Package ‘polypharmacy’

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Title Calculate several polypharmacy indicators

Description Analyse prescription drug deliveries to calculate several indicators of polypharmacy corresponding to the various definitions found in the literature. Maintainer Guillaume Boucher <guiboucher8@gmail.com>

BugReports <https://github.com/guiboucher/polypharmacy/issues>

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## polypharmacy-package Calculate several polypharmacy indicators

Description

This package analyse prescription drug deliveries to calculate several indicators of polypharmacy corresponding to the various definitions found in the literature.

Details

It is essential to know the concepts used to calculate the various polypharmacy indicators to adequately use this package.

The core of the package is the data\_process() function that creates the data.table of drug treatments by restructuring the drug delivery records (usually extracted from a pharmacy or a health insurance information system) into continuous periods of drug availability (called drug treatments), applying user-defined arguments such as the grace periods between renewals or the longest treatment duration that an individual may accumulate through the successive renewals.

Then, each polypharmacy indicator can be computed using the corresponding function (ind\_simult(), ind\_stdcumul(), ind\_wcumul(), ind\_stdcontinuous(), ind\_ucontinuous()) or using the overall function indicators() to select the desired indicator(s) to be calculated at once.

Prior to running data\_process() the user may need to pre-process the table of original drug delivery records to break down combination drug into their individual components (drugs\_bkdn()) and/or to overwrite some delivery durations of specified drugs with constant durations (cst\_trt\_dur()).

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See Also

Useful links:

* Report bugs at <https://github.com/guiboucher/polypharmacy/issues>

*cst\_deliv\_duration*

## cst\_deliv\_duration Constant delivery duration drugs

Description

Overwrites the delivery durations with constant durations for each drug code listed in a userprovided table.

Usage cst\_deliv\_duration(

Rx\_deliv,

Rx\_drug\_code,

Rx\_deliv\_dur,

Cst\_deliv\_dur,

Cst\_drug\_code,

Cst\_duration

)

Arguments

|  |  |
| --- | --- |
| Rx\_deliv | Name of the table listing all prescription drugs delivered. |
| Rx\_drug\_code | Column name of Rx\_deliv that contains the drug unique identifier. |
| Rx\_deliv\_dur | Column name of the constant treatment duration in the Rx\_deliv table. |
| Cst\_deliv\_dur | Name of the table that contains the constant delivery durations that will overwrite that in the Rx\_deliv table for the specified drug codes. |
| Cst\_drug\_code | Column name of Cst\_deliv\_dur that contains the drug unique identifier (same format as Rx\_drug\_code). |
| Cst\_duration  Value | Column name of the constant treatment duration in the Cst\_deliv\_dur table (same format as Rx\_deliv\_dur). |

data.table of the same structure as Rx\_deliv.

Examples

Rx\_dt <- data.frame(id = c(rep(1, 3), rep(2, 2)), code = c("A", "B", "C", "B", "D"), duration = c(rep(15, 3), 15, 90))

cst\_dt <- data.frame(codes = c("A", "C", "D"), dur = c(50, 100, 45))

Rx\_cst <- cst\_deliv\_duration(Rx\_deliv = Rx\_dt,

Rx\_drug\_code = "code", Rx\_deliv\_dur = "duration",

Cst\_deliv\_dur = cst\_dt,

Cst\_drug\_code = "codes", Cst\_duration = "dur")

## data\_process

## data\_process Create the table of the drug treatments

Description

Reads a table of successive drug delivery records (usually extracted from a pharmacy or a health insurance information system) and creates the table required for the calculation of the polypharmacy indicators by applying various user-defined arguments, incorporating hospital stays into the treatment periods and reconstruct continuous treatment periods by merging quasi continuous and/or overlapping drugs deliveries.

Usage data\_process(

Rx\_deliv,

Rx\_id,

Rx\_drug\_code,

Rx\_drug\_deliv,

Rx\_deliv\_dur,

Cohort = NULL,

Cohort\_id = NULL,

Hosp\_stays = NULL,

Hosp\_id = NULL,

Hosp\_admis = NULL, Hosp\_discharge = NULL, study\_start = NULL, study\_end = NULL, grace\_fctr = 0.5, grace\_cst = 0, max\_reserve = NULL, cores = parallel::detectCores(logical = FALSE), ...

