

Package ‘ATQ’

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Title Alert Time Quality - Evaluating Timely Epidemic Metrics

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Description Provides tools for evaluating timely epidemic detection models within school absenteeism-based surveillance systems. Introduces the concept of alert time quality as an evaluation metric. Includes functions to simulate populations, epidemics, and alert metrics associated with epidemic spread using population census data. The methods are based on research published in Vanderkruk et al. (2023) <[doi:10.1186/s12889-023-15747-z](https://doi.org/10.1186/s12889-023-15747-z)> and Ward et al. (2019) <[doi:10.1186/s12889-019-7521-7](https://doi.org/10.1186/s12889-019-7521-7)>.

License GPL (>= 3)

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alarm_metrics	<i>Create an Alarm Metrics Object</i>
---------------	---------------------------------------

Description

This function creates an object of class "alarm_metrics" from a list of metric matrices. It's used to organize and structure the results from various epidemic alarm metrics calculations.

Usage

```
alarm_metrics(metrics_list)
```

Arguments

`metrics_list` A list containing matrices for different alarm metrics (FAR, ADD, AATQ, FATQ, WAATQ, WFATQ).

Value

An object of class "alarm_metrics" which is a list with the input metrics.

Examples

```

# Generate sample alarm metrics data
set.seed(123)
generate_metric_matrix <- function() {
  matrix(runif(15 * 11), nrow = 15, ncol = 11,
         dimnames = list(paste("Lag", 1:15),
                         paste("Threshold", seq(0.1, 0.6, by = 0.05))))
}

sample_metrics <- list(
  FAR = generate_metric_matrix(),
  ADD = generate_metric_matrix(),
  AATQ = generate_metric_matrix(),
  FATQ = generate_metric_matrix(),
  WAATQ = generate_metric_matrix(),
  WFATQ = generate_metric_matrix()
)

# Create an alarm_metrics object
alarm_metrics_obj <- alarm_metrics(sample_metrics)

# Check the class of the resulting object
class(alarm_metrics_obj)

# Access a specific metric
head(alarm_metrics_obj$AATQ)

# Use with other functions (assuming they're defined in your package)
# plot(alarm_metrics_obj, metric = "FAR")

```

alarm_plot_data

Create Alarm Plot Data Object

Description

This function creates an object of class "alarm_plot_data" from epidemic data and best models. It ensures that the input data is in the correct format for plotting.

Usage

```
alarm_plot_data(epidemic_data, best_models)
```

Arguments

epidemic_data A data frame or list of data frames containing epidemic data.
best_models A list of data frames containing the best models for each metric.

Value

An object of class "alarm_plot_data" containing the epidemic data and best models.

Examples

```

# Generate sample epidemic data
set.seed(123)
epidemic_data <- data.frame(
  Date = rep(1:300, 3),
  ScYr = rep(1:3, each = 300),
  pct_absent = runif(900, 0, 0.1),
  lab_conf = rpois(900, lambda = 5),
  ref_date = rep(c(rep(0, 299), 1), 3),
  Case = rbinom(900, 1, 0.1),
  window = rep(c(rep(0, 280), rep(1, 20)), 3)
)

# Generate sample best models data
generate_best_model <- function() {
  data.frame(
    Date = sample(1:300, 50),
    ScYr = sample(1:3, 50, replace = TRUE),
    Alarm = sample(0:1, 50, replace = TRUE),
    lag = sample(1:15, 50, replace = TRUE),
    thres = runif(50, 0, 1)
  )
}

best_models <- list(
  AATQ = generate_best_model(),
  FATQ = generate_best_model(),
  FAR = generate_best_model(),
  ADD = generate_best_model(),
  WFATQ = generate_best_model(),
  WAATQ = generate_best_model()
)

# Create alarm_plot_data object
plot_data <- alarm_plot_data(epidemic_data, best_models)

# Check the structure of the resulting object
str(plot_data)

```

best_model

Create Best Model

Description

This function sets the class of the given model data to "best_model".

Usage

```
best_model(model_data)
```

Arguments

model_data A data frame containing the model data.

Value

An object of class "best_model" containing the model data.

Examples

```
# Generate sample model data
sample_model_data <- data.frame(
  ScYr = rep(1:3, each = 100),
  Date = rep(1:100, 3),
  Alarm = sample(c(0, 1), 300, replace = TRUE, prob = c(0.9, 0.1)),
  lag = sample(1:15, 300, replace = TRUE),
  thres = runif(300, 0.1, 0.6)
)

# Create best model
best_model_data <- best_model(sample_model_data)

# Print the class of the best model
class(best_model_data)
```

catchment_sim	<i>Simulating catchment areas</i>
---------------	-----------------------------------

Description

Function to simulate specified catchments of square area ($a \times a$). The number of schools in each catchment area is simulated via a specified distribution function, with gamma distribution as the default.

