

Package ‘TheOrdinals’

July 11, 2026

Type Package

Title Aggregation and Consensus Methods for Preference-Approvals

Version 0.1.0

Description Tools for aggregating ordinal preference data into a group consensus. The package implements DIVA (Divide and Conquer for Preference-Approvals), a distance-based aggregation method for preference-approvals, that is, preference data in which voters express both a (weak) ranking and an approval of the alternatives. The consensus is the preference-approval minimising the average distance to the set of voters, measured through the family of distances of Erdamar, Garcia-Lapresta, Perez-Roman and Sanver (2014) <[doi:10.1016/j.mathsocsci.2013.10.005](https://doi.org/10.1016/j.mathsocsci.2013.10.005)>. Methods and applications are described in Albano and Romano (2026) <[doi:10.1007/s11634-025-00663-4](https://doi.org/10.1007/s11634-025-00663-4)>. The package is designed to be extended with further methods for ordinal preference data.

License GPL-3

Encoding UTF-8

Language en-GB

Depends R (>= 3.5.0)

Imports ConsRank

Suggests testthat (>= 3.0.0), knitr, rmarkdown

VignetteBuilder knitr

LazyData true

RoxygenNote 7.3.3

Config/testthat/edition 3

NeedsCompilation no

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Repository CRAN

Date/Publication 2026-07-11 09:00:07 UTC

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diva	<i>DIVA consensus for preference-approvals</i>
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Description

Computes the DIVA (Divide and Conquer for Preference-Approvals) consensus of a set of preference-approvals. The consensus is the preference-approval that minimises the average distance [pref_dist](#) to the set of voters, and it is guaranteed to be admissible (its ranking and approval components are consistent).

Usage

```
diva(x, search = FALSE, algorithm = "quick", lambda = 0.5, verbose = FALSE)
```

Arguments

x	A numeric matrix of preference-approvals with $2n$ columns: the first n columns are the ranking component and the last n columns the approval component (see TheOrdinals-package).
search	Logical; if TRUE, when the average approval of some alternatives is exactly tied (0.5) all admissible approval completions are explored instead of breaking the tie deterministically. Defaults to FALSE.
algorithm	Branch-and-bound or heuristic algorithm used by consrank to find the consensus ranking. Defaults to "quick"; "decor" is exact for small n , and "fast" or any other algorithm accepted by consrank may also be used.
lambda	Weight in $[0, 1]$ given to the ranking component of the distance; the approval component receives weight $1 - \text{lambda}$. Defaults to 0.5 .
verbose	Logical; if TRUE progress messages report which branch produced the solution. Defaults to FALSE.

Details

The algorithm first looks for a direct solution in which the consensus ranking and the consensus approval are already compatible. If none exists, it explores two branches: from the consensus ranking it derives admissible approvals ([find_approval](#)), and from the consensus approval it derives admissible rankings by solving the consensus separately within approved and unapproved alternatives. The branch yielding the smaller average distance is returned.

Value

An object of class "diva": a list with components

consensus Data frame with the consensus preference-approval(s); a ranking component followed by an approval component. More than one row is returned when several solutions are tied.

d_lambda The minimised average distance.

elapsed A difftime with the computing time.

lambda, algorithm, search The arguments used.

References

Albano, A. and Romano, M. (2026). A distance-based aggregation method for finding consensus in preference-approvals. *Advances in Data Analysis and Classification*. doi:10.1007/s11634025-006634

See Also

[diva_sensitivity](#), [pref_dist](#)

Examples

```
x <- rbind(
  c(1, 2, 3, 4, 1, 1, 0, 0),
  c(2, 1, 3, 4, 1, 0, 0, 0),
  c(1, 2, 4, 3, 1, 1, 0, 0),
  c(1, 3, 2, 4, 1, 1, 1, 0)
)
res <- diva(x, algorithm = "quick")
res
res$d_lambda
```

diva_sensitivity

Sensitivity of the DIVA consensus to the weighting parameter

Description

Computes the minimised average distance of the DIVA consensus over a grid of values of the weighting parameter `lambda`, which is useful to assess how the relative weight of the ranking and approval components affects the consensus. Unlike [diva](#), only the achieved distance is returned, not the consensus preference-approval itself.

