:</b> Success. Problem is dual infeasible</li> <li><b>3:</b> Partial Success. Solution found but full accuracy was not achieved</li> <li><b>4:</b> Failure. Maximum number of iterations reached</li> <li><b>5:</b> Failure. Stuck at edge of primal feasibility</li> <li><b>6:</b> Failure. Stuch at edge of dual infeasibility</li> <li><b>7:</b> Failure. Lack of progress</li> <li><b>8:</b> Failure. <math>X</math> or <math>Z</math> (or Newton system <math>O</math>) is singular</li> <li><b>9:</b> Failure. Detected NaN or Inf values</li> </ul>

**Author(s)**

Hector Corrada Bravo. CSDP written by Brian Borchers.

**References**

- <https://github.com/coin-or/Csdp/>
- Borchers, B.:  
*CSDP, A C Library for Semidefinite Programming* Optimization Methods and Software 11(1):613-623, 1999  
<http://euler.nmt.edu/~brian/csdpaper.pdf>
- Lu, F., Lin, Y., and Wahba, G.:  
*Robust Manifold Unfolding with Kernel Regularization* TR 1108, October, 2005.  
<http://pages.stat.wisc.edu/~wahba/ftp1/tr1108rr.pdf>

**Examples**

```
C <- list(matrix(c(2,1,
                  1,2),2,2,byrow=TRUE),
          matrix(c(3,0,1,
                  0,2,0,
                  1,0,3),3,3,byrow=TRUE),
          c(0,0))
A <- list(list(matrix(c(3,1,
                      1,3),2,2,byrow=TRUE),
              matrix(0,3,3),
              c(1,0)),
          list(matrix(0,2,2),
              matrix(c(3,0,1,
                      0,4,0,
                      1,0,5),3,3,byrow=TRUE),
              c(0,1)))

b <- c(1,2)
K <- list(type=c("s","s","l"),size=c(2,3,2))
csdp(C,A,b,K)

# Manifold Unrolling broken stick example
# using simple triplet symmetric matrices
X <- matrix(c(-1,-1,
              0,0,
              1,-1),nc=2,byrow=TRUE);
d <- as.vector(dist(X)^2);
d <- d[-2]

C <- list(.simple_triplet_diag_sym_matrix(1,3))
A <- list(list(simple_triplet_sym_matrix(i=c(1,2,2),j=c(1,1,2),v=c(1,-1,1),n=3)),
          list(simple_triplet_sym_matrix(i=c(2,3,3),j=c(2,2,3),v=c(1,-1,1),n=3)),
          list(matrix(1,3,3)))

K <- list(type="s",size=3)
csdp(C,A,c(d,0),K)
```

**Description**

Support for sparse matrices in package Rcsdp. The class `simple_triplet_sym_matrix` is defined to provide support for symmetric sparse matrices. It's definition is copied from the package `relations` by Kurt Hornik. Coercion functions from objects of class `matrix` and classes in the `Matrix` hierarchy are provided.

**Usage**

```
simple_triplet_sym_matrix(i,j,v,n=max(c(i,j)),check.ind=FALSE)
## S3 method for class 'matrix'
as.simple_triplet_sym_matrix(x,check.sym=FALSE,...)
## S3 method for class 'simple_triplet_sym_matrix'
as.matrix(x,...)
## S3 method for class 'simple_triplet_sym_matrix'
as.vector(x,...)
.simple_triplet_zero_sym_matrix(n,mode="double")
.simple_triplet_diag_sym_matrix(x,n)
.simple_triplet_random_sym_matrix(n,occ=.1,nnz=occ*n*(n+1)/2,rfun=rnorm,seed=NULL,...)
```

**Arguments**

<code>i</code>	Row indices of non-zero entries.
<code>j</code>	Column indices of non-zero entries.
<code>v</code>	Non-zero entries.
<code>n</code>	Size of matrix.
<code>check.ind</code>	Checks that arguments <code>i</code> and <code>j</code> indicate entries in the lower triangular part of the matrix. Default <code>FALSE</code> .
<code>check.sym</code>	Checks if matrix object is symmetric. Default <code>FALSE</code> .
<code>x</code>	Object of class <code>matrix</code> or <code>simple_triplet_sym_matrix</code> .
<code>mode</code>	Type of zero matrix to create. Default <code>double</code> .
<code>occ</code>	Ratio of occupancy of random sparse matrix. Default <code>.1</code> .
<code>nnz</code>	Number of non-zero entries in random sparse matrix. Default corresponds to <code>occ=.1</code> .
<code>rfun</code>	Function to generate random entries in sparse matrix. Default <code>rnorm</code> .
<code>seed</code>	Random number generator seed. Set by function <code>set.seed</code> before generating random sparse matrix. Default <code>NULL</code> .
<code>...</code>	Arguments passed on to casting functions.

