Package ‘lphom’

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adjust2integers

Description

Takes as input an object generated with an algorithm of the lphom-family (lphom, tslphom, nslphom, tslphom_dual, nslphom_joint, ....) and returns as output an object of the same class as the input object with all their relevant estimated (local and global) transfer matrices of counts updated to their closest integer matrices. The rest of main components of the object are also accordingly updated.

Usage

adjust2integers(x, solver = "symphony", ...)

Arguments

x
An object output of a lphom family algorithm

solver
A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used.

... Other arguments passed on the method. Not currently used.

Details

The updating of the matrices is performed using integer linear programming after imposing all the row- and column-constraints.
Value

An object of the same class and components as x with its components properly updated after adjusting the estimated count matrices in x using integer linear programming

Author(s)

Jose M. Pavia, <pavia@uv.es>

References

...

Examples

```r
mt.ts <- tslphom(France2017P[, 1:8], France2017P[, 9:12], new_and_exit_voters = "raw")
mt.ts <- adjust2integers(mt.ts, solver = "lp_solve")
```

---

**confidence_intervals_pjk**

*Confidence Intervals for lphom estimates*

Description

Estimates confidence intervals for the (vote) transfer probabilities obtained with lphom()

Usage

```r
confidence_intervals_pjk(lphom.object, level = 0.9, num.d = 11, B = 30)
```

Arguments

- `lphom.object` An object output of the lphom() function.
- `level` A number between 0 and 1 to be used as level of confidence for the intervals. By default 0.90.
- `num.d` Number maximum of different disturbances, d, to be initially considered. Positive integer greater than or equal to 5. By default, 11.
- `B` Integer that determines the number of simulations to be performed for each disturbance value. By default, 30.

Value

A list with the following components

- `TM.estimation` Transfer matrix of probability point estimates.
- `TM.lower` Transfer matrix of lower values for the probability estimates.
- `TM.upper` Transfer matrix of upper values for the probability estimates.
- `level` Confidence level used when computing the confidence intervals.
error_lphom

Author(s)

Jose M. Pavia, <pavia@uv.es>
Rafael Romero <rromero@eio.upv.es>

References


See Also

lphom error_lphom

Examples

# Do not run
# mt.lphom <- lphom(France2017P[, 1:8], France2017P[, 9:12], “raw”, NULL, FALSE)
# set.seed(533423)
# confidence_intervals_pjk(mt.lphom, level = 0.90, num.d = 5, B = 8)

error_lphom

Global error of a lphom estimated table

Description

Estimation of the error index (EI) of a RxC vote transfer matrix obtained with lphom()

Usage

error_lphom(
  lphom.object,
  upper.alfa = 0.1,
  show.plot = TRUE,
  num.d = 11,
  B = 30
)

Arguments

lphom.object An object output of the lphom() function.
upper.alfa Upper bound that will not be exceed by the EI estimate with a confidence 1 - alpha. By default, 0.10.
error_lphom

show.plot  TRUE/FALSE. Indicates whether the plot showing the relationship between EI and HETe estimated by simulation for the election under study should be displayed as a side-effect. By default, TRUE.

num.d  Number maximum of different disturbances, d, to be initially considered. Positive integer greater than or equal to 5. By default, 11.

B  Integer that determines the number of simulations to be performed for each disturbance value. By default, 30.

Value

A list with the following components

- **EI.estimate**   Point estimate for EI.
- **EI.upper** Uppb bound with confidence 1 - alpha of the EI estimate
- **figure**  ggplot2 object describing the graphical representation of the relationship between EI and HETe.
- **equation**  lm object of the adjustment between EI and HETe.
- **statistics** A four column matrix with the values of HET, HETe, EI and d associated with each simulated scenario.
- **TMs.real** Array with the simulated real transfer matrices associated with each scenario.
- **TMs.estimate** Array with the estimated transfer matrices associated with each scenario.

Note

ggplot2 is needed to be installed for this function to work.

See equation (12) in Romero et al. (2020) for a definition of the EI index.

Author(s)

Jose M. Pavia, <pavia@uv.es>
Rafael Romero <rromero@eio.upv.es>

References


See Also

- lphom
- confidence_intervals_pjk

Examples

```r
mt.lphom <- lphom(France2017P[, 1:8], France2017P[, 9:12], "raw", NULL, FALSE)
set.seed(253443)
example <- error_lphom(mt.lphom, upper.alfa = 0.10, show.plot = FALSE, num.d = 5, B = 8)
example$EI.estimate
```
Description

Data frame containing the official results recorded in the first and second rounds of the 2017 French presidential election in the 107 territorial French departments and in an artificial department that groups the French electors living abroad.

Usage

data(France2017D)

Format

A table containing 108 observations and 13 variables:

**ABSTENTION** Number of people abstaining (NonVoters) in the first-round of 2017 Presidential Election.

**BLANK_NULL** Number of people voting either blank or null in the first-round of 2017 Presidential Election.

**MACRON** Number of votes gained at a national level by Emmanuel Macron in the first-round of 2017 Presidential Election.

**LE_PEN** Number of votes gained at a national level by Marine Le Pen in the first-round of 2017 Presidential Election.

**FILLON** Number of votes gained at a national level by Francois Fillon in the first-round of 2017 Presidential Election.

**MELENCHON** Number of votes gained at a national level by Jean-Luc Melenchon in the first-round of 2017 Presidential Election.

**HAMON** Number of votes gained at a national level by Benoit Hamon in the first-round of 2017 Presidential Election.

**DUPONT.AIGNAN** Number of votes gained at a national level by Nicolas Dupont-Aignan in the first-round of 2017 Presidential Election.

**OTHERS** Number of votes gained at a national level by the rest of candidates in the first-round of 2017 Presidential Election.

**ABSTENTION2** Number of people abstaining (NonVoters) in the second-round of 2017 Presidential Election.

**BLANK_NULL2** Number of people voting either blank or null in the second-round of 2017 Presidential Election.

**MACRON2** Number of votes gained at a national level by Emmanuel Macron in the second-round of 2017 Presidential Election.

**LE_PEN2** Number of votes gained at a national level by Marine Le Pen in the second-round of 2017 Presidential Election.
Source


Description

Data frame containing the provisional results of the first and second rounds of the 2017 French presidential election in the 12 French continental regions (Auvergne-Rhone-Alpes, Bourgogne-Franche-Comte, Brittany, Centre-Val de Loire, Grand Est, Hauts-de-France, Ile-de-France, Normandy, Nouvelle-Aquitaine, Occitanie, Pays de la Loire, Provence-Alpes-Cote d'Azur) plus an additional region that covers Corsica and the rest of French overseas regions.

Usage

data(France2017P)

Format

A table containing 13 observations and 12 variables:

ABSTENTION Number of people abstaining (NonVoters) and voting either blank or null in the first-round of 2017 Presidential Election.
MACRON Number of votes gained at a national level by Emmanuel Macron in the first-round of 2017 Presidential Election.
LE_PEN Number of votes gained at a national level by Marine Le Pen in the first-round of 2017 Presidential Election.
FILLON Number of votes gained at a national level by Francois Fillon in the first-round of 2017 Presidential Election.
MELENCHON Number of votes gained at a national level bu Jean-Luc Melenchon in the first-round of 2017 Presidential Election.
HAMON Number of votes gained at a national level by Benoit Hamon in the first-round of 2017 Presidential Election.
DUPONT Number of votes gained at a national level by Nicolas Dupont-Aignan in the first-round of 2017 Presidential Election.
OTHERS Number of votes gained at a national level by the rest of candidates in the first-round of 2017 Presidential Election.
ABSTENTION2 Number of people abstaining (NonVoters) in the second-round of 2017 Presidential Election.
BLANK_NULL Number of people voting either blank or null in the second-round of 2017 Presidential Election.
MACRON2 Number of votes gained at a national level by Emmanuel Macron in the second-round of 2017 Presidential Election.
LE_PEN2 Number of votes gained at a national level by Marine Le Pen in the second-round of 2017 Presidential Election.
Source


\[\text{Source} \]

\[\text{Description} \]

Estimates RxC vote transfer matrices (ecological contingency tables) with \textit{lclphom}

\[\text{Usage} \]

\[\text{lclphom}( \]
\[\text{votes_election1}, \]
\[\text{votes_election2}, \]
\[\text{new_and_exit_voters = c("raw", "regular", "simultaneous", "full", "gold"),} \]
\[\text{structural_zeros = NULL,} \]
\[\text{iter.max = 1000,} \]
\[\text{uniform = TRUE,} \]
\[\text{distance.local = c("abs", "max", "none"),} \]
\[\text{integers = FALSE,} \]
\[\text{solver = "lp_solve",} \]
\[\text{integers.solver = "symphony",} \]
\[\text{verbose = FALSE,} \]
\[\text{...} \]
\[) \]

\[\text{Arguments} \]

\[\text{votes_election1} \]

\[\text{data.frame (or matrix) of order } I \times J \text{ (likely of final order } I \times (J-1) \text{ in regular and raw scenarios when net entries are estimated by the function) with the votes gained by the } J \text{ political options competing on election 1 (or origin) in the } I \text{ territorial units considered. In general, the row marginals of the } I \text{ tables.} \]

\[\text{votes_election2} \]

\[\text{data.frame (or matrix) of order } I \times K \text{ (likely of final order } I \times (K-1) \text{ in regular and raw scenarios when net exits are estimated by the function) with the votes gained by the } K \text{ political options competing on election 2 (or destination) in the } I \text{ territorial units considered. In general, the column marginals of the } I \text{ tables.} \]

\[\text{new_and_exit_voters} \]

\[\text{A character string indicating the level of information available regarding new entries and exits of the election censuses between the two elections. This argument captures the different options discussed on Section 3 of Romero et al. (2020). This argument admits five values: raw, regular, simultaneous, full and gold. Default, raw. The argument simultaneous should be used in a typical ecological inference problem.} \]
structural_zeros
Default, NULL. A list of vectors of length two, indicating the election options for which no transfer of votes are allowed between election 1 and election 2. For instance, when new_and_exit_voters is set to "regular", lphom implicitly states structural_zeros = list(c(J,K)) in case exits and/or entries are computed because the sum by rows of votes_election1 and votes_election2 does not coincide.