Usage

```
diva_sensitivity(
  x,
  search = FALSE,
  algorithm = "quick",
  lambda = seq(0, 1, by = 0.1),
  verbose = FALSE
)
```

Arguments

<code>x</code>	A numeric matrix of preference-approvals with $2n$ columns: the first n columns are the ranking component and the last n columns the approval component (see TheOrdinals-package).
<code>search</code>	Logical; if TRUE, when the average approval of some alternatives is exactly tied (0.5) all admissible approval completions are explored instead of breaking the tie deterministically. Defaults to FALSE.
<code>algorithm</code>	Algorithm used by consrank ; defaults to "quick", which is convenient for the repeated evaluations of a sensitivity analysis.
<code>lambda</code>	Numeric vector of weights in $[0, 1]$ at which to evaluate the consensus distance. Defaults to <code>seq(0, 1, by = 0.1)</code> .
<code>verbose</code>	Logical; if TRUE progress messages report which branch produced the solution. Defaults to FALSE.

Value

A list with components `d_lambda` (named numeric vector of the minimised average distances, one per value of `lambda`) and `lambda` (the grid used).

See Also

[diva](#)

Examples

```
x <- rbind(
  c(1, 2, 3, 4, 1, 1, 0, 0),
  c(2, 1, 3, 4, 1, 0, 0, 0),
  c(1, 2, 4, 3, 1, 1, 0, 0),
  c(1, 3, 2, 4, 1, 1, 1, 0)
)
s <- diva_sensitivity(x)
s$d_lambda
```

find_approval	<i>Admissible approvals of a ranking</i>
---------------	--

Description

Given a (weak) ranking, enumerates the approval vectors that are consistent with it, i.e. the approval boundaries that can be placed between consecutive buckets of the ranking. The result combines the ranking with each admissible approval, so that every row is a valid preference-approval.

Usage

```
find_approval(ranking)
```

Arguments

ranking	A numeric vector with the positions of the alternatives in the ranking (ties allowed).
---------	--

Value

A data frame with $2n$ columns and (buckets + 1) rows, where buckets is the number of distinct positions in ranking. The first n columns repeat the ranking and the last n columns hold the admissible approval vectors (from "approve none" to "approve all").

See Also

```
pa\_universe, is\_consistent
```

Examples

```
find_approval(c(1, 2, 2, 3))
```

formula1_1950	<i>Formula 1 World Championship (1950) preference-approvals</i>
---------------	---

Description

Preference-approval data built from the 1950 Formula 1 World Championship: the classification of each of the 7 Grands Prix is read as a ranking of the 81 drivers, and the top five finishers of each race are taken as approved. Used as a real-data application in Albano and Romano (2026).

Usage

```
formula1_1950
```

Format

A numeric matrix with 7 rows (Grands Prix) and 162 columns. The first 81 columns are the ranking component and the last 81 columns the approval component (1 approved, 0 not). Both blocks are named after the drivers.

Source

PrefLib (<https://preflib.github.io/PrefLib-Jekyll/>); processed in the replication material of Albano and Romano (2026).

References

Albano, A. and Romano, M. (2026). A distance-based aggregation method for finding consensus in preference-approvals. *Advances in Data Analysis and Classification*. doi:10.1007/s11634025-006634

Examples

```
data(formula1_1950)
dim(formula1_1950)
```

french_election_2002 *French Presidential Election (2002) preference-approvals*

Description

Preference-approval data on the 15 candidates of the first round of the 2002 French presidential election, used as a real-data application in Albano and Romano (2026). Each voter provides a ranking of the candidates together with an approval of a subset of them. Only the admissible preference-approvals (those whose ranking and approval are concordant) are retained.

Usage

```
french_election_2002
```

Format

A numeric matrix with one row per voter and 30 columns. The first 15 columns are the ranking component (positions, ties allowed) and the last 15 columns the approval component (1 approved, 0 not). Both blocks of columns are named after the candidates' surnames.

Source

Erdamar et al. (2014) and the replication material of Albano and Romano (2026); original survey data file 00029-00000001.dat.

