Package 'qlifetable'

October 13, 2022

Title Managing and Building of Quarterly Life Tables

Version 0.0.1-13

Description Manages, builds and computes statistics and datasets for the construction of quarterly (sub-annual) life tables by exploiting micro-data from either a general or an insured population.
References:
Pavía and Lledó (2022) <doi:10.1111/rssa.12769>.

License EPL

Encoding UTF-8

Imports stats, methods

Suggests ggplot2, scales

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R topics documented:

`coord_age` *Time elapsed (in years) since last birthday and the date of the event*

Description

Computes the time(s) elapsed (in years) between the date(s) of last birthday and the date(s) of event(s) for each member of a population. The age coordinate(s) corresponding to an 1x1-year Lexis diagram, using by default the same length of year employed to compute the (related) time coordinate(s).

Usage

```
coord_age(
  date.birth,
  date.event,
  random.b = TRUE,
  random.e = TRUE,
  constant.age.year = FALSE
)
```

Arguments

`date.birth`	A character vector with the dates of birth in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.b = FALSE', or a random hour by default.
`date.event`	A character vector with the dates of events in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.e = FALSE', or a random hour, by default. This vector must have either length 1, when the aim is to compute for all the members of the population the age coordinate in an 1x1-year Lexis diagram in the same temporal point, or the same length as 'date.birth', when the aim is to compute for each member of the population the age coordinate in the moment of the event (e.g., death).
`random.b`	A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the birth occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.birth' even if those have been declared. By default, TRUE.
`random.e`	A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the event occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.event' even if those have been declared. By default, TRUE.
`constant.age.year`	A 'TRUE/FALSE' argument indicating whether the length of the year should be constant, 365.25 days, or variable, depending on the time lived for the person in

each year since her/his dates of birth and event. By default, FALSE. The advantage of using a non-constant (person-dependent) length of year is congruence when estimating time exposed at risk: in each year the time exposed along the time and age axes will coincide.

Value

A numeric vector of the same length as data.birth

Note

If 'constant.age.year = FALSE' (default), the length of the year for each person is computed as a weighted average of the lengths of the years that the person has lived between the dates of birth and event using as weight the time lived for the person during each year.

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

See Also

coord_time, exact_age

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
dates.e <- c("2002-03-23", "2009-04-12", "2019-01-01")
coord_age(dates.b, dates.e)
```

---

coord_time *Time elapsed (in years) since the beginning of the year*

Description

Computes the time(s) elapsed (in years) between the beginning of the year and the date(s) of the event(s). The time coordinate(s) in a Lexis diagram.

Usage

```
coord_time(date.event, random.e = TRUE)
```

Arguments

date.event	A character vector with the dates of events in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.e = FALSE', or a random hour, by default.
random.e	A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the event occurs within the day is randomly selected. This overwrites "hour:min:secs" in 'date.event' even if this has been declared.

Value

A numeric vector of the same length as data.event

@seealso coord_age, exact_age

Note

The length of the year is 365 days in non-leap years and 366 days in leap years.

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

Examples

```
dates <- c("2002-03-23", "2009-04-12", "2019-01-01")
coord_time(dates)
dates <- "2019-01-01 14:00:00"
coord_time(dates, FALSE)
```

---

count_events_quarter *Data frame of number of events occurring in each Lexis-diagram quarter*

Description

Computes for each integer age and each combination of age and seasonal quarter the number of events occurring in population. The computation is performed using the associated data frame of quarterly variables corresponding to the population obtained using the quarterly_variables function.

Usage

```
count_events_quarter(x)
```

Arguments

x	A data.frame output of the quarterly_variables function.

Value

A data frame with the time exposed at risk for each (potential) combination of integer age and age and season quarter of the input dataset. The data frame has the following components:

age	Integer age to which the time exposed at risk corresponds.
quarter.age	Age quarter to which the time exposed at risk corresponds.
quarter.calendar	Calendar (time, season) quarter to which the time exposed at risk corresponds.
number.events	Number of events that occurred during the quarter determined for the combination of 'age', 'quarter.age' and 'quarter.calendar'.

Note

The structure of the dataset is similar to those obtained using the time_exposed_outs, time_exposed_ins and time_exposed_stock functions.

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
dates.e <- c("2002-03-23", "2009-04-12", "2019-01-01")
x <- quarterly_variables(dates.b, dates.e)
out <- count_events_quarter(x)
```

`distribute_excess` *Randomly distributes the excess of recorded births in a given day*

Description

Randomly distributes a number of births equivalent to the excess of registered births on a given day of a year among the different days of that year.

