Package: propop (via r-universe)

Title Project Population Growth in Switzerland using the Cohort
Component Method

Version 0.2.0

Description The purpose of this package is to project the development
of the population at different spatial levels (e.g., cantons,
districts, municipalities) using the cohort component method
and the parameters provided by the Federal Statistical Office
(FSO).

URL https://statistik-aargau.github.io/propop

BugReports https://github.com/statistik-aargau/propop

License GPL (>= 3)

Depends R (>= 2.10)

Imports assertthat, BFS, cli, dplyr, Matrix, stringi, tibble, tidyr

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Repository https://swissstatsr.r-universe.dev

RemoteUrl https://github.com/statistik-aargau/propop

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Contents

| aggregate_measures | *Aggregate evaluation measures* |

Description

Returns descriptive summary statistics of model accuracy and bias measures across demographic
groups and years. The returned statistics are particularly useful for comparing the model perfor-
mance for different groups or different models.

Usage

```
aggregate_measures(data, weight_groups = NULL)
```

Arguments

data   data frame created with function `compute_measures`.

weight_groups   character, optional argument indicating one or more column names to obtain
                evaluation criteria weighted for specific groups (e.g., age groups, nationality).

Value

#' A data frame. The data frame includes the following summary measures:

- mpe is the mean percentage error (**mpe**; or mean algebraic percentage error **malpe**); it is a bias
  indicator as it takes the **direction** of the error into account. Positive values indicate that the
  projections were, overall, too high. Negative values indicate that the projections were, overall,
  too low. The closer the value is too zero, the lower the bias.

- medpe is the median (or middle value) of the percentage error (**medpe**). Particularly useful for
  small samples or skewed distributions. The closer the value is too zero, the lower the bias.

- mape is the mean **absolute** percentage / proportional error (**mape**). It considers variance (or
  amplitude) and can be seen as a measure of precision. The smaller the value, the lower is the
  average error.

- `medape` is the median (or middle value) of the **absolute** percentage error (**medape**). Particularly useful for small samples or skewed distributions. The smaller the value, the lower is the average error.
- `rmse` is the root mean square error; it is an indication of the robustness or quality of the projection. The smaller the value, the more robust the projection.
- `wmape` is the **weighted** mean **absolute** percentage error (**wmape**); in contrast to mape, this measure weights each absolute percentage error according to the population size of the "focal" group (e.g., nationality, age group) and thus considers domain size. Put differently, errors count more in populous groups than in less populous groups. This measure is particularly useful when population sizes vary strongly. The closer the value, the more precise is the projection.
- `n_measure` is the number of times a summary measure occurs (per weight group if requested).
- `ape_under_1` is a measure to gauge the error distribution; it indicates the proportion of observations that have absolute percentage errors smaller than 1%.
- `ape_under_5` is a measure to gauge the error distribution; it indicates the proportion of observations that have absolute percentage errors smaller than 5%.

References

Baker, J., et al. (2015). Sub-county population estimates using administrative records: A municipal-level case study in New Mexico. In M. N. Hoque & L. B. Potter (Eds.), Emerging techniques in applied demography (pp. 63-79). Springer, https://doi.org/10.1007/978-94-017-8990-5_6

Bérard-Chagnon, J. (2015) Using tax data to estimate the number of families and households in Canada. In M. N. Hoque & L. B. Potter (Eds.), Emerging techniques in applied demography (pp. 137-153). Springer, https://doi.org/10.1007/978-94-017-8990-5_10

Reinhold M. & Thomsen, S. L. (2015) Subnational population projections by age: An evaluation of combined forecast techniques, Population Research and Policy Review, 34, 593-613, https://doi.org/10.1007/s11113-015-9362-0

Wilson, T. (2012). Forecast accuracy and uncertainty of Australian Bureau of Statistics state and territory population projections, International Journal of Population Research, 1, 419824, https://doi.org/10.1155/2012/419824

Wilson, T. (2016). Evaluation of alternative cohort-component models for local area population forecasts, Population Research and Policy Review, 35, 241-261, https://doi.org/10.1007/s11113-015-9380-y

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| compute_measures | *Compute evaluation measures* |

Description

Uses the differences between a benchmark and the results from a projection to compute performance measures.