References

Albano, A. and Romano, M. (2026). A distance-based aggregation method for finding consensus in preference-approvals. *Advances in Data Analysis and Classification*. doi:10.1007/s11634025-006634

Examples

```
data(french_election_2002)
dim(french_election_2002)

diva(french_election_2002, algorithm = "quick")
```

is_consistent	<i>Preference-approval consistency check</i>
---------------	--

Description

Checks whether a ranking and an approval vector form an admissible preference-approval, i.e. whether they satisfy the consistency condition of Definition 1 in Albano and Romano (2026): approved alternatives must be ranked above unapproved ones, and tied alternatives must share the same approval status.

Usage

```
is_consistent(ranking, approval)
```

Arguments

- ranking A numeric vector with the positions of the alternatives in the ranking (ties allowed).
- approval A numeric (0/1) vector of the same length as ranking, with 1 for approved and 0 for unapproved alternatives.

Value

A single logical value: TRUE if the pair is a valid preference-approval, FALSE otherwise.

References

Albano, A. and Romano, M. (2026). A distance-based aggregation method for finding consensus in preference-approvals. *Advances in Data Analysis and Classification*. doi:10.1007/s11634025-006634

Examples

```
is_consistent(c(1, 2, 3, 4), c(1, 1, 0, 0))
is_consistent(c(1, 2, 3, 4), c(0, 1, 0, 0))
```

pa_small	<i>Small synthetic universe of preference-approvals (n = 4)</i>
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Description

The complete universe of preference-approvals on four alternatives, generated with [pa_universe](#). Provided as a small, fast example for the documentation and the tests.

Usage

pa_small

Format

A numeric matrix with 8 columns. The first 4 columns are the ranking component and the last 4 columns the approval component.

See Also

[pa_universe](#)

Examples

```
data(pa_small)
head(pa_small)
```

pa_universe	<i>Universe of preference-approvals</i>
-------------	---

Description

Generates the full set (universe) of preference-approvals on n alternatives, by enumerating every weak order on n items (via [univranks](#)) and, for each, all the admissible approval boundaries (via [find_approval](#)).

Usage

pa_universe(n, verbose = FALSE)

Arguments

- | | |
|---------|--|
| n | Number of alternatives. The size of the universe grows very quickly with n, so values beyond a handful are impractical. |
| verbose | Logical; if TRUE a message reports the number of preference-approvals generated and the elapsed time. Defaults to FALSE. |

Value

A data frame with $2n$ columns, one row per preference-approval. The first n columns are the ranking component and the last n the approval component.

See Also

[find_approval](#), [diva](#)

Examples

```
u <- pa_universe(3)
head(u)
nrow(u)
```

pref_dist	<i>Distance between preference-approvals</i>
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Description

Computes the family of distances d_λ for preference-approvals introduced by Erdamar et al. (2014), a convex combination of the (normalised) Kemeny distance on the ranking component and the (normalised) Hamming distance on the approval component.

Usage

```
pref_dist(x, y = NULL, lambda = 0.5)
```

Arguments

x	A numeric matrix (or vector) of preference-approvals with $2n$ columns: the first n columns are the ranking component and the last n columns are the approval component (see TheOrdinals-package).
y	An optional second set of preference-approvals in the same format. If NULL (the default) the within-set distance matrix of x is returned.
lambda	Weight in $[0, 1]$ given to the ranking component; the approval component receives weight $1 - \text{lambda}$. Defaults to 0.5.

Value

A numeric matrix of distances. When y is NULL it is the $\text{nrow}(x)$ by $\text{nrow}(x)$ matrix of pairwise distances; otherwise it is the $\text{nrow}(x)$ by $\text{nrow}(y)$ matrix of distances between the rows of x and the rows of y.

References

Erdamar, B., Garcia-Lapresta, J. L., Perez-Roman, D. and Sanver, M. R. (2014). Measuring consensus in a preference-approval context. *Mathematical Social Sciences*, 39-46. [doi:10.1016/j.mathsocsci.2013.10.005](#)

See Also[diva](#)**Examples**

```
x <- rbind(
  c(1, 2, 3, 4, 1, 1, 0, 0),
  c(2, 1, 3, 4, 1, 0, 0, 0),
  c(1, 2, 4, 3, 1, 1, 0, 0)
)
pref_dist(x)
pref_dist(x, lambda = 0.8)
```

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