iter.max
Maximum number of iterations to be performed. The process ends when either the number of iterations reaches iter.max or when there is no error reduction in any local unit between two consecutive iterations. By default, 1000.

uniform
A TRUE/FALSE value that indicates if census exits affects all the electoral options in a (relatively) similar fashion in each voting unit: equation (13) of Pavia and Romero (2021a). Default, TRUE.

distance.local
A string argument that indicates whether the second step of the lphom_local algorithm should be performed to solve potential indeterminacies of local solutions. Default, "abs". If distance.local = "abs" lphom_local selects in its second step the matrix closer to the temporary global solution under L_1 norm, among the first step compatible matrices. If distance.local = "max" lphom_local selects in its second step the matrix closer to the temporary global solution under L_Inf norm, among the first step compatible matrices. If distance.local = "none", the second step of lphom_local is not performed.

integers
A TRUE/FALSE value that indicates whether the problem is solved in integer values in each iteration, including zero (lphom) and local solutions. Initial LP matrices are approximate to the closest integer solution solving the corresponding Integer Linear Program. Default, FALSE.

solver
A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.

integers.solver
A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

verbose
A TRUE/FALSE value that indicates if the main outputs of the function should be printed on the screen. Default, FALSE.

... Other arguments to be passed to the function. Not currently used.

Details
Description of the new_and_exit_voters argument in more detail.

- raw: The default value. This argument accounts for the most plausible scenario when estimating vote transfer matrices: A scenario with two elections elapsed at least some months where only the raw election data recorded in the I territorial units, in which the area under study is divided, are available. In this scenario, net exits (basically deaths) and net entries (basically new young voters) are estimated according to equation (7) of Romero et al. (2020). Constraints defined by equations (8) and (9) of Romero et al. (2020) and (13) of Pavia and
Romero (2021a) are imposed. In this scenario, when net exits and/or net entries are negligible (such as between the first- and second-round of French Presidential elections), they are omitted in the outputs.

- **regular**: For estimating vote transfer matrices, this value accounts for a scenario with two elections elapsed at least some months where (i) the column \( J \) of \( \text{votes}_\text{election1} \) corresponds to new young electors who have the right to vote for the first time, (ii) net exits (basically a consequence of mortality), and maybe other additional net entries, are computed according equation (7) of Romero et al. (2020), and (iii), when \( \text{uniform} = \text{TRUE} \), within each unit it is assumed that net exits affect equally all the first \( J-1 \) options of election 1, i.e., equation (13) of Pavia and Romero (2021a) is applied. Constraints (8) and (9) of Romero et al. (2020) are imposed to start the process.

- **simultaneous**: This is the value to be used in a classical ecological inference problems, such as for racial voting, and in a scenario with two simultaneous elections. In this scenario, the sum by rows of \( \text{votes}_\text{election1} \) and \( \text{votes}_\text{election2} \) must coincide. Constraints defined by equations (8) and (9) of Romero et al. (2020) and (13) of Pavia and Romero (2021a) are not included in the model.

- **full**: This value accounts for a scenario with two elections elapsed at least some months, where: (i) the column \( J-1 \) of \( \text{votes}_\text{election1} \) totals new young electors that have the right to vote for the first time; (ii) the column \( J \) of \( \text{votes}_\text{election1} \) measures new immigrants that have the right to vote; and (iii) the column \( K \) of \( \text{votes}_\text{election2} \) corresponds to total exits of the census lists (due to death or emigration). In this scenario, the sum by rows of \( \text{votes}_\text{election1} \) and \( \text{votes}_\text{election2} \) must agree and constraints (8) and (9) of Romero et al. (2020) are imposed.

- **gold**: This value accounts for a scenario similar to full, where total exits are separated out between exits due to emigration (column \( K-1 \) of \( \text{votes}_\text{election2} \)) and death (column \( K \) of \( \text{votes}_\text{election2} \)). In this scenario, the sum by rows of \( \text{votes}_\text{election1} \) and \( \text{votes}_\text{election2} \) must agree. The same restrictions as in the above scenario apply but for both columns \( K-1 \) and \( K \) of the vote transition probability matrix.

### Value

A list with the following components

- **VTM**: A matrix of order \( J \times K \) with the estimated percentages of row-standardized vote transitions from election 1 to election 2.

- **VTM.votes**: A matrix of order \( J \times K \) with the estimated vote transitions from election 1 to election 2.

- **OTM**: A matrix of order \( K \times J \) with the estimated percentages of the origin of the votes obtained for the different options of election 2.

- **HETe**: The estimated heterogeneity index as defined in equation (15) of Pavia and Romero (2021a).

- **VTM.complete**: A matrix of order \( J' \times K' \) with the estimated proportions of row-standardized vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.
VTM.complete.votes
A matrix of order $J' \times K'$ with the estimated vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.

VTM.prop.units
An array of order $J' \times K' \times I$ with the estimated proportions of vote transitions from election 1 to election 2 attained for each unit in the solution.

VTM.votes.units
An array of order $J' \times K' \times I$ with the estimated matrix of vote transitions from election 1 to election 2 attained for each unit in the solution.

VTM.complete.last.iter
A matrix of order $J' \times K'$ with the estimated proportions of vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units, corresponding to the final iteration.

VTM.sequence
Array of order $J' \times K' \times (\text{iter}+1)$ (where $\text{iter}$ is the effective number of iterations performed) of the intermediate estimated matrices corresponding to each iteration.

HETe.sequence
Numeric vector of length $\text{iter}+1$ with the HETe coefficients corresponding to the matrices in VTM.sequence.

VTM.prop.units.last.iter
An array of order $J' \times K' \times I$ with the estimated proportions of vote transitions from election 1 to election 2 attained for each unit in the final iteration.

VTM.votes.units.last.iter
An array of order $J' \times K' \times I$ with the estimated matrix of vote transitions from election 1 to election 2 attained for each unit in the final iteration.

zeros
A list of vectors of length two, indicating the election options for which no transfer of votes are allowed between election 1 and election 2.

iter
The real final number of iterations performed before ending the process.

iter.units
A matrix of order $I \times (\text{iter}+1)$ with the number of iteration corresponding to the solution selected for each unit in each iteration.

errors
A vector of length $I$ with the minimal error observed in the sequence for each unit. It corresponds to the unit-error associated with the solution linked with either VTM.prop.units or VTM.votes.units.

inputs
A list containing all the objects with the values used as arguments by the function.

origin
A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.

destination
A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.

EHet
A matrix of order $I \times K$ measuring in each spatial unit a distance to the homogeneity hypothesis, that is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results with the solution in each territorial unit for each option of election 2.
solution_init  A list with the main outputs produced by \texttt{lphom}().

- \texttt{VTM\_init}: A matrix of order JxK with the estimated percentages of vote transitions from election 1 to election 2 initially obtained by \texttt{lphom}().
- \texttt{VTM\_votes\_init}: A matrix of order JxK with the estimated vote transitions from election 1 to election 2 initially obtained by \texttt{lphom}().
- \texttt{OTM\_init}: A matrix of order KxJ with the estimated percentages of the origin of the votes obtained for the different options of election 2 initially obtained by \texttt{lphom}().
- \texttt{HETe\_init}: The estimated heterogeneity index defined in equation (10) of Romero et al. (2020).
- \texttt{EHet\_init}: A matrix of order IxK measuring in each spatial unit the distance to the homogeneity hypothesis, that is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results, using the \texttt{lphom}() solution, in each territorial unit for each option of election 2.
- \texttt{VTM\_complete\_init}: A matrix of order J’xK’ with the estimated proportions of vote transitions from election 1 to election 2 initially obtained by \texttt{lphom}(), including in regular and raw scenarios the row and the column corresponding to net\_entries and net\_exits even when they are really small, less than 1% in all units.
- \texttt{VTM\_complete\_votes\_init}: A matrix of order J’xK’ with the estimated vote transitions from election 1 to election 2 initially obtained by \texttt{lphom}(), including in regular and raw scenarios the row and the column corresponding to net\_entries and net\_exits even when they are really small, less than 1% in all units.

