Package ‘migration.indices’

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BugReports https://github.com/daroczig/migration.indices/issues

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Description This package provides various indices, like Crude Migration Rate,
different Gini indices or the Coefficient of Variation among others, to
show the (un)equality of migration.

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Aggregated System-wide Coefficient of Variation

Description

The Aggregated System-wide Coefficient of Variation is simply the sum of the Aggregated In-migration \( \text{migration.acv.in} \) and the Aggregated Out-migration Coefficient of Variation \( \text{migration.acv.out} \).

Usage

\[ \text{migration.acv}(m) \]

Arguments

- \( m \) migration matrix

Value

A number where a higher \( \neq 0 \) shows more spatial focus.

References

See Also

migration.cv.in migration.cv.out migration.acv.in migration.acv.out

Examples

data(migration.hyp)
migration.acv(migration.hyp)  # 0.333333
migration.acv(migration.hyp2)  # 0.375

---

**Aggregated In-migration Coefficient of Variation**

Description

The Aggregated In-migration Coefficient of Variation is the weighted average of the In-migration Coefficient of Variation (`migration.cv.in`).

Usage

```
migration.acv.in(m)
```

Arguments

- `m` migration matrix

Value

A number where a higher (≠ 0) shows more spatial focus.

References


See Also

migration.cv.in migration.cv.out migration.acv.out migration.acv

Examples

data(migration.hyp)
migration.acv.in(migration.hyp)  # 0.333333
migration.acv.in(migration.hyp2)  # 0.25
migration.acv.out  \textit{Aggregated Out-migration Coefficient of Variation}

\textbf{Description}

The Aggregated Out-migration Coefficient of Variation is the weighted average of the Out-migration Coefficient of Variation ($\texttt{migration.cv.out}$).

\textbf{Usage}

\begin{verbatim}
migration.acv.out(m)
\end{verbatim}

\textbf{Arguments}

- \texttt{m} migration matrix

\textbf{Value}

A number where a higher ($\neq 0$) shows more spatial focus.

\textbf{References}


\textbf{See Also}

- \texttt{migration.cv.in}
- \texttt{migration.cv.out}
- \texttt{migration.acv.in}
- \texttt{migration.acv}

\textbf{Examples}

\begin{verbatim}
data(migration.hyp)
migration.acv.out(migration.hyp)  # 0
migration.acv.out(migration.hyp2)  # 0.125
\end{verbatim}

\begin{center}
\underline{migration.cmr  \textit{Crude Migration Rate}}
\end{center}

\textbf{Description}

Crude Migration Rate

\textbf{Usage}

\begin{verbatim}
migration.cmr(m, PAR, k = 100)
\end{verbatim}
Arguments

- **m**: migration matrix
- **PAR**: population at risk (estimated average population size)
- **k**: scaling constant (set to 100 by default to result in percentage)

Value

percentage (when k=100)

References


Examples

```r
data(migration.world)
migration.cmr(migration.world, 6e+9)
```

---

**migration.connectivity**

*Migration Connectivity Index*

Description

The Migration Connectivity Index measures "the proportion of the total number of potential inter-regional flows which are not zero":

$$ I_{MC} = \sum_i \sum_{j \neq i} \frac{MC_{ij}}{n(n-1)} $$

where $MC_{ij}$ is 0 if the flow from $i$ to $j$ is zero and let it be 1 otherwise.

Usage

```
migration.connectivity(m)
```

Arguments

- **m**: migration matrix

Value

A number between 0 and 1 where zero shows no connections between regions.
References


Examples

```r
data(migration.hyp)
migration.connectivity(migration.hyp)
data(migration.world)
migration.connectivity(migration.world)
```

---

**migration.cv.in**  
*In-migration Coefficient of Variation*

Description

As "the coefficient of variation is defined as the standard deviation to mean ratio of a distribution", the In-migration Coefficient of Variation is computed by dividing the standard deviation (with the nominator being $n$ instead of $n - 1$) of the in-migration flows by the mean.

Usage

```r
migration.cv.in(m)
```

Arguments

- `m` migration matrix

Value

A numeric vector of standardized values where a higher ($\neq 0$) shows more spatial focus.

References


See Also

- `migration.cv.out`  
- `migration.acv.in`  
- `migration.acv.out`  
- `migration.acv`

Examples

```r
## Not run:
data(migration.hyp)
migration.cv.in(migration.hyp)  # 0.2000000 0.5000000 0.3333333
migration.cv.in(migration.hyp2)  # 0.2000000 0.0000000 0.4285714

## End(Not run)
```
Description

As "the coefficient of variation is defined as the standard deviation to mean ratio of a distribution", the Out-migration Coefficient of Variation is computed by dividing the standard deviation (with the nominator being \( n \) instead of \( n - 1 \)) of the out-migration flows by the mean.

