Package ‘Rcsdp’

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Title R Interface to the CSDP Semidefinite Programming Library

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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://projects.coin-or.org/Csdp/

NeedsCompilation yes

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csdp
Solve semidefinite program with CSDP

Description

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

$$\max \text{ tr}(CX)$$

s.t. $$A(X) = b$$

$$X \succeq 0$$

with $$A(X)_i = \text{tr}(A_iX)$$ 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

$$\min b'y$$

s.t. $$A'(y) - C = Z$$

$$Z \succeq 0$$

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

```r
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:
  - **type**: A character vector with entries "s" or "l" 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.
  - **size**: 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$\text{type} = "s"$ then the jth element of the list must define a symmetric matrix of size K$\text{size}$. 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$\text{type} = "l"$ then the jth element of the list must be a numeric vector of length K$\text{size}$.

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.

Value

x  Optimal primal solution X. A list containing blocks in the same structure as explained above. Each element is of class "matrix" or a numeric vector as appropriate.

z  Optimal dual solution Z. A list containing blocks in the same structure as explained above. Each element is of class "matrix" or a numeric vector as appropriate.

y  Optimal dual solution y. A vector of the same length as argument b

pobj  Optimal primal objective value

dobj  Optimal dual objective value

status  Status of returned solution.

0: Success. Problem solved to full accuracy
1: Success. Problem is primal infeasible
2: Success. Problem is dual infeasible
3: Partial Success. Solution found but full accuracy was not achieved
4: Failure. Maximum number of iterations reached
5: Failure. Stuck at edge of primal feasibility
6: Failure. Stuck at edge of dual infeasibility
7: Failure. Lack of progress
8: Failure. X or Z (or Newton system O) is singular
9: Failure. Detected NaN or Inf values

Author(s)

Hector Corrada Bravo. CSDP written by Brian Borchers.
References

- https://projects.coin-or.org/Csdp/
- Borchers, B.:
  http://euler.nmt.edu/~brian/csdppaper.pdf
- Lu, F., Lin, Y., and Wahba, G.:
  *Robust Manifold Unfolding with Kernel Regularization* TR 1108, October, 2005.
  http://www.stat.wisc.edu/~wahba/ftp1/tr1108rr.pdf

Examples

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

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, 1, -1), ncol=2, byrow=TRUE);
d <- as.vector(dist(X)^2);

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

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

Support for sparse matrices in package Rcspdp. 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

```r
simple_triplet_sym_matrix(i, j, v, n=max(c(i, j)), check.ind=FALSE)
```

## S3 method for class 'matrix'

```r
as.simple_triplet_sym_matrix(x, check.sym=FALSE)
```

## S3 method for class 'simple_triplet_sym_matrix'

```r
as.matrix(x,...)
```

## S3 method for class 'simple_triplet_sym_matrix'

```r
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

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

Details
TO DO

Value
TO DO

Author(s)
Hector Corrada Bravo

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# TO DO

---
csdp.control

Pass control parameters to csdp solver.

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)
# csp.control

## 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://projects.coin-or.org/Csdp/](https://projects.coin-or.org/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://projects.coin-or.org/Csdp/](https://projects.coin-or.org/Csdp/)

## Examples

```r
params <- csdp.control(axtol=1e-6)
```
**readsdpa**  
*Reading and writing semidefinite programs for SDPA format files.*

**Description**

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

**Usage**

```r
readsdpa(file="", verbose=FALSE)  
writesdpa(C,A,b,K,file="")  
readsdpa.sol(K,C,m,file="")  
writesdpa.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 `csdp`
- `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 `readsdpa` 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](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 `readsdpa` returns a list with elements `C,A,b,K`. Function `readsdpa.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](http://euler.nmt.edu/~brian/sdplib/FORMAT)
readsdpa

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