**Details**

TO DO

**Value**

TO DO

**Author(s)**

Hector Corrada Bravo

**References**

TO DO

**See Also**

[csdp](#)

**Examples**

```
# TO DO
```

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csdp.control

*Pass control parameters to csdp solver.*

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**Description**

Utility function to pass control parameters to csdp solver.

**Usage**

```
csdp.control(axtol = 1e-08,  
  atytol = 1e-08,  
  objtol = 1e-08,  
  pinftol = 1e+08,  
  dinftol = 1e+08,  
  maxiter = 100,  
  minstepfrac = 0.9,  
  maxstepfrac = 0.97,  
  minstepp = 1e-08,  
  minstepd = 1e-08,  
  usexzgap = 1,  
  tweakgap = 0,  
  affine = 0,  
  printlevel = 1,  
  perturbobj = 1,  
  fastmode = 0)
```

**Arguments**

axtol	Tolerance for primal feasibility.
atytol	Tolerance for dual feasibility.
objtol	Tolerance for relative duality gap.
pinftol	Tolerance for primal infeasibility.
dinftol	Tolerance for dual infeasibility.
maxiter	Maximum number of iterations used.
minstepfrac	Minimum distance to edge of feasibility region for step.
maxstepfrac	Maximum distance to edge of feasibility region for step.
minstepp	Failure is declared if primal line search step size is shorter than this parameter.
minstepd	Failure is declared if dual line search step size is shorter than this parameter.
usexzgap	If 0, then use objective function duality gap.
tweakgap	If 1 (and usexzgap=0) then "fix" negative duality gaps.
affine	If 1, only use affine primal-dual steps and do not use barrier function.
printlevel	If 0, no printing, 1 normal printing, higher values result in more debug printing.
perturbobj	Amount of objective permutation used.
fastmode	If 1, csdp will be faster but also less accurate.

**Details**

Parameters are fully described in CSDP user guide. <https://github.com/coin-or/Csdp/>

**Value**

A list with values for all parameters. Any parameters not passed to function are set to default.

**Author(s)**

Hector Corrada Bravo, CSDP by Brian Borchers

**References**

<https://github.com/coin-or/Csdp/>

**Examples**

```
params <- csdp.control(axtol=1e-6)
```

readsdp

*Reading and writing semidefinite programs for SDPA format files.***Description**

Functions to read and write semidefinite program data and solutions in SDPA format.

**Usage**

```
readsdp(file="", verbose=FALSE)
writesdp(C,A,b,K, file="")
readsdp.sol(K,C,m, file="")
writesdp.sol(X,Z,y,K, file="")
```

**Arguments**

file	The name of the file to read from or write to.
C	Block structured cost matrix
A	List of block structured constraint matrices
b	RHS vector
K	Cone specification, as used in <a href="#">csdp</a>
X	Block structured primal optimal solution matrix
Z	Block structured dual optimal solution matrix
y	Dual optimal solution vector
verbose	Printout information as problem is read. Passed to CSDP's readsdp function. Default FALSE
m	Number of constraints in problem.

**Details**

Block structured matrices must be specified as described in [csdp](#). Files read must be in SDPA format (see <http://euler.nmt.edu/~brian/sdplib/FORMAT>). However, these functions don't support comments or grouping characters (e.g. braces, parentheses) in the block sizes specification.

**Value**

Function readsdp returns a list with elements C, A, b, K. Function readsdp.sol returns a list with elements X, Z, y. All returned matrices are lists of objects of class simple\_triplet\_sym\_matrix.

**Author(s)**

Hector Corrada Bravo

**References**

<http://euler.nmt.edu/~brian/sdplib/FORMAT>



*readsdpa*

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**See Also**

[cspd](#)

**Examples**

# TO DO

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