Usage

migration.cv.out(m)

Arguments

m migration matrix

Value

A numeric vector of standardized values where a higher (\( \neq 0 \)) shows more spatial focus.

References


See Also

migration.cv.in migration.acv.in migration.acv.out migration.acv

Examples

```r
## Not run:
data(migration.hyp)
migration.cv.out(migration.hyp)  # 0 0 0
migration.cv.out(migration.hyp2)  # 0.00 0.25 0.00

## End(Not run)
```
Migration Effectiveness Index

Description

The Migration Effectiveness Index "measures the degree of (a)symmetry or (dis)equilibrium in the network of interregional migration flows":

\[ MEI = 100 \frac{\sum_i |D_i - O_i|}{\sum_i |D_i + O_i|} \]

where \( D_i \) is the total inflows to zone \( i \) and \( O_i \) is the total outflows from zone \( i \).

Usage

\[ \text{migration.efficiency}(m) \]

Arguments

\( m \) migration matrix

Value

A number between 0 and 100 where the higher number shows an efficient mechanism of population redistribution.

References


Examples

\[ \text{data(migration.hyp)} \]
\[ \text{migration.efficiency(migration.hyp)} \]
\[ \text{data(migration.world)} \]
\[ \text{migration.efficiency(migration.world)} \]
migration.field.diagram

Joint plot for in and out-migration fields

Description

This migration field diagram makes easy to visualize both direction of migration. E.g. points above the diagonal "are outward redistributors, while those below that line are inward redistributors."

Usage

```r
migration.field.diagram(m, method = c("gini", "acv"),
 title = "Migration field diagram",
 xlab = "Out-migration", ylab = "In-migration")
```

Arguments

- `m` migration matrix
- `method` measurement of in and out-migration
- `title` plot title
- `xlab` label for x axis
- `ylab` label for y axis

References


Examples

```r
## not run:
data(migration.world)
par(mfrow = c(2, 1))
migration.field.diagram(migration.world)
migration.field.diagram(migration.world, method = 'acv')

## End(Not run)
```
**migration.gini**  

**Spatial Gini Indexes**

**Description**

This is a wrapper function computing all the following Gini indices:

- **Total Flows Gini Index** ([migration.gini.total](#))
- **Rows Gini Index** ([migration.gini.row](#))
- **Standardized Rows Gini Index** ([migration.gini.row.standardized](#))
- **Columns Gini Index** ([migration.gini.col](#))
- **Standardized Columns Gini Index** ([migration.gini.col.standardized](#))
- **Exchange Gini Index** ([migration.gini.exchange](#))
- **Standardized Exchange Gini Index** ([migration.gini.exchange.standardized](#))
- **Out-migration Field Gini Index** ([migration.gini.out](#))
- **Migration-weighted Out-migration Gini Index** ([migration.weighted.gini.out](#))
- **In-migration Field Gini Index** ([migration.gini.in](#))
- **Migration-weighted In-migration Gini Index** ([migration.weighted.gini.in](#))
- **Migration-weighted Mean Gini Index** ([migration.weighted.gini.mean](#))

**Usage**

```r
migration.gini(m, corrected = TRUE)
```

**Arguments**

- `m`  
  **migration matrix**

- `corrected`  
  to use Bell et al. (2002) updated formulas instead of Plane and Mulligan (1997)

**Value**

List of all Gini indices.

**References**


**See Also**

- [migration.gini.col](#)
- [migration.gini.row](#)
- [migration.gini.exchange](#)
- [migration.gini.in](#)
- [migration.gini.out](#)
migration.gini.col

Examples

data(migration.hyp)
migration.gini(migration.hyp)
migration.gini(migration.hyp2)

migration.gini.col  Columns Gini Index

Description

The Columns Gini index concentrates on the "relative extent to which the destination selections of in-migrations are spatially focused":

$$G^R_{TR} = \frac{\sum_j \sum_{i \neq j} \sum_{g \neq i,j} |M_{ij} - M_{gj}|}{(2n(n-1)-1) \sum_i \sum_{j \neq i} M_{ij}}$$

This implementation solves the above formula by computing the dist matrix for each columns.

Usage

migration.gini.col(m)

Arguments

m  migration matrix

Value

A number between 0 and 1 where 0 means no spatial focusing and 1 shows maximum focusing.