\textbf{Author(s)}

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\textbf{See Also}

\texttt{lphom tslphom nslphom}

Other linear programing ecological inference functions: \texttt{lp\_apriori()}, \texttt{lphom\_dual()}, \texttt{lphom\_joint()}, \texttt{lphom()}, \texttt{nslphom\_dual()}, \texttt{nslphom\_joint()}, \texttt{nslphom()}, \texttt{tslphom\_dual()}, \texttt{tslphom\_joint()}, \texttt{tslphom()}.

\textbf{Examples}

```r
mt.lc <- lclphom(France2017P[, 1:8], France2017P[, 9:12], new_and_exit_voters= "raw")
mt.lc$VTM
mt.lc$HETe
mt.lc$solution_init$HETe_init
```
**Description**

Estimates RxC vote transfer matrices (ecological contingency tables) with lphom

**Usage**

```r
lphom(
  votes_election1, 
  votes_election2, 
  new_and_exit_voters = c("raw", "regular", "simultaneous", "full", "gold"), 
  structural_zeros = NULL, 
  integers = FALSE, 
  verbose = FALSE, 
  solver = "lp_solve", 
  integers.solver = "symphony", 
  ...
)
```

**Arguments**

- **votes_election1**
  data.frame (or matrix) of order IxJ (likely of final order Ix(J-1) in regular and raw scenarios when net entries are estimated by the function) with the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. In general, the row marginals of the I tables.

- **votes_election2**
  data.frame (or matrix) of order IxK (likely of final order Ix(K-1) in regular and raw scenarios when net exits are estimated by the function) with the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, the column marginals of the I tables.

- **new_and_exit_voters**
  A character string indicating the level of information available regarding new entries and exits of the election censuses between the two elections. This argument captures the different options discussed on Section 3 of Romero et al. (2020). This argument admits five values: raw, regular, simultaneous, full and gold. Default, raw. The argument simultaneous should be used in a typical ecological inference problem.

- **structural_zeros**
  Default NULL. A list of vectors of length two, indicating the election options for which no transfer of votes are allowed between election 1 and election 2. For instance, when new_and_exit_voters is set to "regular", lphom implicitly states structural_zeros = list(c(J,K)) in case exits and/or entries are computed because the sum by rows of votes_election1 and votes_election2 does not coincide.
**integers**

A TRUE/FALSE value that indicates whether the LP solution of counts (votes) must be approximate to the closest integer solution using ILP to generate the final solution. Default, FALSE.

**verbose**

A TRUE/FALSE value that indicates if the main outputs of the function should be printed on the screen. Default, FALSE.

**solver**

A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.

**integers.solver**

A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

... Other arguments to be passed to the function. Not currently used.

**Details**

Description of the `new_and_exit_voters` argument in more detail.

- **raw**: The default value. This argument accounts for the most plausible scenario when estimating vote transfer matrices: A scenario with two elections elapsed at least some months where only the raw election data recorded in the $I$ territorial units, in which the area under study is divided, are available. In this scenario, net exits (basically deaths) and net entries (basically new young voters) are estimated according to equation (7) of Romero et al. (2020). Constraints defined by equations (8) and (9) of Romero et al. (2020) are imposed. In this scenario, when net exits and/or net entries are negligible (such as between the first- and second-round of French Presidential elections), they are omitted in the outputs.

- **regular**: For estimating vote transfer matrices, this value accounts for a scenario with two elections elapsed at least some months where (i) the column $J$ of votes_election1 corresponds to new young electors who have the right to vote for the first time and (ii) net exits (basically a consequence of mortality), and maybe other additional net entries, are computed according equation (7) of Romero et al. (2020), and (iii) we assume net exits affect equally all the first $J-1$ options of election 1, hence (8) and (9) constraints of Romero et al. (2020) are imposed.

- **simultaneous**: This is the value to be used in a classical ecological inference problems, such as for racial voting, and in a scenario with two simultaneous elections. In this scenario, the sum by rows of votes_election1 and votes_election2 must coincide. Constraints defined by equations (8) and (9) of Romero et al. (2020) are not included in the model.

- **full**: This value accounts for a scenario with two elections elapsed at least some months, where: (i) the column $J-1$ of votes_election1 totals new young electors that have the right to vote for the first time; (ii) the column $J$ of votes_election1 measures new immigrants that have the right to vote; and (iii) the column $K$ of votes_election2 corresponds to total exits of the census lists (due to death or emigration). In this scenario, the sum by rows of votes_election1 and votes_election2 must agree and constraints (8) and (9) of Romero et al. (2020) are imposed.

- **gold**: This value accounts for a scenario similar to full, where total exits are separated out between exits due to emigration (column $K-1$ of votes_election2) and death (column $K$ of
votes_election2). In this scenario, the sum by rows of votes_election1 and votes_election2 must agree. The same restrictions as in the above scenario apply but for both columns \(K-1\) and \(K\) of the vote transition probability matrix.

**Value**

A list with the following components:

- **VTM**: A matrix of order \(J \times K\) with the estimated percentages of row-standardized vote transitions from election 1 to election 2.
- **VTM.votes**: A matrix of order \(J \times K\) with the estimated vote transitions from election 1 to election 2.
- **OTM**: A matrix of order \(K \times J\) with the estimated percentages of the origin of the votes obtained for the different options of election 2.
- **HETe**: The estimated heterogeneity index defined in equation (11) of Romero et al. (2020).
- **VTM.complete**: A matrix of order \(J' \times K'\) with the estimated proportions of row-standardized vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.
- **VTM.complete.votes**: A matrix of order \(J' \times K'\) with the estimated vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.
- **inputs**: A list containing all the objects with the values used as arguments by the function.
- **origin**: A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.
- **destination**: A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.
- **EHet**: A matrix of order \(I \times K\) measuring in each spatial unit a distance to the homogeneity hypothesis. That is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results in each territorial unit for each option of election 2.

**Author(s)**

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**References**

See Also

tslphom nslphom lclphom

Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom_joint(), nslphom_dual(), nslphom_joint(), nslphom(), tslphom_dual(), tslphom_joint(), tslphom()  

Examples

lphom(France2017P[, 1:8], France2017P[, 9:12], new_and_exit_voters= "raw")

lphom_dual

Implements lphom_dual algorithm

Description

Estimates RxC vote transfer matrices (ecological contingency tables) with lphom_dual

Usage

lphom_dual(
  votes_election1,
  votes_election2,
  integers = FALSE,
  solver = "lp_solve",
  integers.solver = "symphony",
  ...
)

Arguments

votes_election1

data.frame (or matrix) of order IxJ with the counts to be initially mapped to rows. When estimating vote transfer matrices, the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. The sum by rows of votes_election1 and votes_election2 must coincide.

votes_election2
data.frame (or matrix) of order IxK with the counts to be initially mapped to columns. When estimating vote transfer matrices, the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, The sum by rows of votes_election1 and votes_election2 must coincide.

integers A TRUE/FALSE value that indicates whether the LP solution of counts (votes) must be approximate to the closest integer solution using ILP. Default, FALSE.

solver A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.
integers.solver
A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

... Other arguments to be passed to the function. Not currently used.

Value
A list with the following components

VTM.votes.w  The matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2, attained weighting the two dual solutions using as weights the corresponding HTEe estimates.

VTM.votes.a  The matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2, attained simple averaging the two dual solutions.

HETe.w      Estimated heterogeneity index associated to the VTM.votes.w solution.

HETe.a      Estimated heterogeneity index associated to the VTM.votes.a solution.

VTM12.w    The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes.w solution.

VTM21.w    The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes.w solution.

VTM12.a    The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes.a solution.

VTM21.a    The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes.a solution.

lphom.object.12  The output of the lphom function attained solving the problem X –> Y. That is, mapping votes.election1 to rows and votes.election2 to columns.

lphom.object.21  The output of the lphom function attained solving the problem Y –> X. That is, mapping votes.election2 to rows and votes.election1 to columns.

inputs A list containing all the objects with the values used as arguments by the function.

Author(s)
Jose M. Pavia, <pavia@uv.es>
Rafael Romero <rromero@eio.upv.es>

References
See Also

lphom tslphom_dual nslphom_dual lphom_joint tslphom_joint nslphom_joint

Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_joint(), lphom(), nslphom_dual(), nslphom_joint(), nlphom(), tslphom_dual(), tslphom_joint(), tslphom()

Examples

x <- France2017[, 1:8]
y <- France2017[, 9:12]
y[,1] <- y[,1] - (rowSums(y) - rowSums(x))
mt <- lphom_dual(x, y)
mt$VTM.votes.w
mt$HET.e.w

Description

Estimates RxC vote transfer matrices (ecological contingency tables) with lphom_joint

Usage

lphom_joint(
  votes_election1,
  votes_election2,
  integers = FALSE,
  solver = "lp_solve",
  integers.solver = "symphony",
  ...
)

Arguments

votes_election1
data.frame (or matrix) of order IxJ with the counts to be initially mapped to rows. When estimating vote transfer matrices, the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. The sum by rows of votes_election1 and votes_election2 must coincide.

votes_election2
data.frame (or matrix) of order IxK with the counts to be initially mapped to columns. When estimating vote transfer matrices, the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, The sum by rows of votes_election1 and votes_election2 must coincide.
integers  A TRUE/FALSE value that indicates whether the LP solution of counts (votes) must be approximate to the closest integer solution using ILP. Default, FALSE.

solver  A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.

integers.solver  A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

...  Other arguments to be passed to the function. Not currently used.