Usage

```
compute_measures(combined, weight_groups = NULL)
```

Arguments

`combined`	data frame created with `propop::prepare_evaluation()`.
`weight_groups`	character, optional argument indicating one or more column names to obtain evaluation criteria weighted for specific groups (e.g., age groups, nationality).

Details

The input is a data frame created with `propop::prepare_evaluation()`. It includes a benchmark (typically the observed population records, i.e., the number of people per spatial unit, demographic group, and year) and the corresponding projected number of people. The input can range from low resolution (e.g., total number of people per municipality) to high resolution (e.g., 101 age classes, nationality, sex).

For more details on usage, see `vignette("evaluate", package = "propop")`.

Value

A data frame. The following evaluation criteria can directly be interpreted and used for descriptive comparisons:

- `error` is the forecast error; it quantifies the level of under-projection (negative values) and over-projection (positive values) relative to the benchmark `n_bench`.

- `pe` is the percentage error and expresses the under- / over-projection in percent of the benchmark `n_bench`.

- `ape` is the absolute percentage error; it is the absolute deviation in percent of the benchmark `n_bench`, thus only showing the extent of the error but not the direction.

- `w_ape` is the weighted absolute percentage error; it weighs each absolute percentage error according to the population size of the focal group (e.g., nationality, age group). The weighted version is useful as an aggregated measure when groups vary strongly in terms of population size. Only returned when the argument `weight_groups` contains at least one grouping variable.

The following helper variables are used to compute aggregate measures. They are only returned when weight groups are provided via the argument `weight_groups`.

- `n_tot` is the total number of people (i.e., sum of the number of people in all demographic groups); used to compute the weighted absolute percentage error.

- `group_tot` is the number of people in the focal group; used to compute the weighted absolute percentage error.

- `weight` is the share of the (optional) focal group (e.g., municipality type / size, nationality, age group) relative to all people; used to compute the weighted absolute percentage error.

References

Baker, J., et al. (2015). Sub-county population estimates using administrative records: A municipal-level case study in New Mexico. In M. N. Hoque & L. B. Potter (Eds.), Emerging techniques in applied demography (pp. 63-79). Springer, https://doi.org/10.1007/978-94-017-8990-5_6

Wilson, T. (2012). Forecast accuracy and uncertainty of Australian Bureau of Statistics state and territory population projections, International Journal of Population Research, 1, 419824, `https://doi.org/10.1155/2012/419824`

Wilson, T. (2016). Evaluation of alternative cohort-component models for local area population forecasts, Population Research and Policy Review, 35, 241-261, `https://doi.org/10.1007/s11113-015-9380-y`

Examples

```
## Not run:
# Get evaluation measures without weights
compute_measures(combined)
# Get evaluation measures weighted for groups
compute_measures(combined, weight_groups = c("age", "nat"))

## End(Not run)
```

---

fso_parameters   *Sample parameters to run population projection*

Description

Data frame containing the rates and number of people from the Federal Statistical Office (FSO) required to project the development of four demographic groups for a selected canton (Aargau). The parameters are from the model published in 2020. The sample data only include the reference scenario and the years 2019-2030.

Usage

```
fso_parameters
```

Format

The example data include the required parameters for each demographic group (nationality (2) X sex (2) X age classes (101)) for the years 2019-2030.

Demographic groups

The returned data frame includes parameters for each unique combination of the following demographic variables:

- nat: ch = Swiss; int = foreign / international.
- sex: f = female, m = male.
- age: 101 one-year age classes, ranging from 0 to 100 (including those older than 100).

Parameters

The following parameters are included in the returned data frame:

- `year`: character, year of projection.

- `scen`: character, projection scenario.

- `birth_rate`: numeric, number of children per year.

- `births_int_ch`: numeric, proportion of children with Swiss nationality born to non-Swiss mothers.

- `mor`: numeric, prospective mortality (probability of death).

- `emi`: numeric, rate of people emigrating abroad.

- `acq`: numeric, rate of acquisition of Swiss citizenship.

- `imm_int`: numeric, number of people immigrating from abroad.