References


See Also

migration.gini.row migration.gini.col.standardized

Examples

data(migration.hyp)
migration.gini.col(migration.hyp)  # 0.05555556
migration.gini.col(migration.hyp2)  # 0.04166667
migration.gini.col.standardized

Standardized Columns Gini Index

Description

The standardized version of the Columns Gini Index (migration.gini.col) by dividing that with the Total Flows Gini Index (migration.gini.total):

\[ G_C^{T*} = 100 \frac{G_C^T}{G_T} \]

As this index is standardized, it "facilitate comparisons from one period to the next" of the columns indices.

Usage

migration.gini.col.standardized(m, 
gini.total = migration.gini.total(m, FALSE))

Arguments

- **m** migration matrix
- **gini.total** optionally pass the pre-computed Total Flows Gini Index to save computational resources

Value

A percentage range from 0% to 100% where 0% means that the migration flows are uniform, while a higher value indicates spatial focusing.

References


See Also

migration.gini.col migration.gini.row.standardized

Examples

data(migration.hyp)
migration.gini.col.standardized(migration.hyp) # 25
migration.gini.col.standardized(migration.hyp2) # 22.22222
Description

The Exchange Gini Index "indicates the contribution to spatial focusing represented by the \( n(n-q) \) net interchanges in the system":

\[
G_{RC,CR}^{T} = \frac{\sum_{i} \sum_{j \neq i} |M_{ij} - M_{ji}|}{(2n(n-1) - 1) \sum_{i} \sum_{j \neq i} M_{ij}}
\]

This implementation solves the above formula by simply subtracting the transposed matrix’s values from the original one at a time.

Usage

\[
migration.gini.exchange(m)
\]

Arguments

\[
m \quad \text{migration matrix}
\]

Value

A number between 0 and 1 where 0 means no spatial focusing and 1 shows maximum focusing.

References


See Also

\[
migration.gini \migration.gini.exchange.standardized
\]

Examples

\[
data(migration.hyp)
migration.gini.exchange(migration.hyp) \quad \# 0.05555556
\]

\[
migration.gini.exchange(migration.hyp2) \quad \# 0.04166667
\]
**migration.gini.exchange.standardized**

*Standardized Exchange Gini Index*

**Description**

The standardized version of the Exchange Gini Index (migration.gini.exchange) by dividing that with the Total Flows Gini Index (migration.gini.total):

\[
G_{TR,CR}^{RC} = 100 \frac{G_{TR,CR}^T}{G^T}
\]

As this index is standardized, it "facilitate comparisons from one period to the next" of the exchange indices.

**Usage**

```
migration.gini.exchange.standardized(m, gini.total = migration.gini.total(m, FALSE))
```

**Arguments**

- `m` migration matrix
- `gini.total` optionally pass the pre-computed Total Flows Gini Index to save resources

**Value**

A percentage range from 0% to 100% where 0% means that the migration flows are uniform, while a higher value indicates spatial focusing.

**References**


**See Also**

- migration.gini
- migration.gini.exchange

**Examples**

```
data(migration.hyp)
migration.gini.exchange.standardized(migration.hyp) # 25
migration.gini.exchange.standardized(migration.hyp2) # 22.22222
```
In-migration Field Gini Index

Description

The In-migration Field Gini Index is a decomposed version of the Columns Gini Index (migration.gini.col) representing "the contribution of each region’s columns to the total index" (migration.gini.total):

\[ G_j^I = \frac{\sum_{i\neq j} \sum_{k \neq j, i} |M_{ij} - M_{kj}|}{2(n-2)\sum_{i\neq j} M_{ij}} \]

These Gini indices facilitate the direct comparison of different territories without further standardization.

Usage

migration.gini.in(m, corrected = TRUE)

Arguments

- m: migration matrix
- corrected: Bell et al. (2002) updated the formula of Plane and Mulligan (1997) to be \(2(n-2)\) instead of \(2(n-1)\) because "the number of comparisons should exclude the diagonal cell in each row and column, and the comparison of each cell with itself".

Value

A numeric vector with the range of 0 to 1 where 0 means no spatial focusing and 1 shows maximum focusing.