Value

A list with the following components

VTM.votes  A matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2.

HETe  The estimated heterogeneity index associated to the VTM.votes solution.

VTM12  The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes solution.

VTM21  The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes solution.

EHet12  A matrix of order IxK measuring in each unit a distance to the homogeneity hypothesis. That is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results in each territorial unit for each option of election two. The matrix Eik.

EHet21  A matrix of order IxJ measuring in each unit a distance to the homogeneity hypothesis. That is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results in each territorial unit for each option of election one. The matrix Eij.

inputs  A list containing all the objects with the values used as arguments by the function.

Author(s)

Jose M. Pavia, <pavia@uv.es>

Rafael Romero <rromero@eio.upv.es>

References

See Also

lphom lphom_dual tslphom_dual nslphom_dual tslphom_joint nslphom_joint

Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom(), nslphom_dual(), nslphom_joint(), nslphom(), tslphom_dual(), tslphom_joint(), tslphom()

Examples

```r
x <- France2017P[, 1:8]
y <- France2017P[, 9:12]
y[,1] <- y[,1] - (rowSums(y) - rowSums(x))
mt <- lphom_joint(x, y)
mt$VTM.votes
mt$HETe
```

---

lp_apriori

Implements lp_apriori models

Description

Adjusts an initial J0xK0 vote transfer matrix (ecological contingency table) to guarantee (i) congruency with aggregate results and (ii) completeness.

Usage

```r
lp_apriori(
  votes_election1,
  votes_election2,
  apriori,
  weights = "constant",
  new_and_exit_voters = "raw",
  uniform = TRUE,
  solver = "lp_solve",
  integers = TRUE,
  integers.solver = "symphony",
  ...
)
```

Arguments

votes_election1

data.frame (or matrix) of order IxJ1 (or vector of length J1) with the votes gained by (or the numbers corresponding to) the J1 political options competing on election 1 (or origin) in the I territorial units considered.

votes_election2

data.frame (or matrix) of order IxK2 (or vector of length K2) with the votes gained by (or the numbers corresponding to) the K2 political options competing on election 2 (or destination) in the I territorial units considered.
lp_apriori

data.frame (or matrix) of order J0xK0 with an initial estimate of the (row-
standardized) voter transition proportions/factions, pjk0, between the first J0 elec-
tion options of election 1 and the first K0 election options of election 2. It could
be also a data.frame (matrix) of counts. This matrix can contain some missing
values.

weights
Either a numeric matrix (or data.frame) of order J0xK0 of weights, wjk, or a
character string indicating the structure of weights to be used. As character
string this argument admits seven different values: constant, x, xy, expected,
counts, sqrt, or sd. Default, constant (i.e., wjk = 1). The wjk coefficients
measure the (relative) degree of confidence we have in the a priori values pjk0.
Everything else constant, the greater a weight wjk the closer the estimated pjk
and the pjk0 proportions will be. As numeric matrix, this matrix can contain
some missing values, usually located in the same cells than the missing values
of apriori.

new_and_exit_voters
A character string indicating the level of information available regarding new en-
tries and exits of the election censuses between the two elections. This argument
captures the different options discussed in Pavia (2022). This argument admits
eight values: raw, regular, ordinary, simultaneous, enriched, semifull, full and gold. Default, raw.

uniform
A TRUE/FALSE value that indicates if census exits affect all the electoral op-
tions in a (relatively) similar fashion; depending on the scenario any equation(s)
among equations (6) to (11) of Pavia (2022) could be used in the underlying
model. Default, TRUE.

solver
A character string indicating the linear programming solver to be used, only
lp_solve and symphony are allowed. By default, lp_solve. The package
Rsymphony needs to be installed for the option symphony to be used.

integers
A TRUE/FALSE value that indicates whether the LP solution of counts (votes)
must be approximate to the closest integer solution using ILP to generate the
final solution. Default, TRUE.

integers.solver
A character string indicating the linear programming solver to be used to to
the closest integer solution, only symphony and lp_solve are allowed. By de-
fault, symphony. The package Rsymphony needs to be installed for the option
symphony to be used. Only used when integers = TRUE.

... Other arguments to be passed to the function. Not currently used.

Details
Description of the new_and_exit_voters argument in more detail.

• raw: The default value. This argument accounts for the most plausible scenario when adjusting
vote transfer matrices. A scenario with two elections elapsed at least some months where only
the raw election data recorded in I territorial units (where I can be equal to one), in which
the area under study is divided, are available. In this scenario, net exits and net entries are
estimated according to equation (7) of Romero et al. (2020). When both net entries and exits
are no null, constraint (15) of Pavia (2022) applies. If uniform = TRUE constraints (7) of Pavia
(2022) are also imposed. In this scenario, J could be equal to J1 or J1 + 1 and K equal to K2 or K2 + 1.

- **simultaneous**: This is the value to be used in simultaneous elections and when the user is interested in adjusting other type of transfer matrices such as the one that typically arise in classical ecological inference problems. In this scenario, the sum by rows of votes_election1 and votes_election2 must coincide. In this case, the function just implements the basic model defined by equations (1) to (5) of Pavia (2022).

- **regular**: This value accounts for a scenario with two elections elapsed at least some months where (i) the column J1 of votes_election1 corresponds to new young electors who have the right to vote for the first time, (ii) net exits and maybe other additional net entries are computed according to equation (7) of Romero et al. (2020), and (iii) we can (or not) assume that net exits affect equally all the first J1 - 1 options of election 1. When both net entries and exits are null, constraints (12) and (15) of Pavia (2022) apply and if uniform = TRUE constraints (11) of Pavia (2022) are also imposed. In this scenario, J could be equal to J1 or J1 + 1 and K equal to K2 or K2 + 1.

- **ordinary**: This value accounts for a scenario with two elections elapsed at least some months where (i) the column K1 of votes_election2 corresponds to electors who died in the interperiod election, (ii) net entries and maybe other additional net exits are computed according to equation (7) of Romero et al. (2020), and (iii) we can assume that exits affect equally all the J1 options of election 1. When both net entries and exits are no null, constraints (13) and (15) of Pavia (2022) apply and if uniform = TRUE constraints (8) and (9) of Pavia (2022) are also imposed. In this scenario, J could be equal to J1 or J1 + 1 and K equal to K2 or K2 + 1.

- **enriched**: This value accounts for a scenario that somewhat combine regular and ordinary scenarios. We consider two elections elapsed at least some months where (i) the column J1 of votes_election1 corresponds to new young electors who have the right to vote for the first time, (ii) the column K1 of votes_election2 corresponds to electors who died in the interperiod election, (iii) other (net) entries and (net) exits are computed according to equation (7) of Romero et al. (2020), and (iv) we can assume (or not) that exits affect equally all the J1 - 1 options of election 1. When both net entries and exits are no null, constraints (12) to (15) of Pavia (2022) apply and if uniform = TRUE constraints (10) and (11) of Pavia (2022) are also imposed. In this scenario, J could be equal to J1 or J1 + 1 and K equal to K2 or K2 + 1.

- **semifull**: This value accounts for a scenario with two elections elapsed at least some months, where: (i) the column J of votes_election1 totals new electors (young and immigrants) that have the right to vote for the first time and (ii) the column K of votes_election2 corresponds to total exits of the census lists (due to death or emigration). In this scenario, the sum by rows of votes_election1 and votes_election2 must agree and constraint (15) of Pavia (2022) apply. Additionally, if uniform = TRUE constraints (8) of Pavia (2022) are also imposed.

- **full**: This value accounts for a scenario with two elections elapsed at least some months, where (i) the column J - 1 of votes_election1 totals new young electors that have the right to vote for the first time, (ii) the column J of votes_election1 measures new immigrants that have the right to vote and (iii) the column K of votes_election2 corresponds to total exits of the census lists (due to death or emigration). In this scenario, the sum by rows of votes_election1 and votes_election2 must agree and constraints (13) and (15) of Pavia (2022) apply. Additionally, if uniform = TRUE constraints (11) of Pavia (2022) are also imposed.
• gold: This value accounts for a scenario similar to full, where total exits are separated out between exits due to emigration (column K - 1 of votes_election2) and death (column K of votes_election2). In this scenario, the sum by rows of votes_election1 and votes_election2 must agree. Constraints (12) to (15) of Pavia (2022) apply and if uniform = TRUE constraints (10) and (11) of Pavia (2022) are also imposed.

**Value**

A list with the following components:

- **VTM**
  A matrix of order JxK with the estimated percentages of row-standardized vote transitions from election 1 to election 2. In **raw**, **regular**, **ordinary** and **enriched** scenarios when the percentage of net entries is small, less than 1% of the census, net entries are omitted (i.e., J = J0) even if estimates for net entries different from zero are obtained. Likewise, in the same scenarios When the percentage of net exits is small, less than 1% of the census, net exits are omitted (i.e., K = K0) even if estimates for net exits different from zero are obtained.

- **VTM.votes**
  A matrix of order JxK with the estimated vote transitions from election 1 to election 2. In **raw**, **regular**, **ordinary** and **enriched** scenarios when the percentage of net entries is small, less than 1% of the census, net entries are omitted (i.e., J = J0) even if estimates for net entries different from zero are obtained. Likewise, in the same scenarios When the percentage of net exits is small, less than 1% of the census, net exits are omitted (i.e., K = K0) even if estimates for net exits different from zero are obtained.