- `mig_ch`: numeric, national / inter-cantonal net migration (number of immigrants minus number of emigrants).

- `spatial_unit`: character, indicating the user requested spatial unit(s).

Details about calculated variables

`births_int_ch` is calculated by dividing the number of live newborns with Swiss citizenship born to non-Swiss mothers by the number of all live newborns born to non-Swiss mothers.

`mig_ch` is calculated as the difference between the immigration from other cantons and the emigration to other cantons.

Source

Data obtained from the Swiss Federal Statistical Office (FSO):

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_101/-/px-x-0104020000_101.px/

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_102/-/px-x-0104020000_102.px

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_103/-/px-x-0104020000_103.px/

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_106/-/px-x-0104020000_106.px/

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_109/-/px-x-0104020000_109.px/

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fso_population   *Sample population data from the Federal Statistical Office*

Description

Data frame containing the starting population required to project the development of four demographic groups for a selected canton (Aargau). The data from 2018 were obtained from the Federal Statistical Office (FSO).

Usage

```
fso_population
```

Format

The example population records include the number of people of each demographic group (nationality (2) X sex (2) X age classes (101)) for the canton of Aargau in 2018.

Value

A data frame. For each of the four demographic groups (female / male, Swiss / foreign nationals), there are 101 age classes, resulting in a total of 404 rows per requested year and spatial unit. Columns included in the returned data frame:

year character, year in which the population was recorded.

spatial_unit character, indicating the spatial entities (e.g., cantons, districts, municipalities).

nat character, ch = Swiss, int = foreign / international.

sex character f = female, m = male.

age numeric, 101 one-year age classes, ranging from 0 to 100 (including those older than 100).

n numeric, number of people per year, spatial entity, and demographic group.

Source

Federal Statistical Office: `https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0102010000_101/-/px-x-0102010000_101.px/`

`fso_projections`	*Sample population projections from FSO for the canton of Aargau*

Description

Data frame containing the population projections from the Federal Statistical Office (FSO) for four demographic groups for the canton of Aargau. The projections are from the model published in 2020. The sample data only include the reference scenario and the years 2019-2030.

Usage

```
fso_projections
```

Format

The example projections include the projected number of people of each demographic group (nationality (2) X sex (2) X age classes (101)) for the years 2019-2030.

Variables

- `year`: character, year of projection.

- `scen`: character, only including the "reference" scenario.

- `nat`: character, ch = Swiss; int = foreign / international.

- `sex`: character, f = female, m = male.

- `age`: numeric, 101 one-year age classes, ranging from 0 to 100 (including those older than 100).

- `spatial_unit`: character, indicating that the data refer to the canton Aargau.

- `n_projected`: numeric, number of people per demographic group and year.

Source

Federal Statistical Office: https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_101/-/px-x-0104020000_101.px/

---

get_parameters *Get projection parameters from FSO*

Description

Users who do not have the mandatory projection parameters for propop::propop() can use this convenience function to download them from the Federal Statistical Office (FSO). The parameters are only available on the level of cantons. For smaller-scale projections, the parameters must be scaled down. In addition to the parameters, the function also returns the projected population (i.e., number of expected people). All parameters and projections are from the FSO model published in 2020. The variables births_int_ch and mig_ch are not directly available from the FSO. They are calculated by the function.

To get projection parameters, you must use the spelling defined in the corresponding FSO table. See vignette("prepare_data", package = "propop").

Changes to the API interface may break this function. If problems occur, we recommend following the step-by-step procedure described in vignette("prepare_data", package = "propop").

Usage

```
get_parameters(
  number_fso_ref = "px-x-0104020000_101",
  number_fso_high = "px-x-0104020000_102",
  number_fso_low = "px-x-0104020000_103",
  number_fso_rates = "px-x-0104020000_109",
  number_fso_births = "px-x-0104020000_106",
  year_first,
  year_last,
  spatial_units
)
```

Arguments

number_fso_ref character, px-x table ID for number parameters (reference scenario), defaults to "px-x-0104020000_101".

number_fso_high

character, px-x table ID for number parameters (high growth scenario), defaults to "px-x-0104020000_102".

number_fso_low character, px-x table ID for for number parameters (low growth scenario, defaults to "px-x-0104020000_103".

number_fso_rates

character, px-x table ID for rate parameters, defaults to "px-x-0104020000_109".

number_fso_births

character, px-x table ID required to compute the share of Swiss newborns from non-Swiss mothers, defaults to "px-x-0104020000_106".

year_first	numeric, first year for which the parameters and projections are to be downloaded.
year_last	numeric, last year for which the parameters and projections are to be downloaded.
spatial_units	character vector, indicating at least one spatial entity for which the projection will be run. Typically a canton.