)

Arguments

|  |  |
| --- | --- |
| Rx\_deliv | Name of the table listing all prescription drugs deliveries including the run-in period. See *Details*. |
| Rx\_id | Column name of Rx\_deliv containing individual unique identifier (any format). |
| Rx\_drug\_code | Column name of Rx\_deliv that contains the drug unique identifier (any format). |
| Rx\_drug\_deliv | Column name of Rx\_deliv that contains the dates of the drug delivery (Date format, see *Details*). |
| Rx\_deliv\_dur | Column name of Rx\_deliv that contains the duration of the delivery (integer number). |
| Cohort | Name of the table providing the unique identifiers of the study cohort. Only the ids listed in both the Cohort and the Rx\_deliv tables will be returned. if Cohort =NULL, all ids of the Rx\_deliv table will be returned. |
| Cohort\_id | Column name of Cohort containing individual’s unique identifiers (same format as Rx\_id). If Cohort is not NULL and Cohort\_id is NULL, Cohort\_id will take the same value as Rx\_id. |

*data\_process*

|  |  |
| --- | --- |
| Hosp\_stays | Name of the table listing all hospital stays. (see *Details* for possible format). |
| Hosp\_id | Column name of Hosp\_stays containing individual’s unique identifier (same format as Rx\_id). If Hosp\_stays is not NULL and Hosp\_id is NULL, Hosp\_id will take the same value as Rx\_id. |
| Hosp\_admis | Column name of Hosp\_stays that contains the date of admission in hospital (Date format, see *Details*). |

Hosp\_discharge Column name of Hosp\_stays that contains the date of discharge from hospital

(Date format, see *Details*).

study\_start,study\_end

Defines the first and last day of the study period for which the polypharmacy indicator(s) need to be calculated. All treatment periods prior to study\_start and past study\_end are not transcribed into the result table (Date format, see

*Details*).

grace\_fctr,grace\_cst

Numbers ≥ 0. Two types of grace periods can be applied. One is proportional to the treatment duration of the latest delivery (grace\_fctr) and the other is a constant number of days (grace\_cst).

|  |  |
| --- | --- |
| max\_reserve | An integer number ≥ 0 or NULL. Longest treatment duration, in days, that can be stored from successive overlapping deliveries. When max\_reserve=NULL no limit is applied. When max\_reserve=0 no accumulation of extra treatment duration is accounted for. |
| cores | The number of cores to use when executing data\_process(). See parallel::detectCores. |

Details

Variables:

* Rx\_id, Cohort\_id and Hosp\_id columns must be of the same class (integer, numeric, character, ...).
* Rx\_drug\_deliv, Hosp\_admis and Hosp\_discharge can be 1) as.Date('yyyy-mm-dd'), 2) as.character('yyyy-mm-dd') or 3) as.integer() where 0 is January 1*st*, 1970.

Arguments:

* study\_start and study\_end can be 1) as.Date('yyyy-mm-dd'), 2) as.character('yyyy-mm-dd') or 3) as.integer() where 0 is January 1*st*, 1970.

Hospital stays:

Drug availability is assumed to continue during the hospital stay as it is on the day prior admission. The patient is assumed to resume the consumption of the drugs delivered by community pharmacists (as recorded in Rx\_deliv) the day after hosp\_discharge.

Run-in period:

A run-in period is necessary to account for the medications that are available to the individuals on the day of study\_start. It is recommended to include a run-in period of about 6 months (e.g. 7 months to account for possible delays) as some drugs are delivered for up to 6 months at once.

Grace period:

The grace period is used to determine if two successive deliveries can be considered as a continuous treatment even if there is a gap of several days for which no treatment is apparently available. Two successive deliveries of an identical drug are considered part of a single continuous treatment if the next delivery doesn’t occur more than grace\_cst + (grace\_fctr × Rx\_deliv\_dur) days after the end of the latest drug delivery. The availability of extra drugs accumulated over the successive deliveries is accounted for prior to evaluating the duration of the gap between deliveries. *data\_process*

Performance

For better performance, date columns are converted to integer numbers.

... verif\_cols=FALSE : For better performance, you can avoid columns class checking with verif\_cols=FALSE. Not recommended.