- **weights**
  A matrix of order JxK with the weights used to adjust the a priori vote transitions from election 1 to election 2.

- **OTM**
  A matrix of order KxJ with the estimated percentages of the origin of the votes obtained for the different options of election 2.

- **VTM.complete**
  A matrix of order JxK with the estimated proportions of row-standardized vote transitions from election 1 to election 2. In **raw**, **regular**, **ordinary** and **enriched** scenarios, this matrix includes the row and the column corresponding to net entries and net exits (when they are present) even when they are really small.

- **VTM.complete.votes**
  A matrix of order JxK with the estimated vote transitions from election 1 to election 2. In **raw**, **regular**, **ordinary** and **enriched** scenarios, this matrix includes the row and the column corresponding to net entries and net exits (when they are present) even when they are really small.

- **inputs**
  A list containing all the objects with the values used as arguments by the function.

- **origin**
  A vector with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.

- **destination**
  A vector with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.
nsphom

Implements nsphom algorithm

Description

Estimates RxC vote transfer matrices (ecological contingency tables) with nsphom

Usage

nsphom(
  votes_election1,
  votes_election2,
  new_and_exit_voters = c("raw", "regular", "simultaneous", "full", "gold"),
  structural_zeros = NULL,
  iter.max = 10,
  min.first = FALSE,
  uniform = TRUE,
  distance.local = c("abs", "max", "none"),
  integers = FALSE,
  solver = "lp.solve",
  integers.solver = "symphony",
  burnin = 0,
  verbose = FALSE,
)
Arguments

votes_election1

data.frame (or matrix) of order IxJ (likely of final order Ix(J-1) in regular and raw scenarios when net entries are estimated by the function) with the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. In general, the row marginals of the I tables.

votes_election2

data.frame (or matrix) of order IxK (likely of final order Ix(K-1) in regular and raw scenarios when net exits are estimated by the function) with the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, the column marginals of the I tables.

new_and_exit_voters

A character string indicating the level of information available regarding new entries and exits of the election censuses between the two elections. This argument captures the different options discussed on Section 3 of Romero et al. (2020). This argument admits five values: raw, regular, simultaneous, full and gold. Default, raw. The argument simultaneous should be used in a typical ecological inference problem.

structural_zeros

Default, NULL. A list of vectors of length two, indicating the election options for which no transfer of votes are allowed between election 1 and election 2. For instance, when new_and_exit_voters is set to "regular", lphom implicitly states structural_zeros = list(c(J,K)) in case exits and/or entries are computed because the sum by rows of votes_election1 and votes_election2 does not coincide.

iter.max

Maximum number of iterations to be performed. The process ends when either the number of iterations reaches iter.max or when the maximum variation between two consecutive estimates of the probability transfer matrix is less than tol. By default, 10.

min.first

A TRUE/FALSE value. If FALSE, the matrix associated with the minimum HETe after performing iter.max iterations is taken as solution. If TRUE, the associated matrix to the instant in which the first decrease of HETe occurs is taken as solution. The process stops at that moment. In this last scenario (when min.first = TRUE), burnin = 0 is forced and iter.max is at least 100. Default, FALSE.

uniform

A TRUE/FALSE value that indicates if census exits affects all the electoral options in a (relatively) similar fashion in each voting unit: equation (13) of Pavia and Romero (2021). Default, TRUE.

distance.local

A string argument that indicates whether the second step of the lphom_local algorithm should be performed to solve potential indeterminacies of local solutions. Default, "abs". If distance.local = "abs" lphom_local selects in its second step the matrix closer to the temporary global solution under L_1
norm, among the first step compatible matrices. If `distance.local = "max"` lphom_local selects in its second step the matrix closer to the temporary global solution under L_infinity norm, among the first step compatible matrices. If `distance.local = "none"`, the second step of lphom_local is not performed.

**integers**
A TRUE/FALSE value that indicates whether the problem is solved in integer values in each iteration, including iteration zero (lphom) and intermediate and final local solutions. If TRUE, the initial LP matrices are approximated in each iteration to the closest integer solution solving the corresponding Integer Linear Program. Default, FALSE.

**solver**
A character string indicating the linear programming solver to be used, only `lp_solve` and `symphony` are allowed. By default, `lp_solve`. The package Rsymphony needs to be installed for the option `symphony` to be used.

**integers.solver**
A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only `symphony` and `lp_solve` are allowed. By default, `symphony`. The package Rsymphony needs to be installed for the option `symphony` to be used. Only used when `integers = TRUE`.

**burnin**
Number of initial solutions to be discarded before determining the final solution. By default, 0.

**verbose**
A TRUE/FALSE value that indicates if the main outputs of the function should be printed on the screen. Default, FALSE.

**tol**
Maximum deviation allowed between two consecutive iterations. The process ends when the maximum variation between two proportions for the estimation of the transfer matrix between two consecutive iterations is less than `tol` or the maximum number of iterations, `iter.max`, has been reached. By default, 0.00001.

... Other arguments to be passed to the function. Not currently used.

**Details**
Description of the `new_and_exit_voters` argument in more detail.

- **raw**: The default value. This argument accounts for the most plausible scenario when estimating vote transfer matrices: A scenario with two elections elapsed at least some months where only the raw election data recorded in the I territorial units, in which the area under study is divided, are available. In this scenario, net exits (basically deaths) and net entries (basically new young voters) are estimated according to equation (7) of Romero et al. (2020). Constraints defined by equations (8) and (9) of Romero et al. (2020) and (13) of Pavia and Romero (2021a) are imposed. In this scenario, when net exits and/or net entries are negligible (such as between the first- and second-round of French Presidential elections), they are omitted in the outputs.

- **regular**: For estimating vote transfer matrices, this value accounts for a scenario with two elections elapsed at least some months where (i) the column J of `votes_election1` corresponds to new young electors who have the right to vote for the first time, (ii) net exits (basically a consequence of mortality), and maybe other additional net entries, are computed according equation (7) of Romero et al. (2020), and (iii), when `uniform = TRUE`, within each
unit it is assumed that net exits affect equally all the first $J$-1 options of election 1, i.e., equation (13) of Pavia and Romero (2021a) is applied. Constraints (8) and (9) of Romero et al. (2020) are imposed to start the process.

- simultaneous: This is the value to be used in a classical ecological inference problems, such as for racial voting, and in a scenario with two simultaneous elections. In this scenario, the sum by rows of votes_election1 and votes_election2 must coincide. Constraints defined by equations (8) and (9) of Romero et al. (2020) and (13) of Pavia and Romero (2021a) are not included in the model.

- full: This value accounts for a scenario with two elections elapsed at least some months, where: (i) the column $J$-1 of votes_election1 totals new young electors that have the right to vote for the first time; (ii) the column $J$ of votes_election1 measures new immigrants that have the right to vote; and (iii) the column $K$ of votes_election2 corresponds to total exits of the census lists (due to death or emigration). In this scenario, the sum by rows of votes_election1 and votes_election2 must agree and constraints (8) and (9) of Romero et al. (2020) are imposed.

- gold: This value accounts for a scenario similar to full, where total exits are separated out between exits due to emigration (column $K$-1 of votes_election2) and death (column $K$ of votes_election2). In this scenario, the sum by rows of votes_election1 and votes_election2 must agree. The same restrictions as in the above scenario apply but for both columns $K$-1 and $K$ of the vote transition probability matrix

**Value**

A list with the following components

- **VTM** A matrix of order $J \times K$ with the estimated percentages of row-standardized vote transitions from election 1 to election 2.

- **VTM.votes** A matrix of order $J \times K$ with the estimated vote transitions from election 1 to election 2.

- **OTM** A matrix of order $K \times J$ with the estimated percentages of the origin of the votes obtained for the different options of election 2.

- **HETe** The estimated heterogeneity index as defined in equation (15) of Pavia and Romero (2021).

- **VTM.complete** A matrix of order $J' \times K'$ with the estimated proportions of row-standardized vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.

- **VTM.complete.votes** A matrix of order $J' \times K'$ with the estimated vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.

- **VTM.sequence** Array of order $J' \times K' \times (iter+1)$ (where iter is the effective number of iterations performed) of the estimated matrices corresponding to each iteration.

- **HETe.sequence** Numeric vector of length $iter+1$ with the HETe coefficients corresponding to the matrices in VTM.sequence.
VTM.prop.units  An array of order J’xK’xI with the estimated proportions of vote transitions from election 1 to election 2 attained for each unit in the selected iteration.

VTM.votes.units  An array of order J’xK’xI with the estimated matrix of vote transitions from election 1 to election 2 attained for each unit in the selected iteration.

zeros  A list of vectors of length two, indicating the election options for which no transfer of votes are allowed between election 1 and election 2.

iter  The real final number of iterations performed before ending the process.

iter.min  Number of the iteration associated to the selected VTM solution.

inputs  A list containing all the objects with the values used as arguments by the function.

origin  A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.

destination  A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.