Usage

```
distribute_excess(
  date.birth,
  day = "01-01",
  maximum.excess = 50,
  date.event = NULL
)
```

Arguments

`date.birth`	A character vector with the dates of birth in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population.
`day`	A character vector in format "mm-dd" with the day of the year for which the (assumed) excess must be randomly distributed. By default, "01-01".
`maximum.excess`	A numeric value indicating the percentage of births registered above the average to be surpassed in the target day in order to consider that in that day an excess of births has been artificially recorded.
`date.event`	A character vector with the dates of events in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") linked to the population of births. By default, NULL. When the dates of births are linked to some dates of events and both occur in the same year, it can happen that some imputed dates of births be posterior to the dates of events. The inclusion of this argument (when different of NULL) avoids this possibility happening.

Value

A numeric vector of the same length and order as data.birth.

Note

We consider that in a day an excess of births has been registered if the percentage of the number of births recorded in that day surpasses the average number of births registered during the days of the corresponding year in a amount higher than ‘maximum.excess‘.

An excess usually happens in official statistics on the first of January. This occurs as a consequence of established protocols in country border systems, because when an immigrant does not know her/his day of birth, the border officials usually record them as January, 1. This provokes an artificial peak of dates of births in that date.

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

See Also

time_exposed_ins, time_exposed_outs

Examples

```
dates <- c("1920-05-13", "1999-04-12", "2019-01-01", "2019-01-01",
           "2022-01-01", "2022-01-01", "2022-01-01", "2022-01-01", "2022-01-01")
distribute_excess(dates)
```

---

exact_age *Time elapsed (in years) since the dates of birth and event.*

Description

Computes the time(s) elapsed (in years) between the date(s) of birth and the date(s) of event(s).

Usage

```
exact_age(
  date.birth,
  date.event,
  random.b = TRUE,
  random.e = TRUE,
  constant.age.year = FALSE
)
```

Arguments

date.birth	A character vector with the dates of birth in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if ‘random.b = FALSE‘, or a random hour by default.

`date.event` A character vector with the dates of events in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.e = FALSE', or a random hour, by default. This vector must have either length 1, when the aim is to compute the exact age of all the members of the population in the same temporal point or the same length as 'date.birth' when the aim is to compute for each member of the population the exact age in the moment of the event (e.g., death).

`random.b` A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the birth occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.birth' even if those have been declared. By default, TRUE.

`random.e` A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the event occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.event' even if those have been declared. By default, TRUE.

`constant.age.year` A 'TRUE/FALSE' argument indicating whether the length of the year should be constant, 365.25 days, or variable, depending on the time lived for the person in each year since her/his dates of birth and event. By default, FALSE. The advantage of using a non-constant (person-dependent) length of year is congruence when estimating time exposed at risk: in each year the time exposed along the time and age axes will coincide.

Value

A numeric vector of the same length as data.birth

Note

If 'constant.age.year = FALSE' (default), the length of the year for each person is computed as a weighted average of the lengths of the years that the person has lived between the dates of birth and event using as weight the time lived for the person during each year.

Author(s)

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

See Also

coord_age, coord_time

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
dates.e <- c("2002-03-23", "2009-04-12", "2019-01-01")
exact_age(dates.b, dates.e)
```

`plot.qlifetable` *Graphical representation in a 4x4 raster of a qlifetable data frame.*

Description

Plot method for a data frame of events or time exposed occurring in each Lexis-diagram quarter for a set of ages. This is a plot method for the objects typically obtained using the function `count_events_quarter` or whatever of the time_exposed_ functions (e.g., `time_exposed_outs`).

Usage

