

# Package ‘MSCA’

July 21, 2025

**Title** Unsupervised Clustering of Multiple Censored Time-to-Event Endpoints

**Version** 1.2.1

**Description** Provides basic tools and wrapper functions for computing clusters of instances described by multiple time-to-event censored endpoints. From long-format datasets, where one instance is described by one or more dated records, the main function, `make_state_matrices()`, creates state matrices. Based on these matrices, optimised procedures using the Jaccard distance between instances enable the construction of longitudinal typologies. The package is under active development, with additional tools for graphical representation of typologies planned. For methodological details, see our accompanying paper: `Delord M, Douiri A (2025) <[doi:10.1186/s12874-025-02476-7](https://doi.org/10.1186/s12874-025-02476-7)>`.

**License** GPL-3

**Encoding** UTF-8

**RoxygenNote** 7.3.2

**LinkingTo** Rcpp, RcppArmadillo, RcppParallel,

**SystemRequirements** GNU make

**Imports** Rcpp, fastkmedoids, RcppParallel (>= 5.1.10), data.table, dplyr, Matrix, rlang

**Depends** R (>= 3.5)

**LazyData** true

**Suggests** knitr, rmarkdown, cluster, fastcluster

**VignetteBuilder** knitr

**NeedsCompilation** yes

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EHR	<i>Description of the EHR dataset</i>
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Description

This is a toy dataset to illustrate the use of the the MSCA library

Format

A data frame with 3000 records and 3 variables:

- link\_id** Unique patient identifier
- reg** Registered long-term condition
- aos** Age at onset of the registered long-term condition

Source

Toy dataset

Examples

```
# Load the dataset
data(EHR)

# Display the first few rows
head(EHR)
```

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fast\_clara\_jaccard      *Fast CLARA-like clustering using Jaccard dissimilarity*


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## Description

Implements a CLARA (Clustering Large Applications) strategy using Jaccard dissimilarity computed on individual patients state matrices. The algorithm repeatedly samples subsets of the data, performs PAM clustering on each subset, and selects the medoids that minimise the total dissimilarity across the full dataset. Final assignments are made by mapping all data points to the nearest selected medoid.

## Usage

```
fast_clara_jaccard(
  data,
  k,
  samples = 20,
  samplesize = NULL,
  seed = 123,
  frac = 1
)
```

## Arguments

data	A state matrix of censored time-to-event indicators as computed by the <code>make_state_matrix</code> function.
k	Number of returned clusters.
samples	Number of random samples drawn from the analysed population.
samplesize	Number of patients per sample (default: $\min(50 + 5k, \text{ncol}(\text{data}))$ ).
seed	Random seed for reproducibility (default: 123).
frac	Fraction of the population to use for cost computation (default: 1).

## Details

This implementation adapts the original CLARA method described by Kaufman and Rousseeuw (1990) in "Finding Groups in Data: An Introduction to Cluster Analysis".

## Value

A list with index of patients from the sample a, medoid indices, cluster assignment, and cost.

**clustering** An integer vector of cluster assignments for each patient.

**medoids** Indices of medoids associated with the lower cost.

**sample** Indices of the sampled columns used in clustering.

**cost** Total cost (sum of dissimilarities to assigned medoids).

**Note**

To improve efficiency, the function used fastpam procedure from the fastkmedoids library and uses optimized Jaccard index computation. For simulation purpose, the frac parameter can be used to reduce time when computing the cost for each sample. The final cost is given using medoids associated with lower cost computed on fractionned data. A final analysis using the proper CLARA method should be conducted setting frac to 1.

**References**

Kaufman, L. & Rousseeuw, P. J. (1990). *Finding Groups in Data: An Introduction to Cluster Analysis*. Wiley.

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fast_jaccard_dist	<i>Compute upper triangle Jaccard distance</i>
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**Description**

Compute upper triangle Jaccard distance

**Usage**

```
fast_jaccard_dist(mat, as.dist = FALSE)
```

**Arguments**

mat	A numeric binary matrix (0/1/NA)
as.dist	Logical. If TRUE, return a dist object; otherwise an upper triangular matrix.