EHet  A matrix of order IxK measuring in each spatial unit a distance to the homogeneity hypothesis, that is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results with the solution in each territorial unit for each option of election 2.

solution_init  A list with the main outputs produced by lphom().
Author(s)

Jose M. Pavia, <pavia@uv.es>
Rafael Romero <rromero@eio.upv.es>

References


See Also

lphom tslphom lclphom

Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom_joint(), lphom(), nslphom_dual(), nslphom_joint(), tslphom_dual(), tslphom_joint(), tslphom()

Examples

```r
mt.ns <- nslphom(France2017[, 1:8], France2017[, 9:12], new_and_exit_voters= "raw")
mt.ns$VTM
mt.ns$HETe
mt.ns$solution_init$HETe_init
```

---

`nslphom_dual` Implements the `nslphom_dual` algorithm

Description

Estimates RxC vote transfer matrices (ecological contingency tables) with `nslphom_dual`

Usage

```r
nslphom_dual(
  votes_election1,
  votes_election2,
  iter.max = 10,
  min.first = FALSE,
  integers = FALSE,
  solver = "lp_solve",
  integers.solver = "symphony",
  tol = 10^-5,
  ...
)
```
Arguments

votes_election1
data.frame (or matrix) of order IxJ with the counts to be initially mapped to rows. When estimating vote transfer matrices, the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. The sum by rows of votes_election1 and votes_election2 must coincide.

cesvotes_election2
data.frame (or matrix) of order IxK with the counts to be initially mapped to columns. When estimating vote transfer matrices, the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, The sum by rows of votes_election1 and votes_election2 must coincide.

iter.max Maximum number of iterations to be performed in each dual linear program. The process ends independently in each system when either the number of iterations reaches iter.max or when the maximum variation between two consecutive estimates of the probability transfer matrix is less than tol. By default, 10.

min.first A TRUE/FALSE value. If FALSE, the matrix associated with the minimum HETe after performing iter.max iterations is taken as solution. If TRUE, the associated matrix to the instant in which the first decrease of HETe occurs is taken as solution. The process stops at that moment. In this last scenario (when min.first = TRUE), iter.max is is forced to be at least 100. Default, FALSE.

integers A TRUE/FALSE value that indicates whether the problem is solved in integer values in each iteration: zero (lphom) and intermediate and final (including unit) solutions. If TRUE, the initial LP matrices are approximated in each iteration to the closest integer solution solving the corresponding Integer Linear Program. Default, FALSE.

solver A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.

integers.solver A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

tol Maximum deviation allowed between two consecutive iterations. The process ends when the maximum variation between two proportions for the estimation of the transfer matrix between two consecutive iterations is less than tol or the maximum number of iterations, iter.max, has been reached. By default, 0.00001.

Value

A list with the following components

VTM.votes.w The matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2, attained weighting the two dual solutions using as weights the corresponding HTEe estimates.
VTM.votes.units.w
The array of order JxKxI with the local estimated cross-distributions of votes of elections 1 and 2 by unit, attained weighting the two dual solutions using as weights the corresponding HTEe estimates.

VTM.votes.a
The matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2, attained simple averaging the two dual solutions.

VTM.votes.units.a
The matrix of order JxKxI with the estimated cross-distributions of votes of elections 1 and 2 by unit, attained weighting the two dual solutions using as weights the corresponding HTEe estimates.

HETe.w
Estimated heterogeneity index associated to the VTM.votes.w solution.

HETe.a
Estimated heterogeneity index associated to the VTM.votes.a solution.

VTM12.w
The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes.w solution.

VTM21.w
The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes.w solution.

VTM12.a
The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes.a solution.

VTM21.a
The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes.a solution.

nslphom.object.12
The output of the nslphom function attained solving the problem X -> Y, that is, mapping votes_election1 to rows and votes_election2 to columns.

nslphom.object.21
The output of the nslphom function attained solving the problem Y -> X, that is, mapping votes_election2 to rows and votes_election1 to columns.

inputs
A list containing all the objects with the values used as arguments by the function.

Author(s)
Jose M. Pavia, <pavia@uv.es>
Rafael Romero <rromero@eio.upv.es>

References

See Also
nslphom lphom_dual tslphom_dual lphom_joint tslphom_joint nslphom_joint
Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom_joint(), lphom(), nslphom_joint(), nslphom(), tslphom_dual(), tslphom_joint(), tslphom()
Examples

```r
x <- France2017P[, 1:8]
y <- France2017P[, 9:12]
y[,1] <- y[,1] - (rowSums(y) - rowSums(x))
mt <- nslphom_dual(x, y)
mt$VTM.votes.w
mt$HETe.w
```

---

### nslphom_joint

*Implements the nslphom_joint algorithm*

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**Description**

Estimates RxC vote transfer matrices (ecological contingency tables) with nslphom_joint

**Usage**

```r
nslphom_joint(
  votes_election1,
  votes_election2,
  iter.max = 10,
  min.first = FALSE,
  integers = FALSE,
  solver = "lp_solve",
  integers.solver = "symphony",
  tol = 0.001,
  ...
)
```

**Arguments**

- **votes_election1**
  - data.frame (or matrix) of order IxJ with the counts to be initially mapped to rows. When estimating vote transfer matrices, the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. The sum by rows of votes_election1 and votes_election2 must coincide.

- **votes_election2**
  - data.frame (or matrix) of order IxK with the counts to be initially mapped to columns. When estimating vote transfer matrices, the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, the sum by rows of votes_election1 and votes_election2 must coincide.

- **iter.max**
  - Maximum number of iterations to be performed. The process ends independently when either the number of iterations reaches iter.max or when the maximum variation between two consecutive estimates of both ways probability transfer matrices are less than tol. By default, 10.
min.first A TRUE/FALSE value. If FALSE, the matrix associated with the minimum HETe after performing iter.max iterations is taken as solution. If TRUE, the associated matrix to the instant in which the first decrease of HETe occurs is taken as solution. The process stops at that moment. In this last scenario (when min.first = TRUE), iter.max is is forced to be at least 100. Default, FALSE.

integers A TRUE/FALSE value that indicates whether the problem is solved in integer values in each iteration: zero (lphom) and intermediate and final (including unit) solutions. If TRUE, the initial LP matrices are approximated in each iteration to the closest integer solution solving the corresponding Integer Linear Program. Default, FALSE.

solver A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.

integers.solver A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

tol Maximum deviation allowed between two consecutive iterations. The process ends when the maximum variation between the estimated cross-distributions of votes between two consecutive iterations is less than tol or the maximum number of iterations, iter.max, has been reached. By default, 0.001.

... Other arguments to be passed to the function. Not currently used.

Value

A list with the following components

VTM.votes A matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2.

HETe The estimated heterogeneity index associated to the VTM.votes solution.

VTM12 The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes solution.

VTM21 The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes solution.

VTM.votes.units An array of order JxKxI with the estimated matrix of cross-distributions of votes of elections 1 and 2 attained for each unit in iteration of the solution.

iter The real final number of iterations performed before ending the process.

iter.min Number of the iteration associated to the selected VTM.votes solution.

EHet12 A matrix of order IxK measuring in each unit a distance to the homogeneity hypothesis. That is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results in each territorial unit for each option of election two. The matrix Eik.
EHet21  A matrix of order IxJ measuring in each unit a distance to the homogeneity hypothesis. That is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results in each territorial unit for each option of election one. The matrix Eij.

inputs  A list containing all the objects with the values used as arguments by the function.

solution_init  A list with the main outputs produced by lphom_joint().

Author(s)

Jose M. Pavia, <pavia@uv.es>
Rafael Romero <rromero@eio.upv.es>

References


See Also

nslphom lphom_dual tslphom_dual nslphom_dual lphom_joint tslphom_joint

Other linear programming ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom_joint(), lphom(), nslphom_dual(), nslphom(), tslphom_dual(), tslphom_joint(), tslphom()

Examples

x <- France2017P[, 1:8]
y <- France2017P[, 9:12]
y[,1] <- y[,1] - (rowSums(y) - rowSums(x))
mt <- nslphom_joint(x, y, iter.max = 3)
mt$VTM.votes
mt$HETe

plot.lphom  Graphical representation of a RxC ecological inference (vote transfer) matrix

Description

Plot method for objects obtained with an algorithm of the lphom-family (lphom, tslphom, nslphom, tslphom_dual, nslphom_joint, ....).
Usage

```r
## S3 method for class 'lphom'
plot(
  x,
  complete = FALSE,
  margins = TRUE,
  digits = 2,
  row.names = NULL,
  col.names = NULL,
  size.numbers = 6,
  size.labels = 4,
  size.margins = 4,
  colour.cells = "deeppink3",
  colour.grid = "blanchedalmond",
  alpha = 0.5,
  which = NULL,
  ...,
  type = "w",
  show.plot = TRUE
)
```

Arguments

- **x**: An object output of a lphom family algorithm.
- **complete**: A TRUE/FALSE argument informing if the complete matrix should be displayed. In regular and raw scenarios this matrix includes the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units. Default, FALSE
- **margins**: A TRUE/FALSE argument informing if the margins of the matrix should be displayed. Default TRUE.
- **digits**: Integer indicating the number of decimal places to be shown. Default, 2.
- **row.names**: Names to be used for the rows of the matrix.
- **col.names**: Names to be used for the columns of the matrix.
- **size.numbers**: A reference number indicating the average font size to be used for the transfer numbers. Default, 6.
- **size.labels**: A number indicating the font size to be used for labels. Default, 4.
- **size.margins**: A number indicating the font size to be used for margin numbers. Default, 4.
- **colour.cells**: Background base colour for cells.
- **colour.grid**: Colour to be used for grid lines.
- **alpha**: A [0,1] number of colour transparency.
- **which**: A vector of integers informing the units for which the aggregate transfer matrix should be plotted. Default, NULL, the global matrix is shown.
- **...**: Other arguments passed on to methods. Not currently used.
type A character string indicating the solution (transfer matrix) to be plotted. Only valid for _dual_ algorithms. `type = "w"` stands for the weighted solution and `type = "a"` for the simple average solution. Default `w`.

show.plot A TRUE/FALSE indicating if the plot should be displayed as a side-effect. By default, TRUE.