Value

A data frame with the rates and number of people from the Federal Statistical Office (FSO) required to project the population development of the requested spatial entities. For each of the four demographic groups (nationality x sex), there are 101 age classes, resulting in a total of 404 rows per requested year and spatial unit.

Demographic groups

The returned data frame includes parameters for each unique combination of the following demographic variables:

- nat: ch = Swiss; int = foreign / international.
- sex: f = female, m = male.
- age: 101 one-year age classes, ranging from 0 to 100 (including those older than 100).

Parameters

The following parameters are included in the returned data frame:

- year: character, year of projection.
- scen: character, projection scenario.
- birth_rate: numeric, number of children per year.
- births_int_ch: numeric, proportion of children with Swiss nationality born to non-Swiss mothers.
- mor: numeric, prospective mortality (probability of death).
- emi: numeric, rate of people emigrating abroad.
- acq: numeric, rate of acquisition of Swiss citizenship.
- imm_int: numeric, number of people immigrating from abroad.
- mig_ch: numeric, national / inter-cantonal net migration (number of immigrants minus number of emigrants).
- spatial_unit: character, indicating the user requested spatial unit(s).

Projected population

n_projected is the the number of people per demographic group and year on December 31 (as projected by the FSO in the 2020 model).

Details about calculated variables

`births_int_ch` is calculated by dividing the number of live newborns with Swiss citizenship born to non-Swiss mothers by the number of all live newborns born to non-Swiss mothers.

`mig_ch` is calculated as the difference between the immigration from other cantons and the emigration to other cantons.

Source

Data obtained from the Swiss Federal Statistical Office (FSO):

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_101/-/px-x-0104020000_101.px/

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_102/-/px-x-0104020000_102.px

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_103/-/px-x-0104020000_103.px/

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_106/-/px-x-0104020000_106.px/

- https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104020000_109/-/px-x-0104020000_109.px/

Examples

```
## Not run:
one_canton <- get_parameters(
  year_first = 2025,
  year_last = 2050,
  spatial_units = c("Aargau")
)
two_cantons_4years <- get_parameters(
  year_first = 2018,
  year_last = 2021,
  spatial_units = c("Aargau", "Zug")
)

## End(Not run)
```

get_population   *Get population data from FSO*

Description

Users who do not have the required population data can use this convenience function to get the mandatory starting population for `propop::propop()` from the Federal Statistical Office (FSO). The function can also be used to obtain historical population records (e.g., for model performance evaluations).

To get population data, you must use the spelling defined in the corresponding FSO table. For more details see `vignette("prepare_data", package = "propop")`.

Changes to the API interface may break this function. If problems occur, see `vignette("prepare_data", package = "propop")`.

Usage

```
get_population(
  number_fso = "px-x-0102010000_101",
  year_first,
  year_last,
  spatial_units
)
```

Arguments

number_fso	character, px-x table ID for population records, defaults to `px-x-0102010000_101`.
year_first	numeric, first year for which the population records are to be downloaded.
year_last	numeric, last year for which the population records are to be downloaded. When downloading the starting population for the projection, this will be the same as `year_first`.
	`year_first` when requesting the starting population for `propop::propop()`
spatial_units	character vector, indicating at least one spatial entity for which the projection will be run. Typically a canton, districts, or municipalities.

Value

A data frame. For each of the four demographic groups (female / male, Swiss / foreign nationals), there are 101 age classes, resulting in a total of 404 rows per requested year and spatial unit. Columns included in the returned data frame:

year character, year in which the population was recorded.

spatial_unit character, indicating the spatial entities (e.g., cantons, districts, municipalities).

nat character, ch = Swiss, int = foreign / international.

sex character f = female, m = male.

age numeric, 101 one-year age classes, ranging from 0 to 100 (including those older than 100).

n numeric, number of people per year, spatial entity, and demographic group.