Usage

```
catchment_sim(n, area, dist_func = stats::rgamma, ...)
```

Arguments

n	number of catchments to be simulated
area	square dimension for catchment (if area = 20, then each catchment dimensions will be 20 x 20)
dist_func	distribution function to simulate number of schools, default is stats::rgamma
...	additional arguments passed to the distribution function

Value

A data frame with n rows and the following columns:

catchID	Unique identifier for each catchment area
num.schools	Number of schools in the catchment area
xStart	Starting x-coordinate of the catchment area
xEnd	Ending x-coordinate of the catchment area
yStart	Starting y-coordinate of the catchment area
yEnd	Ending y-coordinate of the catchment area

Examples

```
# Using default gamma distribution
catch_df1 <- catchment_sim(16, 20, shape = 4.1, rate = 2.7)

# Using normal distribution
catch_df2 <- catchment_sim(16, 20, dist_func = stats::rnorm, mean = 5, sd = 1)

# Using Poisson distribution
catch_df3 <- catchment_sim(16, 20, dist_func = stats::rpois, lambda = 3)
```

 compile_epi

Compile Epidemic Data

Description

Compiles and processes epidemic data, simulating school absenteeism using epidemic and individual data.

Usage

```
compile_epi(epidemic, individual_data, lags = 16, inf_period = 4, T = 300)
```

Arguments

epidemic	A list of simulated epidemic data (output from simepi() or similar function).
individual_data	A data frame of simulated individuals data (output from simulate_households() or similar function).
lags	Maximum number of lags for absenteeism, default = 16 (note that lag of zero is included).
inf_period	Infection period of epidemic, default = 4.
T	Time period, default = 300 days.

Value

A data frame containing compiled epidemic data, including:

Date	Day of the epidemic
ScYr	School year
pct_absent	Percentage of students absent
absent	Number of students absent
absent_sick	Number of students absent due to illness
new_inf	Number of new infections
reported_cases	Number of reported cases
Case	Indicator for lab confirmed flu case that day
sinterm, costerm	Seasonal terms
window	Indicator for "True Alarm" window
ref_date	Indicator for reference date
lag0, lag1, ..., lag15	Lagged absenteeism values

Examples

```
# Assuming you have previously simulated epidemic and individual data:
epidemic <- ssir(1000, alpha = 0.4)
individual_data <- data.frame(elem_child_ind = sample(0:1, 1000, replace = TRUE),
                             schoolID = sample(1:10, 1000, replace = TRUE))

compiled_data <- compile_epi(epidemic, individual_data)
```

```
create_alarm_metrics_summary
```

Create Alarm Metrics Summary

Description

This function creates a summary of alarm metrics, including statistics for each metric, best model parameters, reference dates, and best prediction dates for each epidemic year.

Usage

```
create_alarm_metrics_summary(metrics, best_models, epidemic_data)
```

Arguments

metrics	An object of class "alarm_metrics" containing matrices for different metrics.
best_models	A list of data frames, each containing the best model for a specific metric.
epidemic_data	A data frame containing the epidemic data, including ScYr, Date, and ref_date columns.

Value

An object of class "alarm_metrics_summary" containing summary statistics, best values, reference dates, and best prediction dates for each metric and epidemic year.

Examples

```
# Generate sample data
set.seed(123)

# Generate sample metrics
generate_metric_matrix <- function() {
  matrix(runif(15 * 11), nrow = 15, ncol = 11,
         dimnames = list(paste("Lag", 1:15),
                         paste("Threshold", seq(0.1, 0.6, by = 0.05))))
}

sample_metrics <- list(
  FAR = generate_metric_matrix(),
  ADD = generate_metric_matrix(),
  AATQ = generate_metric_matrix(),
  FATQ = generate_metric_matrix(),
  WAATQ = generate_metric_matrix(),
  WFATQ = generate_metric_matrix()
)

metrics <- structure(sample_metrics, class = c("alarm_metrics", "list"))

# Generate sample best models
generate_best_model <- function() {
  data.frame(
    ScYr = rep(1:3, each = 100),
    Date = rep(1:100, 3),
    Alarm = sample(c(0, 1), 300, replace = TRUE, prob = c(0.9, 0.1)),
    lag = sample(1:15, 300, replace = TRUE),
    thres = runif(300, 0.1, 0.6)
  )
}

best_models <- list(
  best.FAR = generate_best_model(),
  best.ADD = generate_best_model(),
  best.AATQ = generate_best_model(),
  best.FATQ = generate_best_model(),
  best.WAATQ = generate_best_model(),
  best.WFATQ = generate_best_model()
)

# Generate sample epidemic data
epidemic_data <- data.frame(
  ScYr = rep(1:3, each = 365),
  Date = rep(1:365, 3),
  ref_date = c(rep(0, 364), 1)
```



```

)

# Create alarm metrics summary
summary <- create_alarm_metrics_summary(metrics, best_models, epidemic_data)

# Print summary
print(summary)

