

Package ‘mpem’

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Type Package

Title Matrix Partial EM for Incomplete Matrix-Normal Data

Version 0.1.0

Description Fits single-component and finite-mixture Kronecker-structured matrix-normal models and imputes incomplete matrix-variate data using matrix partial expectation-maximization. General MPEM handles arbitrary missingness, while Rect-MPEM exploits rectangular structural missingness. The methods are described in Lu, Andrews and Browne (2026) ``An Efficient EM Algorithm for Both Element-Wise and Structural Missingness in Matrix-Variate Normal Mixture Models" <doi:10.48550/arXiv.2609.00616>.

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URL <https://github.com/LHZMix/MPEM>

BugReports <https://github.com/LHZMix/MPEM/issues>

Encoding UTF-8

RoxygenNote 7.3.3

Depends R (>= 4.1.0)

Imports Rcpp, stats

LinkingTo Rcpp, RcppArmadillo

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

NeedsCompilation yes

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mpem	<i>Matrix partial EM for incomplete matrix-normal data</i>
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Description

mpem() fits either one matrix-normal distribution or a finite mixture of matrix-normal distributions. It estimates separable row and column covariance matrices and imputes missing entries. General MPEM handles arbitrary missingness, while Rect-MPEM exploits a rectangular missing block within each matrix observation. Set $G > 1$ to estimate component membership and component-specific parameters.

Usage

```
mpem(  
  X,  
  row_dim = NULL,  
  col_dim = NULL,  
  method = c("auto", "arbitrary", "structural"),  
  sweeps = 1L,  
  tol = 1e-04,  
  max_iter = 1000L,  
  init = NULL,  
  G = 1L,  
  mixture_init = c("kmeans", "random"),  
  seed = 1L,  
  nstart = 10L,  
  warm_start = 1,  
  ridge = 1e-08,  
  verbose = interactive()  
)
```

Arguments

X	A row_dim by col_dim by n numeric array, or an n by row_dim * col_dim numeric matrix. Missing values must be represented by NA.
row_dim	Number of rows in each matrix observation. Inferred from an array and required for a matrix.
col_dim	Number of columns in each matrix observation. Inferred from an array and required for a matrix.

method	Missing-data method. "arbitrary" uses general MPEM; "structural" uses Rect-MPEM and requires at most one rectangular missing block per observation. "auto" selects Rect-MPEM when every nonempty missingness pattern is rectangular and otherwise selects general MPEM.
sweeps	Number of coordinate sweeps used to update conditional covariance matrices.
tol	Relative convergence tolerance.
max_iter	Maximum number of MPEM iterations.
init	Optional list containing mu, row_cov, col_cov, and scale. Identity covariance factors and an observed-data variance are used by default. Available only when $G = 1$.
G	Number of matrix-normal mixture components. The default $G = 1$ fits the original single-component MPEM model.
mixture_init	Initialization used when $G > 1$. "kmeans" clusters mean-filled observations; "random" creates a balanced random partition.
seed	Integer seed used only for mixture initialization.
nstart	Number of random starts used by mixture k-means initialization.
warm_start	Weight in $[0, 1]$ assigned to the previous conditional covariance approximation in mixture general MPEM.
ridge	Nonnegative numerical ridge used to stabilize mixture covariance estimates.
verbose	If TRUE, print the observed mixture log-likelihood by iteration.

Value

When $G = 1$, an object of class `mpem_fit` containing the imputed data, fitted parameters, and convergence diagnostics. When $G > 1$, an object of class `mpem_mixture_fit` that additionally contains mixing proportions, posterior responsibilities, hard clusters, observed log-likelihood, and BIC.

Examples

```
set.seed(1)
X <- array(rnorm(3 * 2 * 10), dim = c(3, 2, 10))
X[cbind(c(1, 2), c(1, 2), c(1, 2))] <- NA

fit <- mpem(X, method = "auto", max_iter = 3)
anyNA(fit$imputed)
fit$method

X[, , 6:10] <- X[, , 6:10] + 3
mixture_fit <- mpem(X, G = 2, max_iter = 10)
table(mixture_fit$cluster)
```

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