Value data.table with four (4) variables:

* The individual unique identifier which name is defined by Rx\_id.
* The drug unique identifier which name is defined by Rx\_drug\_code.
* tx\_start: The date of initiation of the reconstructed continued treatment (format as date).
* tx\_end: The date of the last day of the reconstructed continued treatment (format as date).

Examples

Rx\_dt1 <- data.frame(id = 1, code = 'A', date=c('2020-01-01','2020-01-09','2020-01-21','2020-02-05','2020-02-21'), duration = 10)

Rx1 <- data\_process(Rx\_deliv = Rx\_dt1,

Rx\_id = 'id', Rx\_drug\_code = 'code',

Rx\_drug\_deliv = 'date', Rx\_deliv\_dur = 'duration')

## With a study cohort

Rx\_dt2 <- data.frame(id = c(1, 1, 1, 2, 2), code = 'A', date=c('2020-01-01','2020-01-09','2020-01-21','2020-02-05','2020-02-21'), duration = 10)

Cohort\_dt2 = data.frame(id = 1, age = 65, sex = 'F', x1 = 'ind8', x2 = 'ex1')

Rx2 <- data\_process(Rx\_deliv = Rx\_dt2,

Rx\_id = 'id', Rx\_drug\_code = 'code',

Rx\_drug\_deliv = 'date', Rx\_deliv\_dur = 'duration',

Cohort = Cohort\_dt2, Cohort\_id = 'id')

## With hospital stays

Hosp\_dt2 <- data.frame(id = 1, start = c('2019-01-01', '2019-12-25'), end = c('2019-05-20', '2019-12-31'))

Rx3 <- data\_process(Rx\_deliv = Rx\_dt2,

Rx\_id = 'id', Rx\_drug\_code = 'code',

Rx\_drug\_deliv = 'date', Rx\_deliv\_dur = 'duration',

Cohort = Cohort\_dt2, Cohort\_id = 'id',

Hosp\_stays = Hosp\_dt2, Hosp\_id = 'id',

Hosp\_admis = 'start', Hosp\_discharge = 'end')

## With study\_start not NULL

Rx3\_start <- data\_process(Rx\_deliv = Rx\_dt2,

Rx\_id = 'id', Rx\_drug\_code = 'code',

Rx\_drug\_deliv = 'date', Rx\_deliv\_dur = 'duration', Cohort = Cohort\_dt2, Cohort\_id = 'id',

Hosp\_stays = Hosp\_dt2, Hosp\_id = 'id', Hosp\_admis = 'start', Hosp\_discharge = 'end', study\_start = '2019-12-29')

*drug\_bkdn*

## drug\_bkdn Translate combination drug deliveries into single active ingredients

Description

Replaces each combination drug into several deliveries of elementary active ingredients according to a user-provided correspondence table.

Usage drug\_bkdn(Rx\_deliv, Rx\_drug\_code, Combn\_drugs, Combn\_drug\_code, Combn\_act\_code)

Arguments

Rx\_deliv Name of the table listing all prescription drugs deliveries.

Rx\_drug\_code Column name of Rx\_deliv that contains the combination drug unique identifiers (any format).

Combn\_drugs Name of the correspondence table listing all elementary active ingredients that make up each combination drug.

Combn\_drug\_code

Column name of Combn\_drugs that contains the combination drug unique identifiers (same format as Rx\_drug\_code).

Combn\_act\_code Column name of elementary active ingredients that is present in Combn\_drugs (same format as Rx\_drug\_code).

Value data.table of the same structure as Rx\_deliv.

Examples

Rx\_dt <- data.frame(id = c(1, 1, 2, 2, 2), codeDrug = c(159, 753, 123, 456, 789))

SplitCode <- data.frame(code = c(159, 159, 456, 456, 456), split\_code = c(1591, 1592, 4567, 4568, 4569))

Rx\_split <- drug\_bkdn(Rx\_deliv = Rx\_dt, Rx\_drug\_code = "codeDrug",

Combn\_drugs = SplitCode, Combn\_drug\_code = "code", Combn\_act\_code = "split\_code")

## indicators Indicators: All selected

Description

Wrapper function for all *Indicator* functions.

