Package 'qap'

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Title Heuristics for the Quadratic Assignment Problem (QAP)

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Description Implements heuristics for the Quadratic Assignment Problem (QAP). Although, the QAP was introduced as a combinatorial optimization problem for the facility location problem in operations research, it also has many applications in data analysis. The problem is NP-hard and the package implements a simulated annealing heuristic.

Suggests testthat

URL https://github.com/mhahsler/qap

BugReports https://github.com/mhahsler/qap/issues

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NeedsCompilation yes

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R topics documented:

qap *Solve Quadratic Assignment Problems (QAP)*

Description

This function implements Quadratic Assignment Problems (QAP) heuristics. Currently there is only a simulated annealing heuristic available, but more will be added in the future.

Usage

```
qap(A, B, method = NULL, ...)
qap.obj(A, B, o)
```

Arguments

A	a symmetric matrix with positive weights/flows between pairs facilities.
B	a symmetric matrix with positive distances between pairs of locations.
method	a character string indicating the used solver. Defaults to "SA", the currently only available method.
...	further arguments are passed on to the solver (see details).
o	a permutation vector for the assignment of facilities to locations.

Details

The objective of the QAP is to find the best facility to location assignment. The assignment is represented by a permutation matrix X and the objective is

$$\min_{X \in \Pi} tr(AXBX^T)$$

qap.obj calculates the objective function for A and B with the permutation o.

Although, the QAP was introduced as a combinatorial optimization problem for the facility location problem in operations research (see Koopmans and Beckmann;1957), it also has many applications in data analysis (see Hubert and Schultz; 1976).

The QAP is known to be NP-hard. This function implements the simple simulated annealing heuristic described by Burkard and Rendl (1984). The code is based on Rendl's FORTRAN implementation of the algorithm available at the QAPLIB website.

The solver has the additional arguments rep = 1L, miter = 2 * nrow(A), fiter = 1.1, ft = 0.5 and maxsteps = 50L

rep integer; number of restarts.

miter integer; number of iterations at fixed temperature.

fiter multiplication factor for miter after miter random transposition trials.

ft multiplication factor for t after miter random transposition trials (between 0 and 1).

maxsteps integer; maximal number of allowed cooling steps.

Value

Returns an integer vector with facility to location assignments. The objective function value is provided as attribute "obj".

Author(s)

Michael Hahsler

References

R.E. Burkard and F. Rendl (1984). A thermodynamically motivated simulation procedure for combinatorial optimization problems. *European Journal of Operations Research,* 17(2):169-174. doi:10.1016/03772217(84)902315

Koopmans TC, Beckmann M (1957). Assignment problems and the location of economic activities. *Econometrica* 25(1):53-76. doi:10.2307/1907742

Hubert, L., and Schultz, J. (1976). Quadratic assignment as a general data analysis strategy. *British Journal of Mathematical and Statistical Psychology,* 29(2), 190-241. doi:10.1111/j.2044-8317.1976.tb00714.x

See Also

read_qaplib

Examples

```
## load the had12 QAPLIB problem
p <- read_qaplib(system.file("qaplib", "had12.dat", package="qap"))
p

## run 1 repetitions verbose
a <- qap(p$A, p$B, verbose = TRUE)
a

## compare with known optimum (gap, % above optimum)
(attr(a, "obj") - p$opt)/p$opt * 100

## run more repetitions quietly
a <- qap(p$A, p$B, rep = 100)
a

## compare with known optimum (gap, % above optimum)
(attr(a, "obj") - p$opt)/p$opt * 100
```

`read_qaplib` *Read QAPLIB Files*

Description

Reads example file in the format used by QAPLIB.

Usage

```
read_qaplib(file)
```

Arguments

`file`	file name.

Details

Problems end with the extension `.dat` and solutions with `.sln`. The code tries to read the problem and, if available in the same directory, it also reads the solution and the known optimal value from the solution file.

The package contains a copy of the problem instances and solutions from QAPLIB. The data is stored in the package in directory `qaplib`.

Value

Returns a list with the components

`D`	distance matrix.
`W`	weight matrix.
`solution`	a known optimal solution (if available).
`opt`	known optimal value (if available).

Author(s)

Michael Hahsler

References

R.E. Burkard, E. Cela, S.E. Karisch and F. Rendl, QAPLIB - A Quadratic Assignment Problem Library, https://www.opt.math.tugraz.at/qaplib/

Examples

```
## load a QAPLIB problem instance
p <- read_qaplib(system.file("qaplib", "had12.dat", package="qap"))
p

## list all QAPLIB instances
dir(system.file("qaplib", package="qap"), pattern = "*.dat")
```

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