

Package ‘rtmpinv’

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Type Package

Title Tabular Matrix Problems via Pseudoinverse Estimation

Version 1.0.0

Description The Tabular Matrix Problems via Pseudoinverse Estimation (TMPinv) is a two-stage estimation method that reformulates structured table-based systems - such as allocation problems, transaction matrices, and input-output tables - as structured least-squares problems. Based on the Convex Least Squares Programming (CLSP) framework, TMPinv solves systems with row and column constraints, block structure, and optionally reduced dimensionality by (1) constructing a canonical constraint form and applying a pseudoinverse-based projection, followed by (2) a convex-programming refinement stage to improve fit, coherence, and regularization (e.g., via Lasso, Ridge, or Elastic Net).

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Encoding UTF-8

Language en-US

Depends R (>= 4.2)

Imports rclsp (>= 1.0.0)

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

URL <https://github.com/econcz/rtmpinv>

BugReports <https://github.com/econcz/rtmpinv/issues>

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Description

Solve a tabular matrix estimation problem via Convex Least Squares Programming (CLSP).

Usage

```
tmpinv(
  S = NULL,
  M = NULL,
  b_row = NULL,
  b_col = NULL,
  b_val = NULL,
  i = 1L,
  j = 1L,
  zero_diagonal = FALSE,
  reduced = NULL,
  symmetric = FALSE,
  bounds = NULL,
  replace_value = NA_real_,
  tolerance = sqrt(.Machine$double.eps),
  iteration_limit = 50L,
  r = 1L,
  final = TRUE,
  alpha = NULL,
  cond_tolerance = NULL,
  ...
)
```

Arguments

- S** numeric matrix of size $(m + p) \times (m + p)$, optional. A diagonal sign-slack (surplus) matrix with entries in $\{0, \pm 1\}$.
- 0 enforces equality ($=$ b_row or b_col),
 - 1 enforces a lower-than-or-equal (\leq) condition,
 - -1 enforces a greater-than-or-equal (\geq) condition. The first m diagonal entries correspond to row constraints, and the remaining p correspond to column constraints.

<code>M</code>	numeric matrix of size $k \times (mp)$, optional. A model matrix, typically with entries in $\{0, 1\}$. Each row defines a linear restriction on the flattened solution matrix. The corresponding right-hand-side values must be supplied in <code>b_val</code> . This block encodes known cell values.
<code>b_row</code>	numeric vector of length <code>m</code> . Right-hand-side vector of row totals.
<code>b_col</code>	numeric vector of length <code>p</code> . Right-hand-side vector of column totals.
<code>b_val</code>	numeric vector of length <code>k</code> . Right-hand-side vector of known cell values.
<code>i</code>	integer, default = 1. Number of row groups.
<code>j</code>	integer, default = 1. Number of column groups.
<code>zero_diagonal</code>	logical scalar, default = FALSE. If TRUE, enforces a structural zero diagonal.
<code>reduced</code>	integer vector of length 2, optional. Dimensions of the reduced problem. If supplied, estimation is performed block-wise on contiguous submatrices. For example, <code>reduced = c(6, 6)</code> yields 5×5 blocks with one slack row and one slack column (edge blocks may be smaller).
<code>symmetric</code>	logical scalar, default = FALSE. If TRUE, enforces symmetry of the estimated matrix via <code>x <- 0.5 * (x + t(x))</code> . This applies to <code>tmpinv\$x</code> only. For symmetry in the model, add explicit symmetry rows to <code>M</code> instead of using this flag.
<code>bounds</code>	NULL, numeric(2), or list of numeric(2). Bounds on cell values. If a single pair <code>c(low, high)</code> is given, it is applied to all <code>mp</code> cells. Example: <code>c(0, NA)</code> .
<code>replace_value</code>	numeric scalar or NA, default = NA. Final replacement value for any cell that violates the bounds by more than the given tolerance.
<code>tolerance</code>	numeric scalar, default = <code>sqrt(.Machine\$double.eps)</code> . Convergence tolerance for bounds.
<code>iteration_limit</code>	integer, default = 50. Maximum number of iterations allowed in the refinement loop.
<code>r</code>	integer scalar, default = 1. Number of refinement iterations for the first step of the CLSP estimator.
<code>final</code>	logical scalar, default = TRUE. If FALSE, only the first step of the CLSP estimator is performed.
<code>alpha</code>	numeric scalar, numeric vector, or NULL. Regularization parameter for the second step of the CLSP estimator.
<code>cond_tolerance</code>	numeric scalar or NULL, default = NULL. Singular-value cutoff for the custom condition number function. If NULL, the implementation uses an internal relative cutoff of $1e-14$.
<code>...</code>	Additional arguments passed to the rclsp solver.

Value

An object of class "tmpinv" containing the fitted CLSP model (`tmpinv$model`) and solution matrix (`tmpinv$x`).