Source

Federal Statistical Office: https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0102010000_101/
-/px-x-0102010000_101.px/

Examples

```
## Not run:
get_population(
  number_fso = "px-x-0102010000_101",
  year_first = 2018,
  year_last = 2019,
  spatial_units = "- Aargau"
)
get_population(
  year_first = 2018,
  year_last = 2018,
  spatial_units = c("- Aargau", "......0301 Aarberg")
)

## End(Not run)
```

---

prepare_evaluation   *Prepare data for evaluation*

Description

This functions takes benchmark data (typically population records) and population projections and prepares a combined data frame to evaluate the performance of the projection. For more details on usage, see vignette("evaluate", package = "propop").

Usage

```
prepare_evaluation(
  data_benchmark,
  data_projected,
  drop_start_year = FALSE,
  age_groups = NULL
)
```

Arguments

data_benchmark data frame containing benchmark data (e.g., actual / official population records obtained with propop::get_population()).

data_projected data frame containing population projections; can be created with propop::propop().

drop_start_year

logical, indicating if starting population shall be removed from data_projected.

age_groups character, optional argument ("age_groups_3") indicating if the data shall be aggregated into the predefined three age groups (0-19, 20-64, over 65 years). Using aggregated groups will lead to smaller projection errors than using 101 age classes. Currently only one option is available for aggregating age groups. Defaults to using 101 one-year age classes.

Value

Returns a data frame with the number of people from the benchmark and from the projection. Each row contains a unique combination of year, spatial unit, and demographic group.

Input data and variables

Both input data frames must contain the following variables for the **same range of years**:

year character, year in which the population was recorded.

spatial_unit character, indicating the spatial entities (e.g., cantons, districts, municipalities).

nat character, ch = Swiss, int = foreign / international.

sex character, f = female, m = male.

age numeric, 101 one-year age classes, ranging from 0 to 100 (including those older than 100).

n numeric, number of people per year, spatial entity, and demographic group.

Examples

```
## Not run:
combined <- prepare_evaluation(
  data_benchmark = output_get_population,
  data_projected = output_propop,
  drop_start_year = TRUE
)
combined_grouped <- prepare_evaluation(
  data_benchmark = output_get_population,
  data_projected = output_propop,
  drop_start_year = TRUE,
  age_groups = "age_groups_3"
)

## End(Not run)
```

---

project_raw   *Project population development (raw results)*

Description

Core function that uses the cohort component method and matrix algebra to project population development. The function can be used for different spatial levels (e.g., cantons, municipalities) and for one scenario at a time.

This function provides projections in a **raw** version in which key information is missing (e.g., which age groups the rows represent). To conveniently obtain an enriched, more informative output, use the **wrapper function** propop::propop() (which internally uses propop::project_raw()).

The parameters and start populations for different spatial levels can be obtained from the Swiss Federal Statistical Office (FSO). For instructions on how to download this information from STAT-TAB, see vignette("prepare_data", package = "propop").

The projection parameters need to be passed on as a single data frame to `project_raw` with (with the parameters as columns). The column types, names, and factor levels need to match those specified below.

The method used to calculate the projections is a 'cohort-component analysis' implemented with matrices due to programming performance benefit compared to data frames. In a nutshell, the starting population ('n') is multiplied by the survival rate to obtain the number of people which transition into the projected next year (year + 1). Then, the absolute number of people immigrating from outside Switzerland and the migration saldo for people from outside the respective canton is added to the surviving population. This results in the starting population for projection the next year. Newborn children are added aeparately to the new starting population of each year.

The starting population is clustered in 404 groups: 101 age groups times two nationalities times 2 genders. The survival rate is calculated in the function 'create_transition_matrix()' resulting in the matrix 'L'. We use the rates for mortality, emigration towards countries outside Switzerland and the rate for the acquisition of the Swiss citizenship by the foreign population to calculate survival rates. The model from the FSO also includes the rate of emigration to other cantons in the survival rate. In contrast, we include the immi- and emigration from and to other cantons by adding the migration balance (German = 'saldo') (immigration + emigration) afterwards.