```
## S3 method for class 'qlifetable'
plot(
  x,
  ...,
  range.ages = NULL,
  key = "numbers",
  decimal.digits = 2,
  color.palette = "grey",
  alpha.max = 1,
  alpha.min = 0.4,
  color.values = "black",
  big.mark = NULL,
  size.values = 3,
  legend.name = NULL,
  name.labels.age = c("Q1", "Q2", "Q3", "Q4"),
  name.labels.season = c("Winter", "Spring", "Summer", "Autumn"),
  show.plot = TRUE
)
```

Arguments

`x`	A data frame of quarterly summary statistics. Typically an output of the function `count_events_quarter` or whatever of the time_exposed_ functions (e.g., `time_exposed_outs`).
`...`	Other arguments passed on to methods. Not currently used.
`range.ages`	A vector of integers informing the aggregation of ages for which the graphical representation should be plotted. Default, NULL, the agggregation of all ages is shown.
`key`	Type of statistic to be presented in the plot. Either 'numbers' or relative 'percentages'.

decimal.digits	Integer indicating the number of decimal places to be shown. Default, 2.
color.palette	Background base color for cells. Default, "grey".
alpha.max	A number in the interval [0, 1]. Maximum level of transparency to be applied for the background to build the palette. Default, 1.
alpha.min	A number in the interval [0, 1]. Minimum level of transparency to be applied for the background to build the palette. Default, 0.4.
color.values	Base color for numbers printed in each cell. Default, "black".
big.mark	A character string indicating the symbol to be used as thousand separator. Default, NULL.
size.values	A number indicating the font size to be used for inner-cells values. Default, 3.
legend.name	Name to be use as name in the legend. Default, NULL.
name.labels.age	Names to be used for the (y) age axis. Default, c("Q1", "Q2", "Q3", "Q4").
name.labels.season	Names to be used for the (x) season axis. Default, c("Winter", "Spring", "Summer", "Autumn").
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.

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Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
dates.e <- c("2002-03-23", "2009-04-12", "2019-01-01")
x <- quarterly_variables(dates.b, dates.e)
out <- time_exposed_outs(x)
p <- plot(out, show.plot = FALSE)
```

quarterly_variables *Data frame of quarterly variables*

Description

Computes punctual risk coordinates in the Lexis diagram and quarterly biometric variables of a population.

Usage

```
quarterly_variables(
  date.birth,
  date.event,
  random.b = TRUE,
  random.e = TRUE,
  constant.age.year = FALSE
)
```

Arguments

date.birth	A character vector with the dates of birth in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.b = FALSE', or a random hour by default.
date.event	A character vector with the dates of events in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of a population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.e = FALSE', or a random hour, by default. This vector must have either length 1, when the aim is to compute the exact age or the (1x1-Lexis) age coordinate of all the members of the population in the same temporal point or the same length as 'date.birth' when the aim is to compute for each member of the population the exact age or the (1x1-Lexis) age coordinate in the moment of the event (e.g., death).
random.b	A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the birth occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.birth' even if those have been declared. By default, TRUE.
random.e	A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the event occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.event' even if those have been declared. By default, TRUE.
constant.age.year	A 'TRUE/FALSE' argument indicating whether the length of the year should be constant, 365.25 days, or variable, depending on the time lived for the person in each year since her/his dates of birth and event. By default, FALSE. The advantage of using a non-constant (person-dependent) length of year is congruence

when estimating time exposed at risk: in each year the time exposed along the time and age axes will coincide.

Value

A data.frame with the following components:

`coord.age` Time elapsed, measure in years, between the last birthday and the date when the event happens.

`coord.time` Time coordinate: time elapsed, measure in years, between the begining of the year and the date when the event happens.

`age.last.birthday`
The integer age at last birthday.

`exact.age.at.event`
Time elapsed, measure in years, between the dates of birth and event.

`quarter.age` Age quarter when the event happens.

`quarter.calendar`
Calendar (time, season) quarter to which the time exposed at risk corresponds.

`year` Year when the event happens.

Note

In the age axis, the length of the years are assumed either constant 365.25 days ('constant.age.year = TRUE') or variable ('constant.age.year = FALSE'), depending on the person. In the time axis, the length of the year is either 365 in non-leap years and 366 in leap years. The advantage of using a non-constant (person-dependent) length of year in the age axis is that in each year the lengths of the years when computing 'coord.age' and 'coord.time' in both axis are equal.