References


See Also

migration.gini, migration.gini.out, migration.weighted.gini
Examples

data(migration.hyp)
migration.gini.in(migration.hyp)  # 0.2000000 0.5000000 0.3333333
migration.gini.in(migration.hyp2)  # 0.2000000 0.0000000 0.4285714
migration.gini.in(migration.hyp, FALSE)  # 0.1000000 0.2500000 0.1666667
migration.gini.in(migration.hyp2, FALSE)  # 0.1000000 0.0000000 0.2142857

---

**migration.gini.out**  **Out-migration Field Gini Index**

### Description

The Out-migration Field Gini Index is a decomposed version of the Rows Gini Index (\texttt{migration.gini.row}) representing "the contribution of each region’s row to the total index" () (\texttt{migration.gini.total}):

\[
G^O_i = \frac{\sum_{j \neq i} \sum_{l \neq i,j} |M_{ij} - M_{il}|}{2(n - 2) \sum_{j \neq k} M_{ij}}
\]

These Gini indices facilitates the direct comparison of different territories without further standardization.

### Usage

\texttt{migration.gini.out(m, corrected = TRUE)}

### Arguments

- \texttt{m}  \hspace{1cm} migration matrix

  Bell et al. (2002) updated the formula of Plane and Mulligan (1997) to be \(2(n - 2)\) instead of \(2(n - 1)\) because "the number of comparisons should exclude the diagonal cell in each row and column, and the comparison of each cell with itself".

### Value

A numeric vector with the range of 0 to 1 where 0 means no spatial focusing and 1 shows maximum focusing.

### References

Description

The Rows Gini index concentrates on the "relative extent to which the destination selections of out-migrations are spatially focused":

\[
G^T_{RT} = \frac{\sum_i \sum_{j \neq i} \sum_{h \neq i,j} |M_{ij} - M_{ih}|}{(2n(n-1)-1) \sum_i \sum_{j \neq i} M_{ij}}
\]

This implementation solves the above formula by computing the dist matrix for each row.

Usage

migration.gini.row(m)

Arguments

m migration matrix

Value

A number between 0 and 1 where 0 means no spatial focusing and 1 shows maximum focusing.

References


See Also

migration.gini.col migration.gini.row.standardized

Examples

data(migration.hyp)
migration.gini.row(migration.hyp) # 0
migration.gini.row(migration.hyp2) # 0.000 0.25 0.000
migration.gini.row(migration.hyp, FALSE) # 0 0 0
migration.gini.row(migration.hyp2, FALSE) # 0.000 0.125 0.000
migration.gini.row.standardized

Standardized Rows Gini Index

Description

The standardized version of the Rows Gini Index (migration.gini.row) by dividing that with the Total Flows Gini Index (migration.gini.total):

\[ G^T_R = 100 \frac{G^T}{G^T} \]

As this index is standardized, it "facilitate comparisons from one period to the next of the rows" indices.

Usage

migration.gini.row.standardized(m, gini.total = migration.gini.total(m, FALSE))

Arguments

m migration matrix

Arguments

m migration matrix

gini.total optionally pass the pre-computed Total Flows Gini Index to save computational resources

Value

A percentage range from 0% to 100% where 0% means that the migration flows are uniform, while a higher value indicates spatial focusing.

References


See Also

migration.gini.row migration.gini.col.standardized

Examples

data(migration.hyp)
migration.gini.row.standardized(migration.hyp) # 0
migration.gini.row.standardized(migration.hyp2) # 11.11111
**migration.gini.total**  
*Total Flows Gini Index*

**Description**

The Total Gini Index shows the overall concentration of migration with a simple number computed by comparing each cell of the migration matrix with every other cell except for the diagonal:

\[
G^T = \frac{\sum_i \sum_{j \neq i} \sum_k \sum_{l \neq k} |M_{ij} - M_{kl}|}{(2n(n - 1) - 1) \sum_i \sum_{j \neq i} M_{ij}}
\]

This implementation solves the above formula by a simple loop for performance issues to compare all values to the others at one go, although smaller migration matrices could also be addressed by a much faster `dist` method. Please see the sources for more details.

**Usage**

`migration.gini.total(m, corrected = TRUE)`

**Arguments**

- `m` migration matrix
- `corrected` Bell et al. (2002) updated the formula of Plane and Mulligan (1997) to have \(2n(n - 1) - 1\) instead of \(2n(n - 1)\) in the denominator to “ensure that the index can assume the upper limit of 1”.

**Value**

A number between 0 and 1 where 0 means no spatial focusing and 1 shows that all migrants are found in one single flow.