```

elementary_pop	<i>Create Elementary Schools population size</i>
----------------	--

Description

Function to simulate elementary school size and assigns it to catchments. The school population is simulated using a specified distribution function, with gamma distribution as the default.

Usage

```
elementary_pop(df, dist_func = stats::rgamma, ...)
```

Arguments

df	output data frame from catchment_sim function
dist_func	distribution function to simulate school population, default is stats::rgamma
...	additional arguments passed to the distribution function

Value

A data frame with the following columns:

catchID	Identifier for the catchment area
schoolID	Unique identifier for each school
schoolPop	Simulated population of the school
xStart	Starting x-coordinate of the catchment area
xEnd	Ending x-coordinate of the catchment area
yStart	Starting y-coordinate of the catchment area
yEnd	Ending y-coordinate of the catchment area

Examples

```
# Simulate catchment areas
catch_df <- catchment_sim(16, 20, shape = 3.5, rate = 2.8)

# Simulate elementary schools using default gamma distribution
elementary_df1 <- elementary_pop(catch_df, shape = 5.1, rate = 0.015)

# Simulate elementary schools using normal distribution
elementary_df2 <- elementary_pop(catch_df, dist_func = stats::rnorm,
                                mean = 300, sd = 50)

# Simulate elementary schools using Poisson distribution
elementary_df3 <- elementary_pop(catch_df, dist_func = stats::rpois,
                                lambda = 250)
```

eval_metrics

Evaluate Alarm Metrics for Epidemic Models

Description

This function calculates various performance metrics for epidemic alarm systems across different lags and thresholds. It evaluates False Alarm Rate (FAR), Added Days Delayed (ADD), Average Alarm Time Quality (AATQ), First Alarm Time Quality (FATQ), and their weighted versions (WAATQ, WFATQ).

Usage

```
eval_metrics(data, maxlag = 15, thres = seq(0.1, 0.6, by = 0.05), topt = 14)
```

Arguments

data	A data frame containing the epidemic data with lagged variables, typically output from the <code>compile_epi</code> function.
maxlag	The maximum number of lags to consider (default: 15).
thres	A vector of threshold values to evaluate (default: <code>seq(0.1, 0.6, by = 0.05)</code>).
topt	Optimal alarm day (default = 14).

Value

A list containing three elements:

metrics	An object of class "alarm_metrics" with the following components: <ul style="list-style-type: none"> • FAR: Matrix of False Alarm Rates for each lag and threshold • ADD: Matrix of Added Days Delayed for each lag and threshold • AATQ: Matrix of Average Alarm Time Quality for each lag and threshold • FATQ: Matrix of First Alarm Time Quality for each lag and threshold
---------	---

- WAATQ: Matrix of Weighted Average Alarm Time Quality for each lag and threshold
- WFATQ: Matrix of Weighted First Alarm Time Quality for each lag and threshold
- best.AATQ: Best model according to AATQ
- best.FATQ: Best model according to FATQ
- best.FAR: Best model according to FAR
- best.ADD: Best model according to ADD
- best.WFATQ: Best model according to WFATQ
- best.WAATQ: Best model according to WAATQ

plot_data	An object of class "alarm_plot_data" for generating plots
summary	An object of class "alarm_metrics_summary" containing summary statistics

See Also

[ssir](#), [compile_epi](#)