Note

1. In the reduced model, S is ignored. Slack behaviour is inferred from block-wise marginal totals. Likewise, M must be a unique row subset of an identity matrix (diagonal-only). Non-diagonal model matrices cannot be mapped into reduced blocks.
2. Internal keyword arguments `b_lim` and `C_lim` are passed to `.tmpinv.instance()` and contain cell-value bounds. These arguments are ignored in the reduced model.

See Also

[clsp](#)

[CVXR-package](#)

Examples

```
## Example 1: AP/TM reconstruction on a symmetric 20x20 matrix
## (10 percent known entries)

RNGkind("L'Ecuyer-CMRG")
set.seed(123456789)

m <- 20L
p <- 20L

# sample (dataset)
X_true <- abs(matrix(rnorm(m * p), nrow = m, ncol = p))
X_true <- 0.5 * (X_true + t(X_true))          # symmetric

idx <- sample.int(
  m * p,
  size = max(1L, floor(0.1 * (m * p))),      # 10 percent known
  replace = FALSE
)

M <- diag(m * p)[idx, , drop = FALSE]
b_row <- rowSums(X_true)
b_col <- colSums(X_true)
b_val <- matrix(as.numeric(X_true)[idx], ncol = 1L)

# model (unique MNBLUE estimator)
result <- tmpinv(
  M = M,
  b_row = b_row,
  b_col = b_col,
  b_val = b_val,
  bounds = c(0, NA),                          # non-negativity
  symmetric = TRUE,
  r = 1L,
  alpha = 1.0
)

# coefficients
```

```

print("true X:")
print(round(X_true, 4))

print("X_hat:")
print(round(result$x, 4))

# numerical stability
print("\nNumerical stability:")
print(paste(" kappaC :", result$model$kappaC))
print(paste(" kappaB :", result$model$kappaB))
print(paste(" kappaA :", result$model$kappaA))

# diagnostics
print("\nGoodness-of-fit:")
print(paste(" NRMSE :", result$model$normse))
print(paste(" Diagnostic band (min):", min(result$model$x_lower)))
print(paste(" Diagnostic band (max):", max(result$model$x_upper)))

# bootstrap NRMSE t-test
tt <- rclsp::ttest(
  result$model,
  sample_size = 30L,
  seed = 123456789L,
  distribution = rnorm,
  partial = TRUE
)
print("\nBootstrap t-test:")
print(tt)

## Example 2: AP/TM reconstruction on a 40x40 matrix
## with zero diagonal and reduced (20,20) submodels
## (20 percent known entries)

RNGkind("L'Ecuyer-CMRG")
set.seed(123456789)

m <- 40L
p <- 40L

# sample (dataset)
X_true <- abs(matrix(rnorm(m * p), nrow = m, ncol = p))
diag(X_true) <- 0 # zero diagonal

idx <- sample.int(
  m * p,
  size = max(1L, floor(0.2 * (m * p))), # 20 percent known
  replace = FALSE
)

M <- diag(m * p)[idx, , drop = FALSE]
b_row <- rowSums(X_true)
b_col <- colSums(X_true)
b_val <- matrix(as.numeric(X_true)[idx], ncol = 1L)

```

```

# model (reduced models of size 20x20)
result <- tmpinv(
  M = M,
  b_row = b_row,
  b_col = b_col,
  b_val = b_val,
  zero_diagonal = TRUE,
  reduced = c(20L, 20L),
  bounds = c(0, NA),
  r = 1L,
  alpha = 1.0
)

print("true X:")
print(round(X_true, 4))

print("X_hat:")
print(round(result$x, 4))

# numerical stability across submodels
kC <- sapply(result$model, function(CLSP) CLSP$kappaC)
kB <- sapply(result$model, function(CLSP) CLSP$kappaB)
kA <- sapply(result$model, function(CLSP) CLSP$kappaA)

print("\nNumerical stability (min-max across models):")
print(paste(" kappaC :", range(kC)))
print(paste(" kappaB :", range(kB)))
print(paste(" kappaA :", range(kA)))

# diagnostics (min-max)
nrmse <- sapply(result$model, function(CLSP) CLSP$nrmse)
x_low <- unlist(lapply(result$model, function(CLSP) CLSP$x_lower))
x_up <- unlist(lapply(result$model, function(CLSP) CLSP$x_upper))

print("\nGoodness-of-fit (min-max across models):")
print(paste(" NRMSE :", range(nrmse)))
print(paste(" Diagnostic band (min):", range(x_low)))
print(paste(" Diagnostic band (max):", range(x_up)))

# bootstrap t-tests across all block models
print("\nBootstrap t-tests:")
tests <- lapply(
  result$model,
  function(CLSP) rclsp::ttest(
    CLSP,
    sample_size = 30L,
    seed = 123456789L,
    distribution = rnorm,
    partial = TRUE
  )
)
print(tests)

```


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