**References**


**See Also**

`migration.gini.col`, `migration.gini.row`, `migration.gini.exchange`, `migration.gini.in`, `migration.gini.out`
Examples

```r
data(migration.hyp)
migration.gini.total(migration.hyp) # 0.2666667
migration.gini.total(migration.hyp2) # 0.225
migration.gini.total(migration.hyp, FALSE) # 0.2222222
migration.gini.total(migration.hyp2, FALSE) # 0.1875
```

migration.hyp | Hypotetical Migration Matrix

Description

A small (3x3) hypothetical migration matrix.

Format

migration matrix

References


migration.indices | Migration indices

Description

This package provides various indices, like Crude Migration Rate, different Gini indices or the Coefficient of Variation among others, to show the (un)equality of migration.
Migration Inequality Index

Description

Measures the distance from an expected distribution:

\[ I_{MI} = \frac{\sum_i \sum_{j \neq i} |M_{ij} - M'_{ij}|}{2} \]

Usage

migration.inequality(m, expected = c("equal", "weighted"))

Arguments

- m: migration matrix
- expected: type of expected distribution

Value

A number between 0 and 1 where 1 shows greater inequality.

References


Examples

data(migration.hyp)
migration.inequality(migration.hyp)
migration.inequality(migration.hyp, expected = 'weighted')
data(migration.world)
migration.inequality(migration.world)
Migration-weighted In-migration Gini Index

Description

The Migration-weighted In-migration Gini Index is a weighted version of the In-migration Field Gini Index (migration.gini.in) "according to the zone of destination's share of total migration and the mean of the weighted values is computed as":

\[
MWG^I = \frac{\sum_j G_j^I \sum_i M_{ij}}{\sum_i M_{ij}}
\]

Usage

`migration.weighted.gini.in(m, mgi = migration.gini.in(m))`

Arguments

- `m` migration matrix
- `mgi` optionally passed (precomputed) Migration In-migration Gini Index

References


See Also

`migration.gini` `migration.gini.in` `migration.weighted.gini.out` `migration.weighted.gini.mean`

Examples

```r
data(migration.hyp)
migration.weighted.gini.in(migration.hyp)  # 0.1222222
migration.weighted.gini.in(migration.hyp2)  # 0.05238095
```
migration.weighted.gini.mean

Migration-weighted Mean Gini Index

Description

The Migration-weighted Mean Gini Index is simply the average of the Migration-weighted In-migration \((\text{migration.weighted.gini.in})\) and the Migration-weighted Out-migration \((\text{migration.weighted.gini.out})\) Gini Indices:

\[
MWG^A = \frac{MWG^O + MWG^I}{2}
\]

Usage

\[
\text{migration.weighted.gini.mean}(m, \text{mwgi}, \text{mwgo})
\]

Arguments

- \(m\): migration matrix
- \(\text{mwgi}\): optionally passed (precomputed) Migration-weighted In-migration Gini Index
- \(\text{mwgo}\): optionally passed (precomputed) Migration-weighted Out-migration Gini Index

Value

This combined index results in a number between 0 and 1 where 0 means no spatial focusing and 1 shows maximum focusing.

References


See Also

- \text{migration.weighted.gini.in}\n- \text{migration.weighted.gini.out}

Examples

\[
data(\text{migration.hyp})
migration.weighted.gini.mean(\text{migration.hyp}) \# 0.06111111
\]

\[
migration.weighted.gini.mean(\text{migration.hyp2}) \# 0.03660714
\]
**migration.weighted.gini.out**

*Migration-weighted Out-migration Gini Index*

**Description**

The Migration-weighted Out-migration Gini Index is a weighted version of the Out-migration Field Gini Index (*migration.gini.out*) "according to the zone of destination’s share of total migration and the mean of the weighted values is computed as":

\[
MWG^O = \frac{\sum_i G_i^O \sum_j M_{ij}^O}{\sum_{ij} M_{ij}^O}
\]

**Usage**

```
migration.weighted.gini.out(m, mgo = migration.gini.out(m))
```

**Arguments**

- `m` migration matrix
- `mgo` optionally passed (precomputed) Migration In-migration Gini Index

**References**


**See Also**

- `migration.weighted.gini.in`
- `migration.weighted.gini.mean`
- `migration.gini`
- `migration.gini.out`
- `migration.weighted.gini.in`
- `migration.weighted.gini.mean`

**Examples**

```
data(migration.hyp)
migration.weighted.gini.out(migration.hyp)  # 0
migration.weighted.gini.out(migration.hyp2)  # 0.02083333
```
migration.world Global Bilateral Migration Database (2000)

Description

Global (country-to-country) matrix of bilateral migrant stocks in 2000 with 226 economies involved.

Format

migration matrix

References

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