Author(s)

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
dates.e <- c("2002-03-23", "2009-04-12", "2019-01-01")
quarterly_variables(dates.b, dates.e)
```

`time_exposed_ins` *Data frame of time exposed at risk for a population of immigrants/portfolio entries*

Description

Computes for each integer age and each combination of age and seasonal quarter the total time exposed at risk (in years) of a population of immigrants/new policies (new production) during the year of the event. The computation is performed using the associated data frame of quarterly variables corresponding to the population obtained using the `quarterly_variables` function.

Usage

```
time_exposed_ins(x)
```

Arguments

`x`	A data.frame output of the `quarterly_variables` function.

Value

A data frame with the time exposed at risk for each (potential) combination of integer age and age and season quarter of the input dataset. The data frame has the following components:

`age`	Integer age to which the time exposed at risk corresponds.
`quarter.age`	Age quarter to which the time exposed at risk corresponds.
`quarter.calendar`	Calendar (time, season) quarter to which the time exposed at risk corresponds.
`time.exposed`	Total time (in years) exposed at risk of the population during the quarter determined for the combination of 'age', 'quarter.age' and 'quarter.calendar'.

Note

The time exposed at risk is computed for each death from the beginning of the year in which the event occurred until the moment of occurrence of the event. Please see the note in the `time_exposed_stock` function.

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

See Also

time_exposed_stock, time_exposed_outs, time_exposed_newborns

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
dates.e <- c("2002-03-23", "2009-04-12", "2019-01-01")
x <- quarterly_variables(dates.b, dates.e)
out <- time_exposed_ins(x)
```

---

time_exposed_newborns *Data frame of time exposed at risk for a population of newborns*

Description

Computes for each combination of age and seasonal quarter the total time exposed at risk (in years) of a population of newborns, during the year of their birth, this is up to the end of the year when they born.

Usage

```
time_exposed_newborns(date.birth, random.b = TRUE)
```

Arguments

date.birth	A character vector with the dates of birth in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of the members of the population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.b = FALSE', or a random hour by default.
random.b	A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the birth occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.birth' even if those have been declared. By default, TRUE.

Value

A data frame with the time exposed at risk for each (potential) combination of integer age and age and season quarter of the population. The data frame has the following components:

age	Integer age to which the time exposed at risk corresponds.
quarter.age	Age quarter to which the time exposed at risk corresponds.
quarter.calendar	Calendar (time, season) quarter to which the time exposed at risk corresponds.
time.exposed	Total time (in years) exposed at risk of the population during the quarter determined for the combination of 'age', 'quarter.age' and 'quarter.season'.

Author(s)

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

See Also

time_exposed_stock, time_exposed_outs, time_exposed_ins

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
out <- time_exposed_newborns(dates.b)
```

---

time_exposed_outs *Data frame of time exposed at risk for a population of deaths/emigrants/exits (portfolio withdrawals, lapses) during the year of the event.*

Description

Computes for each integer age and each combination of age and seasonal quarter the total time exposed at risk (in years) of a population of deceased/emigrants/exits (portfolio withdrawals, lapses) during the year of the event. The computation is performed using the associated data frame of quarterly variables corresponding to the population obtained using the quarterly_variables function.

Usage

```
time_exposed_outs(x)
```

Arguments

x	A data.frame output of the quarterly_variables function.

Value

A data frame with the time exposed at risk for each (potential) combination of integer age and age and season quarter of the input dataset. The data frame has the following components:

age	Integer age to which the time exposed at risk corresponds.
quarter.age	Age quarter to which the time exposed at risk corresponds.

`quarter.calendar`
: Calendar (time, season) quarter to which the time exposed at risk corresponds.

`time.exposed`
: Total time (in years) exposed at risk of the population during the quarter determined for the combination of 'age', 'quarter.age' and 'quarter.calendar'.

Note

The time exposed at risk is computed for each person from the beginning of the year in which the event occurred until the moment of occurrence of the event. Please see the note in the `time_exposed_stock` function.

Author(s)

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

See Also

`time_exposed_stock`, `time_exposed_newborns`, `time_exposed_ins`

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
dates.e <- c("2002-03-23", "2009-04-12", "2019-01-01")
x <- quarterly_variables(dates.b, dates.e)
out <- time_exposed_outs(x)
```

---

time_exposed_stock *Data frame of time exposed at risk for a stock of general/insured population*

Description

Computes for each integer age and each combination of age and seasonal quarter the total time exposed at risk (in years) of a (stock) population of survivors (expected survivors) during a given year.