**Value**

A matrix or dist object of Jaccard dissimilarities (upper triangle)

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get_cluster_sequences	<i>Extract sequences of length k within clusters</i>
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**Description**

For each cluster, extract all sequence of length k from the ordered observations grouped by individual IDs. Returns a list of sequences per cluster.

**Usage**

```
get_cluster_sequences(  
  dt,  
  cl_col = "cl",  
  id_col = "link_id",  
  event_col = "reg",  
  aos_col = "aos",  
  cens = "cens",  
  k = 2  
)
```

**Arguments**

dt	A data.table or data.frame containing the data in a long format.
cl_col	Name of the column containing cluster labels.
id_col	Name of the column identifying individual trajectories (e.g. patient ID).
event_col	Name of the column containing ordered events (e.g. diagnoses, prescriptions).
aos_col	Name of the column containing age at onset.
cens	Code indicating censoring.
k	Integer specifying the sequence length (recommended 2).

**Value**

A named list of data frames, each containing sequences of length k observed in a given cluster.

**Author(s)**

Marc Delord

**References**

Delord M, Douiri A (2025) [doi:10.1186/s12874-025-02476-7](https://doi.org/10.1186/s12874-025-02476-7)

**See Also**

[cspade](#) in the **arulesSequences** package for sequential pattern mining using the SPADE algorithm.

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make_state_matrices	<i>Construct state matrices from longitudinal EHR Data</i>
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### Description

Builds a binary matrix (0/1/NA) encoding whether each individual had each long-term condition (LTC) at each time point from 0 to 1, based on their age of onset. The matrix includes all LTCs, including those used to determine censoring and failure. However, the presence of fail\_code or cens\_code still triggers NA values after their onset.

### Usage

```
make_state_matrices(
  data,
  id = "link_id",
  ltc = "reg",
  aos = "aos",
  l = 111,
  fail_code = "death",
  cens_code = "cens"
)
```

### Arguments

data	A data frame containing one row per condition occurrence.
id	Name of the column identifying individuals.
ltc	Name of the column containing LTC labels.
aos	Name of the column giving age of onset (or time of onset) for each LTC.
l	The maximum time index (inclusive); matrix has $l + 1$ time rows per LTC.
fail_code	Label in ltc indicating a failure event (e.g., death).
cens_code	Label in ltc indicating censoring.

### Value

A matrix with  $(l + 1) \times \text{number of LTCs}$  rows and one column per unique individual. Values are 1 after onset, 0 before, and NA after censor/fail. Rows are named <ltc>\_<time>, and columns are individual IDs.

### Note

For large datasets, computations may be split into multiple jobs to manage memory and performance. Consider reducing the time granularity and/or the number of long-term condition (event of interest) to improve efficiency and stability.

**Author(s)**

@author Marc Delord

**References**

Delord M, Douiri A (2025) doi:[10.1186/s12874-025-02476-7](https://doi.org/10.1186/s12874-025-02476-7)

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sequence_stats	<i>Compute sequence statistics</i>
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**Description**

Computes descriptive statistics for sequences, including sequence frequency for any sequence length, and conditional probability and relative risk for sequences of length 2 (pairwise transitions).

**Usage**

```
sequence_stats(
  seq_data,
  min_seq_freq = 0.01,
  min_conditional_prob = 0,
  min_relative_risk = 0,
  forward = TRUE
)
```

**Arguments**

seq_data	A list of data frames containing sequences, must be the output of <a href="#">get_cluster_sequences</a> .
min_seq_freq	Numeric threshold (default = 0.01). Filters out sequences with relative frequency below this value.
min_conditional_prob	Numeric threshold (default = 0). Applies only for pairwise sequences (k = 2).
min_relative_risk	Numeric threshold (default = 0). Applies only for pairwise sequences (k = 2).
forward	If TRUE only sequences with median age at onset of from is lower than median age at onset of to are kept

**Details**

For k = 2, the function computes:

- **seq\_freq:** Proportion of all sequences that match the pair
- **conditional\_prob:** P(to | from)
- **relative\_risk:** conditional probability divided by the marginal probability of to

For k > 2, only seq\_freq is computed.

**Value**

A list of data frames, each containing the sequence statistics for one cluster.

**See Also**

`get_cluster_sequences`



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