Steps in this function:

1. Checks: Checking input data and parameter settings for correct formats.

2. Data preparation: Preparing vectors e.g. for the projection time frame and creating empty vectors to be filled with data later on.

3. Loop over years for calculating the projections

   - Subsetting parameters: Depending on the selected projection year and on the demographic unit, the parameters for mortality, fertility, acquisition of the Swiss citizenship as well as migration parameters are subset by demographic group.
   - Create matrices: Matrices are build for the survival rate, mortality, fertility and for calculating the number of newborn babies.
   - Creating vectors: Vectors are built for mortality and migration parameters.
   - Projection: The transition matrix 'L' is multiplied by the starting population for the next year. Migrating people are added in absolute numbers. People that are 100 years old and older are clustered into one age group (age = 100). The newborn babies are added to the resulting starting population for the next projection year.

4. Aggregating the data: All projected years are aggregated into one data frame. The function 'propop()', in which this function is contained, automatically adds relevant meta data to the results.

Usage

```
project_raw(
  parameters,
  year_first,
  year_last,
  age_groups = 101,
  fert_first = 16,
  fert_last = 50,
```

```
    share_born_female = 100/205,
    n,
    subregional
)
```

Arguments

parameters   data frame containing the FSO rates and numbers to run the projection for a
                   specific spatial level (e.g., canton, municipality).

- year: projection year.
- spatial_unit: ID of spatial entity (e.g., canton, municipality) for which
  to run the projections.
- scen: projection scenario, used to subset data frames with multiple scenarios (r = reference, l = low growth, h = high growth scenario).
- nat: nationality (ch = Swiss; int = foreign / international).
- sex: sex (f = female, m = male).
- age: age classes; typically ranging from 0 to 100 (incl. >100).
- birth_rate: number of children per year.
- births_int_ch proportion of children with Swiss nationality born to non-
  Swiss mothers.
- mor: prospective mortality rate (probability of death).
- acq: rate of acquisition of Swiss citizenship.
- emi: rate of people emigrating abroad.
- mig_ch: national / inter-cantonal net migration (number of immigrants -
  number of emigrants).
- imm_int: number of people immigrating from abroad.
- mig_sub: within canton net migration. Useful to account for movements
  between different subregions (e.g., municipalities). This argument is **optional.**

year_first   numeric, first year to be projected.

year_last   numeric, last year to be projected.

age_groups   numeric, number of age classes. Creates a vector with 1-year age classes running
                   from 0 to (age_groups - 1). Defaults to 101 (FSO standard number of age
                   groups).

fert_first   numeric, first year of female fertility. Defaults to 16 (FSO standard value).

fert_last   numeric, last year of female fertility. Defaults to 50 (FSO standard value).

share_born_female
                   numeric, fraction of female babies. Defaults to 100 / 205 (FSO standard value).

n   number of people per demographic group and year; should be the year before
                   year_first. Typically extracted from data frame created with propop::get_population().

subregional   boolean, TRUE indicates that subregional migration patterns (e.g., movement
                   between municipalities within a canton) are part of the projection.

Value

Returns an unformatted and unlabeled data frame. It includes the number of people for each demographic group per year (starting year and projected years. The number of rows corresponds to the product of years and demographic groups (e.g., nationality (2) X sex (2) X age groups (101) = 404). Variables included in the output:

n	number of people per demographic group.
IMM_INT	number of immigrants from other countries.
MIG_CH	number of people migrating from / to other superordinate spatial units (typically cantons).
MIG_SUB	number of migrants within the superordinate spatial unit (typically a canton).
MOR	number of deaths (among people older than 0).
EMI_INT	number of emigrants to other countries.
ACQ	number of foreigners who acquire Swiss citizenship (naturalisations).
BIRTHS	number of births.