Usage

```
time_exposed_stock(
  date.birth,
  year,
  type,
  random.b = TRUE,
  constant.age.year = FALSE
)
```

Arguments

date.birth	A character vector with the dates of birth in format either "yyyy-mm-dd" or "yyyy-mm-dd hour:min:secs" (for instance, "2016-01-20 12:00:00") of the members of the population. If "hour:min:secs" is omitted the function imputes either "12:00:00", if 'random.b = FALSE', or a random hour by default.
year	A numeric vector indicating the year for which the total time exposed at risk (by quarter) of the population is to be computed.
type	A character argument informing if the total time exposed to risk is computed either since the beginning of the year or from the end of the year, depending when the census (stock) of population (portfolio) has been made. Only two values are allowed: '"forward"' and '"backward"'. If 'type = "forward"' the time exposed to risk is computed since the beginning of the year (i.e., it is assumed that the population counting has been performed at the beginning of the year of interest). If 'type = "backward"' the time exposed to risk is computed from the end of the year (i.e., it is assumed that the population counting has been performed at the end of the year of interest).
random.b	A 'TRUE/FALSE' argument indicating whether the exact moment ("hour:min:secs") when the birth occurs within the day is randomly selected. If TRUE, this overwrites "hour:min:secs" in 'date.birth' even if those have been declared. By default, TRUE.
constant.age.year	A 'TRUE/FALSE' argument indicating whether the length of the year should be constant, 365.25 days, or variable, depending on the time lived for the person in each year since her/his dates of birth and event. By default, FALSE. The advantage of using a non-constant (person-dependent) length of year is congruence when estimating time exposed at risk: in each year the time exposed along the time and age axes will coincide.

Value

A data frame with the time exposed at risk for each (potential) combination of integer age and age and season/calendar quarter of the population. The data frame has the following components:

age	Integer age to which the time exposed at risk corresponds.
quarter.age	Age quarter to which the time exposed at risk corresponds.
quarter.calendar	Calendar (time, season) quarter to which the time exposed at risk corresponds.

`time.exposed` Total time (in years) exposed at risk of the population during the quarter determined for the combination of ‘age‘, ‘quarter.age‘ and ‘quarter.calendar‘.

Note

Using the notation of a general population, denoting by P the stock of population counted either at the beginning or the end of the year, and by E, I, D and B the emigrants, immigrants, deaths and births recorded during the year, to compute the total time exposed to risk they relate as follows:

If the census (stock) of the population is performed at the beginning of the year of interest, it is initially assumed that all the people is going to survive (is going to be at risk) up to the end of the year. In this case ‘type = "forward"‘ should be used and the total time exposed at risk, in each age a and (r, s) quarter, is through: T(a, r, s) = time_exposed_stock(P) + time_exposed_ins(E) - time_exposed_ins(I) - time_exposed_ins(D) + time_exposed_newborns(B).

If the census (stock) of population is performed at the end of the year of interest, only the people who survives up to that date is included in the counting. In this case ‘type = "backward"‘ should be used and the total time exposed at risk, in each age a and (r, s) quarter, is computed using the expression: T(a, r, s) = time_exposed_survivors(P) - time_exposed_outs(E) + time_exposed_outs(I) + time_exposed_outs(D).

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References

Pavia, JM and Lledo, J (2022). Estimation of the Combined Effects of Ageing and Seasonality on Mortality Risk. An application to Spain. *Journal of the Royal Statistical Society, Series A (Statistics in Society)*, 185(2), 471-497. doi: 10.1111/rssa.12769

See Also

`time_exposed_ins`, `time_exposed_outs`, `time_exposed_newborns`

Examples

```
dates.b <- c("1920-05-13", "1999-04-12", "2019-01-01")
out <- time_exposed_stock(dates.b, year = 2019, type = "backward")
```

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