## indicators

Usage indicators(

processed\_tab,

stats=c("mean","sd","min","p5","p10","p25","median","p75","p90","p95",

"max"), method = c("ind\_simult", "ind\_stdcumul", "ind\_wcumul", "ind\_stdcontinuous",

"ind\_ucontinuous"), stdconti\_pdays,

simult\_ind\_stats = c("mean", "min", "median", "max"), simult\_calendar = FALSE, stdcumul\_nPeriod = 1, cores = parallel::detectCores()

)

Arguments processed\_tab Table created by data\_process function.

stats Statistics to calculate on the drug consumption. See *Details* for possible values. method Indicator functions name to use.

stdconti\_pdays *stdcontinuous* method: Number of days to create intervals [min; min+pdays] and [max-pdays; max] where a drug should be consumed to be counted.

simult\_ind\_stats

*simult* method: Statistics to calculate for each drug user.

simult\_calendar

*simul* method: TRUE or FALSE. Create a table indicating the number of drugs consumed for each day for each user (FALSE by default).

stdcumul\_nPeriod

*std\_cumul* method: Integer value greater or equal to 1 and lesser or equal to the total number of days in the study period. If nPeriod is greater than 1, the study period is divide in nPeriod subperiod and the total number of drugs consumption would be the average of the periods.

cores The number of cores to use when executing ind\_simult(). See parallel::detectCores.

Details stats & simult\_ind\_stats: Possible values are

* 'mean', 'min', 'median', 'max', 'sd';
* 'pX' where *X* is a value in ]0, 100];
* 'q1' = 'p25', 'q2' = 'p50' = 'median', q3 = 'p75'.

Value list of all indicators

*ind\_simult*

## ind\_simult Indicator: Simultaneous

Description

Descriptive statistics on daily consumption.

Usage ind\_simult(

processed\_tab, individual\_stats = c("mean", "min", "median", "max"),

stats=c("mean","sd","min","p5","p10","p25","median","p75","p90","p95",

"max"), calendar = FALSE,

cores = parallel::detectCores()

)

Arguments processed\_tab Table created by data\_process function.

individual\_stats

Statistics to calculate for each drug user. See *Details* for possible values.

stats Statistics to calculate for each individual\_stats. See *Details* for possible values.

calendar TRUE or FALSE. Create a table indicating the number of drugs consumed for each day for each user (FALSE by default).

cores The number of cores to use when executing ind\_simult(). See parallel::detectCores.

Details individual\_stats & stats: Possible values are

* 'mean', 'min', 'median', 'max', 'sd';
* 'pX' where *X* is a value in ]0, 100];
* 'q1' = 'p25', 'q2' = 'p50' = 'median', q3 = 'p75'.

Value list:

* indic: data.table indicating each stats (columns) for each individual\_stats (rows).
* stats\_id: data.table indicating each individual\_stats for each individuals (all cohort).
* min\_conso: data.table indicating each stats for the number of days where an individual consume at least X drugs.
* calendar: If calendar=TRUE, data.table indicating the number of drugs consumed for each day (only for individuals who has at least 1 day with 1 drug consumption).

# *ind\_stdcontinuous*

Examples dt\_process <- data\_process(

Rx\_deliv = data.frame(

ID = c(1, 1, 1, 2, 2), Code = c('A', 'B', 'C', 'D', 'E'),

Date = c('2020-01-01', '2020-01-05', '2020-01-10', '2020-01-15', '2020-01-26'), Duration = c(20, 15, 10, 5, 3)

), Rx\_id = 'ID', Rx\_drug\_code = 'Code', Rx\_drug\_deliv = 'Date', Rx\_deliv\_dur = 'Duration', cores = 1

)

dt\_simult <- ind\_simult(dt\_process, cores = 1)

dt\_calendar <- ind\_simult(dt\_process, calendar = TRUE, cores = 1)

## ind\_stdcontinuous Indicator: Standard Continuous

Description

Descriptive statistics.

A drug is counted if there is a least 1 consumption in the interval [min; min+pdays] and another in [max-pdays; max]. In other words, a drug consumption is considered continuous if there is a consumption at the beginning and at the end of the period.r

Usage ind\_stdcontinuous(

processed\_tab, pdays,

stats=c("mean","sd","min","p5","p10","p25","median","p75","p90","p95",

"max")

)

Arguments processed\_tab Table created by data\_process function.

pdays Number of days to create intervals [min; min+pdays] and [max-pdays; max] where a drug should be consumed to be counted.

stats Statistics to calculate on the drug consumption. See *Details* for possible values.

