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.
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Enhances Matrix
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Description

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

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

$$\text{s.t. } A(X) = b$$

$$X \succeq 0$$

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

$$\min b^t y$$

$$\text{s.t. } A'(y) - C = Z$$

$$Z \succeq 0$$

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 jth entry is "s", then the jth 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 \( n_{\text{blocks}} \) blocks specified by \( K \), then the matrix must be a list with \( n_{\text{blocks}} \) components.
2. If \( K[\text{type}] == "s" \) then the \( j \)th 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 \( j \)th 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/

Examples

```r
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(c(3,0,1,
                                0,4,0,
                                1,0,5),3,3,byrow=TRUE),
                                c(0,1))),
           list(matrix(0,2,2),
                matrix(c(0,3,0,
                         0,0,3,
                         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);
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(2,2,3),j=c(2,2,3),v=c(1,-1,1),n=3)),
            list(simple_triplet_sym_matrix(i=c(1,2,3),j=c(1,2,3),v=c(1,-1,1),n=3)))
K <- list(type="s",size=3)
csdp(C,A,c(d,0),K)
```
csdp-sparse

Simple support for sparse matrices

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'
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

- `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.
Details
TO DO

Value
TO DO

Author(s)
Hector Corrada Bravo

References
TO DO

See Also
csdp

Examples
# TO DO

---

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

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>file</td>
<td>The name of the file to read from or write to.</td>
</tr>
<tr>
<td>C</td>
<td>Block structured cost matrix</td>
</tr>
<tr>
<td>A</td>
<td>List of block structured constraint matrices</td>
</tr>
<tr>
<td>b</td>
<td>RHS vector</td>
</tr>
<tr>
<td>K</td>
<td>Cone specification, as used in csdp</td>
</tr>
<tr>
<td>X</td>
<td>Block structured primal optimal solution matrix</td>
</tr>
<tr>
<td>Z</td>
<td>Block structured dual optimal solution matrix</td>
</tr>
</tbody>
</table>
readsdpa

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://infohost.nmt.edu/~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://infohost.nmt.edu/~sdplib/FORMAT

See Also

csdp

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