Value

Invisibly returns the (ggplot) description of the plot, which is a list with components that contain the plot itself, the data, information about the scales, panels etc.

Note

ggplot2 is needed to be installed for this function to work.

Author(s)

Jose M. Pavia, <pavia@uv.es>

Examples

```r
mt.ns <- nslphom(France2017P[, 1:8], France2017P[, 9:12], new_and_exit_voters= "raw")
p <- plot(mt.ns, show.plot = FALSE)
p
```

---

**print.lphom**

Print a summary of a lphom-family object

**Description**

Print method for objects obtained with an algorithm of the lphom-family (lphom, tslphom, nslphom, tslphom_dual, nslphom_joint, ....).

**Usage**

```r
## S3 method for class 'lphom'
print(x, ..., margins = TRUE, digits = 2)
```

**Arguments**

- `x` An object output of a `lphom` family algorithm.
- `...` Other arguments passed on to methods. Not currently used.
- `margins` A TRUE/FALSE argument informing if the margins of the matrix should be displayed. Default TRUE.
- `digits` Integer indicating the number of decimal places to be shown. Default, 2.
Author(s)

Jose M. Pavia, <pavia@uv.es>

Examples

mt.ns <- nslphom(France2017P[, 1:8], France2017P[, 9:12], new_and_exit_voters="raw")
print(mt.ns, digits = 2, margins = TRUE)

Description

Print method for summary.lphom objects

Usage

## S3 method for class 'summary.lphom'
print(x, ..., margins = TRUE, digits = 2)

Arguments

x An summary.lphom class object.
...

margins A TRUE/FALSE argument informing if the margins of the matrix should be displayed. Default TRUE.
digits Integer indicating the number of decimal places to be shown. Default, 2.

Description

Summarize a lphom-family object

Usage

## S3 method for class 'lphom'
summary(object, ...)

Arguments

object An object output of a lphom family algorithm.
...

Other arguments passed on to methods. Not currently used.
Value

An object of class "summary_lphom".

Author(s)

Jose M. Pavia, <pavia@uv.es>

Examples

mt.ns <- nslphom(France2017P[, 1:8], France2017P[, 9:12], new_and_exit_voters= "raw")
summary(mt.ns)

 tslphom Implements tslphom algorithm

Description

Estimates RxC vote transfer matrices (ecological contingency tables) with tslphom

Usage

tslphom(
  votes_election1,
  votes_election2,
  new_and_exit_voters = c("raw", "regular", "simultaneous", "full", "gold"),
  structural_zeros = NULL,
  uniform = TRUE,
  distance.local = c("abs", "max", "none"),
  integers = FALSE,
  verbose = FALSE,
  solver = "lp_solve",
  integers.solver = "symphony",
  ...
)

Arguments

votes_election1

data.frame (or matrix) of order IxJ (likely of final order Ix(J-1) in regular and raw scenarios when net entries are estimated by the function) with the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. In general, the row marginals of the I tables.

votes_election2

data.frame (or matrix) of order IxK (likely of final order Ix(K-1) in regular and raw scenarios when net exits are estimated by the function) with the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, the column marginals of the I tables.
new_and_exit_voters
A character string indicating the level of information available regarding new entries and exits of the election censuses between the two elections. This argument captures the different options discussed on Section 3 of Romero et al. (2020). This argument admits five values: raw, regular, simultaneous, full and gold. Default, raw. The argument simultaneous should be used in a typical ecological inference problem.

structural_zeros
Default NULL. A list of vectors of length two, indicating the election options for which no transfer of votes are allowed between election 1 and election 2. For instance, when new_and_exit_voters is set to "regular", lphom implicitly states structural_zeros = list(c(J,K)) in case exits and/or entries are computed because the sum by rows of votes_election1 and votes_election2 does not coincide.

uniform
A TRUE/FALSE value that indicates if census exits affects all the electoral options in a (relatively) similar fashion in each voting unit: equation (13) of Pavia and Romero (2021). Default, TRUE.

distance.local
A string argument that indicates whether the second step of the lphom_local algorithm should be performed to solve potential indeterminacies of local solutions. Default, "abs". If distance.local = "abs" lphom_local selects in its second step the matrix closer to the temporary global solution under L_1 norm, among the first step compatible matrices. If distance.local = "max" lphom_local selects in its second step the matrix closer to the temporary global solution under L_Inf norm, among the first step compatible matrices. If distance.local = "none", the second step of lphom_local is not performed.

integers
A TRUE/FALSE value that indicates whether the problem is solved in integer values in both iterations, including iteration zero (lphom) and final (including unit) solutions. If TRUE, the LP matrices are approximated to the closest integer solution solving the corresponding Integer Linear Program. Default, FALSE.

verbose
A TRUE/FALSE value that indicates if the main outputs of the function should be printed on the screen. Default, FALSE.

solver
A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.

integers.solver
A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

... Other arguments to be passed to the function. Not currently used.

Details
Description of the new_and_exit_voters argument in more detail.

- raw: The default value. This argument accounts for the most plausible scenario when estimating vote transfer matrices: A scenario with two elections elapsed at least some months
where only the raw election data recorded in the \( I \) territorial units, in which the area under study is divided, are available. In this scenario, net exits (basically deaths) and net entries (basically new young voters) are estimated according to equation (7) of Romero et al. (2020). Constraints defined by equations (8) and (9) of Romero et al. (2020) and (13) of Pavia and Romero (2021a) are imposed. In this scenario, when net exits and/or net entries are negligible (such as between the first- and second-round of French Presidential elections), they are omitted in the outputs.

- **regular**: For estimating vote transfer matrices, this value accounts for a scenario with two elections elapsed at least some months where (i) the column \( J \) of \( \text{votes}_\text{election1} \) corresponds to new young electors who have the right to vote for the first time, (ii) net exits (basically a consequence of mortality), and maybe other additional net entries, are computed according equation (7) of Romero et al. (2020), and (iii), when \( \text{uniform} = \text{TRUE} \), within each unit it is assumed that net exits affect equally all the first \( J-I \) options of election \( 1 \), i.e., equation (13) of Pavia and Romero (2021a) is applied. Constraints (8) and (9) of Romero et al. (2020) are imposed to start the process.

- **simultaneous**: This is the value to be used in a classical ecological inference problems, such as for racial voting, and in a scenario with two simultaneous elections. In this scenario, the sum by rows of \( \text{votes}_\text{election1} \) and \( \text{votes}_\text{election2} \) must coincide. Constraints defined by equations (8) and (9) of Romero et al. (2020) and (13) of Pavia and Romero (2021a) are not included in the model.

- **full**: This value accounts for a scenario with two elections elapsed at least some months, where: (i) the column \( J-I \) of \( \text{votes}_\text{election1} \) totals new young electors that have the right to vote for the first time; (ii) the column \( J \) of \( \text{votes}_\text{election1} \) measures new immigrants that have the right to vote; and (iii) the column \( K \) of \( \text{votes}_\text{election2} \) corresponds to total exits of the census lists (due to death or emigration). In this scenario, the sum by rows of \( \text{votes}_\text{election1} \) and \( \text{votes}_\text{election2} \) must agree and constraints (8) and (9) of Romero et al. (2020) are imposed.

- **gold**: This value accounts for a scenario similar to full, where total exits are separated out between exits due to emigration (column \( K-I \) of \( \text{votes}_\text{election2} \)) and death (column \( K \) of \( \text{votes}_\text{election2} \)). In this scenario, the sum by rows of \( \text{votes}_\text{election1} \) and \( \text{votes}_\text{election2} \) must agree. The same restrictions as in the above scenario apply but for both columns \( K-I \) and \( K \) of the vote transition probability matrix

**Value**

A list with the following components

- \( \text{VTM} \): A matrix of order \( JxK \) with the estimated percentages of row-standardized vote transitions from election 1 to election 2.
- \( \text{VTM.votes} \): A matrix of order \( JxK \) with the estimated vote transitions from election 1 to election 2.
- \( \text{OTM} \): A matrix of order \( KxJ \) with the estimated percentages of the origin of the votes obtained for the different options of election 2.
- \( \text{HETe} \): The estimated heterogeneity index as defined in equation (15) of Pavia and Romero (2021).
- \( \text{VTM.complete} \): A matrix of order \( J'xK' \) with the estimated proportions of row-standardized vote transitions from election 1 to election 2, including in **regular** and **raw** scenarios.
the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.

**VTM.complete.votes**
A matrix of order J’xK’ with the estimated vote transitions from election 1 to election 2, including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.