Details stats: Possible values are

* 'mean', 'min', 'median', 'max', 'sd';
* 'pX' where *X* is a value in ]0, 100];
* 'q1' = 'p25', 'q2' = 'p50' = 'median', q3 = 'p75'.

Value list:

* indic: data.table indicating each stats (columns).
* stats\_id: data.table indicating the number of drugs use for each individual (all cohort).

# *ind\_stdcumul*

## ind\_stdcumul Indicator: Cumulative (multiple medication)

Description

Descriptive statistics: Sum of different drugs consumed over a given period time.

Usage

ind\_stdcumul( processed\_tab, nPeriod = 1,

stats=c("mean","sd","min","p5","p10","p25","median","p75","p90","p95",

"max")

)

Arguments processed\_tab Table created by data\_process function.

nPeriod Integer value greater or equal to 1 and lesser or equal to the total number of days in the study period. If nPeriod is greater than 1, the study period is divide in nPeriod subperiod and the total number of drugs consumption would be the average of the periods.

stats Statistics to calculate on the drug consumption. See *Details* for possible values.

Details stats: Possible values are

* 'mean', 'min', 'median', 'max', 'sd';
* 'pX' where *X* is a value in ]0, 100];
* 'q1' = 'p25', 'q2' = 'p50' = 'median', q3 = 'p75'.

Value list:

* indic: data.table indicating each stats (columns).
* stats\_id: data.table. For each individual (all cohort), indicate the number of drug use per period (perX where X is a number between 1 and nPeriod) and the mean of the periods (nRx).

# *ind\_wcumul*

## ind\_ucontinuous Indicator: Uninterrupted Continuous

Description

Descriptive statistics for drugs that are consumed every day of the study period.

Usage ind\_ucontinuous( processed\_tab,

stats=c("mean","sd","min","p5","p10","p25","median","p75","p90","p95",

"max")

)

Arguments processed\_tab Table created by data\_process function.

stats Statistics to calculate on the drug consumption. See *Details* for possible values.

Details stats: Possible values are

* 'mean', 'min', 'median', 'max', 'sd';
* 'pX' where *X* is a value in ]0, 100];
* 'q1' = 'p25', 'q2' = 'p50' = 'median', q3 = 'p75'.

Value list:

* indic: data.table indicating each stats (columns).
* stats\_id: data.table indicating the number of drugs use for each individual (all cohort).

## ind\_wcumul Indicator: Weight Cumulative

Description

Description

Usage ind\_wcumul(

processed\_tab,

stats=c("mean","sd","min","p5","p10","p25","median","p75","p90","p95",

"max")

)

*Rx\_processed*

Arguments processed\_tab Table created by data\_process function.

stats Statistics to calculate on the drug consumption. See *Details* for possible values.

Details stats: Possible values are

* 'mean', 'min', 'median', 'max', 'sd';
* 'pX' where *X* is a value in ]0, 100];
* 'q1' = 'p25', 'q2' = 'p50' = 'median', q3 = 'p75'.

Value

list:

* indic: data.table indicating each stats (columns).
* stats\_id: data.table indicating the number of drugs use for each individual (all cohort).

## Rx\_processed Table: Processed "unprocessed table"

Description

Table required for the calculation of the polypharmacy indicators. This table is created by using data\_process() function on Rx\_unprocessed data.

Usage

Rx\_processed

Format

A data.table with 6792 obs and 4 variables:

id Individual unique identifier. code Drug unique identifier. tx\_start The date of initiation of the reconstructed continued treatment (format as date). tx\_end The date of the last day of the reconstructed continued treatment (format as date).

## Rx\_unprocessed

## Rx\_unprocessed Table: Prescription drugs deliveries

Description

Table listing all prescription drugs deliveries.

Usage

Rx\_unprocessed

Format

A data.table with 17060 obs and 4 variables:

id Individual unique identifier code Drug unique identifier start Date of the drug delivery duration Duration of the delivery

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