See Also

propop()

Examples

```
# load package data
data(fso_parameters)
data(fso_population)

# run projection
project_raw(
  parameters = fso_parameters,
  year_first = 2019,
  year_last = 2019,
  n = fso_population |> dplyr::pull(n),
  subregional = FALSE
) |>
  head(10)
```

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propop	*Project population development (enriched results)*

Description

Project population development using the cohort component method (see e.g., here for more details). This **wrapper function** runs the projection and returns a clean data frame with clearly labeled variables and variable levels.

The parameters and start population can be obtained from the Swiss Federal Statistical Office (FSO). For instructions on how to download this information from STAT-TAB, see vignette("prepare_data", package = "propop").

For more details on how to use this function to project the population development on the level of a canton, see vignette("run_projections", package = "propop").

The projection parameters need to be passed to propop::propop() as a **single data frame** (with the parameters as columns). The column types, names, and factor levels need to match the specifications listed below under parameters:

Usage

```
propop(
  parameters,
  population,
  year_first,
  year_last,
  age_groups = 101,
  fert_first = 16,
  fert_last = 50,
  share_born_female = 100/205,
  subregional = FALSE,
  binational = TRUE,
  spatial_unit = "spatial_unit"
)
```

Arguments

parameters   data frame containing the FSO rates and numbers to run the projection for a specific spatial level (e.g., canton, municipality).

- year character, projection year.
- spatial_unit, character, ID of spatial entity (e.g., canton, municipality) for which to run the projections.
- scen, character, projection scenario, is used to subset data frames with multiple scenarios (r = reference, l = low growth, h = high growth).
- nat, character, OPTIONAL; nationality (ch = Swiss; int = foreign/international).
- sex, character (f = female, m = male).
- age, numeric, typically ranging from 0 to 100 (incl. >100).
- birth_rate, numeric, number of children per year.
- births_int_ch, numeric, OPTIONAL; proportion of children with Swiss nationality born to non-Swiss mothers.
- mor, numeric, prospective mortality rate (probability of death).
- acq, numeric, OPTIONAL; rate of acquisition of Swiss citizenship.
- emi, numeric, rate of people emigrating abroad.
- mig_ch, numeric, national / inter-cantonal net migration (number of immigrants - number of emigrants).
- imm_int, numeric, number of people immigrating from abroad.

- mig_sub, numeric, within canton net migration. Useful to account for movements between different subregions (e.g., municipalities). This argument is **optional.**

population   data frame including the starting population of each demographic group. Possible values are the same as in parameters (apart from year). The data frame only includes one year, usually the one preceding the first projected year.

- year character, should be year_first - 1.
- spatial_unit character.
- nat character.
- sex character.
- age numeric.
- n numeric, number of people per demographic group.

year_first   numeric, first year to be projected.

year_last   numeric, last year to be projected.

age_groups   numeric, number of age classes. Creates a vector with 1-year age classes running from 0 to (age_groups - 1). Defaults to 101 (FSO standard number of age groups).

fert_first   numeric, first year of female fertility. Defaults to 16 (FSO standard value).

fert_last   numeric, last year of female fertility. Defaults to 50 (FSO standard value).

share_born_female

                    numeric, fraction of female babies. Defaults to 100 / 205 (FSO standard value).

subregional   boolean, TRUE indicates that subregional migration patterns (e.g., movement between municipalities within a canton) are part of the projection.

binational   boolean, TRUE indicates that projections discriminate between two groups of nationalities. FALSE indicates no distinction between groups of nationalities.

spatial_unit   character, name of variable containing the names of the region or subregions for which the projection shall be performed.

Value

Returns a data frame that includes the number of people for each demographic group per year (for the starting year and each projected year). The number of rows is the product of all years times all demographic groups (e.g., nationality (2) * sex (2) * age groups (101) = 404). Variables included in the output:

age   integer.

sex   factor, female (f) and male (m).

nat   factor, Swiss (ch) and international / foreign (int).

year   integer, indicating starting year / projected years.

spatial_levels   factor, spatial levels for which the projection was run (e.g., canton, municipalities).

n   double, number of people per demographic group.

Examples

```
# Run projection for the sample data (whole canton of Aargau)
propop(
  parameters = fso_parameters,
  year_first = 2019,
  year_last = 2022,
  population = fso_population,
  subregional = FALSE,
  binational = TRUE
)
```

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