**VTM.prop.units**
An array of order J’xK’xI with the estimated proportions of vote transitions from election 1 to election 2 attained for each unit after adjusting the lphom() initial estimate.

**VTM.votes.units**
An array of order J’xK’xI with the estimated matrix of vote transitions from election 1 to election 2 attained for each unit after adjusting the lphom() initial estimate.

**zeros**
A list of vectors of length two, indicating the election options for which no transfer of votes are allowed between election 1 and election 2.

**inputs**
A list containing all the objects with the values used as arguments by the function.

**origin**
A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.

**destination**
A matrix with the final data used as votes of the origin election after taking into account the level of information available regarding to new entries and exits of the election censuses between the two elections.

**EHet**
A matrix of order IxK measuring in each spatial unit a distance to the homogeneity hypothesis, that is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results with the solution in each territorial unit for each option of election 2.

**solution_init**
A list with the main outputs produced by lphom().

- **VTM_init**: A matrix of order JxK with the estimated percentages of vote transitions from election 1 to election 2 initially obtained by lphom().
- **VTM.votes_init**: A matrix of order JxK with the estimated vote transitions from election 1 to election 2 initially obtained by lphom().
- **OTM_init**: A matrix of order KxJ with the estimated percentages of the origin of the votes obtained for the different options of election 2 initially obtained by lphom().
- **HETe_init**: The estimated heterogeneity index defined in equation (10) of Romero et al. (2020).
- **EHet_init**: A matrix of order IxK measuring in each spatial unit the distance to the homogeneity hypothesis, that is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results, using the lphom() solution, in each territorial unit for each option of election 2.
- **VTM.complete_init**: A matrix of order J’xK’ with the estimated proportions of vote transitions from election 1 to election 2 initially obtained by lphom(), including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.
VTM.complete.votes_init: A matrix of order $J'xK'$ with the estimated vote transitions from election 1 to election 2 initially obtained by lphom(), including in regular and raw scenarios the row and the column corresponding to net_entries and net_exits even when they are really small, less than 1% in all units.

Author(s)

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References


See Also

lphom nslphom lclphom

Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom_joint(), lphom(), nslphom_dual(), nslphom_joint(), nslphom(), tslphom_dual(), tslphom_joint()

Examples

```r
mt.ts <- tslphom(France2017P[, 1:8], France2017P[, 9:12], new_and_exit_voters= "raw")
mt.ts$VTM
mt.ts$HETe
mt.ts$solution_init$HETe_init
```

---

**tslphom_dual**

*Implements the tslphom_dual algorithm*

**Description**

Estimates RxC vote transfer matrices (ecological contingency tables) with tslphom_dual

**Usage**

```r
 tslphom_dual(
   votes_election1,
   votes_election2,
   integers = FALSE,
   solver = "lp_solve",
   integers.solver = "symphony",
   ...
 )
```
Arguments

votes_election1
data.frame (or matrix) of order IxJ with the counts to be initially mapped to rows. When estimating vote transfer matrices, the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. The sum by rows of votes_election1 and votes_election2 must coincide.

votes_election2
data.frame (or matrix) of order IxK with the counts to be initially mapped to columns. When estimating vote transfer matrices, the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, the sum by rows of votes_election1 and votes_election2 must coincide.

integers
A TRUE/FALSE value that indicates whether the problem is solved in integer values in both iterations: zero (lphom) and final (including unit) solutions. If TRUE, the LP matrices are approximated to the closest integer solution solving the corresponding Integer Linear Program. Default, FALSE.

solver
A character string indicating the linear programming solver to be used, only lp_solve and symphony are allowed. By default, lp_solve. The package Rsymphony needs to be installed for the option symphony to be used.

integers.solver
A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only symphony and lp_solve are allowed. By default, symphony. The package Rsymphony needs to be installed for the option symphony to be used. Only used when integers = TRUE.

...
Other arguments to be passed to the function. Not currently used.

Value

A list with the following components

VTM.votes.w
The matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2, attained weighting the two dual solutions using as weights the corresponding HTEe estimates.

VTM.votes.units.w
The array of order JxKxI with the local estimated cross-distributions of votes of elections 1 and 2 by unit, attained weighting the two dual solutions using as weights the corresponding HTEe estimates.

VTM.votes.a
The matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2, attained simple averaging the two dual solutions.

VTM.votes.units.a
The matrix of order JxKxI with the estimated cross-distributions of votes of elections 1 and 2 by unit, attained weighting the two dual solutions using as weights the corresponding HTEe estimates.

HETe.w
Estimated heterogeneity index associated to the VTM.votes.w solution.

HETe.a
Estimated heterogeneity index associated to the VTM.votes.a solution.
The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes.w solution.

The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes.w solution.

The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the VTM.votes.a solution.

The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the VTM.votes.a solution.

The output of the tslphom function attained solving the problem X -> Y, that is, mapping votes_election1 to rows and votes_election2 to columns.

The output of the tslphom function attained solving the problem Y -> X, that is, mapping votes_election2 to rows and votes_election1 to columns.

A list containing all the objects with the values used as arguments by the function.

Author(s)

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References


See Also

tslphom lphom_dual nslphom_dual lphom_joint tslphom_joint nslphom_joint

Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom_joint(), lphom(), nslphom_dual(), nslphom_joint(), nslphom(), tslphom_joint(), tslphom()

Examples

```r
x <- France2017[, 1:8]
y <- France2017[, 9:12]
y[,1] <- y[,1] - (rowSums(y) - rowSums(x))
mt <- tslphom_dual(x, y)
mt$VTM.votes.w
mt$HETe.w
```
Implements the tslphom_joint algorithm

Description

Estimates RxC vote transfer matrices (ecological contingency tables) with tslphom_joint

Usage

```r
tslphom_joint(
  votes_election1,
  votes_election2,
  integers = FALSE,
  solver = "lp_solve",
  integers.solver = "symphony",
  ...
)
```

Arguments

- **votes_election1**: data.frame (or matrix) of order IxJ with the counts to be initially mapped to rows. When estimating vote transfer matrices, the votes gained by the J political options competing on election 1 (or origin) in the I territorial units considered. The sum by rows of `votes_election1` and `votes_election2` must coincide.

- **votes_election2**: data.frame (or matrix) of order IxK with the counts to be initially mapped to columns. When estimating vote transfer matrices, the votes gained by the K political options competing on election 2 (or destination) in the I territorial units considered. In general, the sum by rows of `votes_election1` and `votes_election2` must coincide.

- **integers**: A TRUE/FALSE value that indicates whether the problem is solved in integer values in both iterations: zero (lphom) and final (including unit) solutions. If TRUE, the LP matrices are approximated to the closest integer solution solving the corresponding Integer Linear Program. Default, FALSE.

- **solver**: A character string indicating the linear programming solver to be used, only `lp_solve` and `symphony` are allowed. By default, `lp_solve`. The package `Rsymphony` needs to be installed for the option `symphony` to be used.

- **integers.solver**: A character string indicating the linear programming solver to be used to approximate to the closest integer solution, only `symphony` and `lp_solve` are allowed. By default, `symphony`. The package `Rsymphony` needs to be installed for the option `symphony` to be used. Only used when `integers = TRUE`.

- **...**: Other arguments to be passed to the function. Not currently used.
Value

A list with the following components

- **VTM.votes**
  A matrix of order JxK with the estimated cross-distribution of votes of elections 1 and 2.

- **HETe**
  The estimated heterogeneity index associated to the *VTM.votes* solution.

- **VTM12**
  The matrix of order JxK with the estimated row-standardized proportions of vote transitions from election 1 to election 2 associated to the *VTM.votes* solution.

- **VTM21**
  The matrix of order KxJ with the estimated row-standardized proportions of vote transitions from election 2 to election 1 associated to the *VTM.votes* solution.

- **VTM.votes.units**
  An array of order JxKxI with the estimated matrix of cross-distributions of votes of elections 1 and 2 attained for each unit after congruently adjusting the *lphom_joint()* initial estimate.

- **EHet12**
  A matrix of order IxK measuring in each unit a distance to the homogeneity hypothesis. That is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results in each territorial unit for each option of election two. The matrix Eik.

- **EHet21**
  A matrix of order IxJ measuring in each unit a distance to the homogeneity hypothesis. That is, the differences under the homogeneity hypothesis between the actual recorded results and the expected results in each territorial unit for each option of election one. The matrix Eij.

- **inputs**
  A list containing all the objects with the values used as arguments by the function.

- **solution_init**
  A list with the main outputs produced by *lphom_joint()*.

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References


See Also

tslphom lphom_dual tslphom_dual nslphom_dual lphom_joint nslphom_joint

Other linear programing ecological inference functions: lclphom(), lp_apriori(), lphom_dual(), lphom_joint(), lphom(), nslphom_dual(), nslphom_joint(), nslphom(), tslphom_dual(), tslphom()
Examples

\[
\begin{align*}
x & \leftarrow \text{France2017P[, 1:8]} \\
y & \leftarrow \text{France2017P[, 9:12]} \\
y[,1] & \leftarrow y[,1] - (\text{rowSums}(y) - \text{rowSums}(x)) \\
mt & \leftarrow \text{tslphom_joint}(x, y) \\
mt$\text{VTM.votes} & \\
mt$\text{HETe} &
\end{align*}
\]
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