Examples

```
# Generate simulated epidemic data
n_rows <- 7421
n_houses <- 1000

epidemic_new <- ssir(n_rows, T = 300, alpha = 0.298, inf_init = 32, rep = 3)

individual_data <- data.frame(
  houseID = rep(1:n_houses, each = ceiling(n_rows / n_houses))[1:n_rows],
  catchID = sample(1:10, n_rows, replace = TRUE),
  schoolID = sample(1:10, n_rows, replace = TRUE),
  num_people = round(rnorm(n_rows, mean = 4, sd = 1)),
  num_elem_child = round(rnorm(n_rows, mean = 1, sd = 1)),
  xStart = 0,
  xEnd = 5,
  yStart = 0,
  yEnd = 5,
  loc.x = rnorm(n_rows, mean = 2.5, sd = 1),
  loc.y = rnorm(n_rows, mean = 2.5, sd = 1),
  individualID = 1:n_rows,
  elem_child_ind = sample(0:1, n_rows, replace = TRUE)
)

compiled_data <- compile_epi(epidemic_new, individual_data)

# Evaluate alarm metrics
alarm_metrics <- eval_metrics(compiled_data,
                             thres = seq(0.1, 0.6, by = 0.05))

# Access the results
summary(alarm_metrics$summary)
alarm_plots <- plot(alarm_metrics$plot_data)
```

```
for(i in seq_along(alarm_plots)) { print(alarm_plots[[i]]) }
```

plot.alarm_metrics *Plot Heatmap of Alarm Metrics*

Description

This function creates a heatmap visualization of the specified alarm metric across different lags and thresholds.

Usage

```
## S3 method for class 'alarm_metrics'
plot(x, metric = "AATQ", col = heat.colors(12), ...)
```

Arguments

x	An object of class "alarm_metrics" containing matrices of metric values.
metric	A character string specifying which metric to plot. Default is "AATQ". Options include "FAR", "ADD", "AATQ", "FATQ", "WAATQ", "WFATQ".
col	Set heat map color profile, default is heat.colors(15)
...	Additional arguments passed to the image function.

Value

A heatmap plot of the specified metric.

Examples

```
# Generate sample alarm metrics data
set.seed(123)
generate_metric_matrix <- function() {
  matrix(runif(15 * 11), nrow = 15, ncol = 11,
         dimnames = list(paste("Lag", 1:15),
                        paste("Threshold", seq(0.1, 0.6, by = 0.05))))
}

sample_metrics <- list(
  FAR = generate_metric_matrix(),
  ADD = generate_metric_matrix(),
  AATQ = generate_metric_matrix(),
  FATQ = generate_metric_matrix(),
  WAATQ = generate_metric_matrix(),
  WFATQ = generate_metric_matrix(),
  lags = 1:15,
```

```

  thresholds = seq(0.1, 0.6, by = 0.05)
)

# Create an alarm_metrics object
alarm_metrics_obj <- structure(sample_metrics, class = c("alarm_metrics", "list"))

# Plot the heatmap for AATQ (default)
plot(alarm_metrics_obj)

# Plot the heatmap for FAR
plot(alarm_metrics_obj, metric = "FAR")

# Customize the plot
plot(alarm_metrics_obj, metric = "FATQ", col = heat.colors(12))

```

plot.alarm_plot_data *Plot Epidemic Data with Alarm Metrics*

Description

This function creates a series of plots, one for each epidemic year, showing the absenteeism percentage, laboratory confirmed cases, reference dates, and alarm points for different models.

Usage

```

## S3 method for class 'alarm_plot_data'
plot(x, ...)

```

Arguments

`x` An object of class "alarm_plot_data" containing epidemic data and best models.
`...` Additional arguments passed to the plotting function (currently unused).

Value

A list of ggplot objects, one for each epidemic year.

Examples

```

# Generate sample data
# Generate simulated epidemic data
n_rows <- 7421
n_houses <- 1000

epidemic_new <- ssir(n_rows, T = 300, alpha = 0.298, inf_init = 32, rep = 3)

individual_data <- data.frame(
  houseID = rep(1:n_houses, each = ceiling(n_rows / n_houses))[1:n_rows],

```

```

catchID = sample(1:10, n_rows, replace = TRUE),
schoolID = sample(1:10, n_rows, replace = TRUE),
num_people = round(rnorm(n_rows, mean = 4, sd = 1)), # Normal distribution for num_people
num_elem_child = round(rnorm(n_rows, mean = 1, sd = 1)), # Normal distribution for num_elem_child
xStart = 0,
xEnd = 5,
yStart = 0,
yEnd = 5,
loc.x = rnorm(n_rows, mean = 2.5, sd = 1), # Normal distribution for loc.x
loc.y = rnorm(n_rows, mean = 2.5, sd = 1), # Normal distribution for loc.y
individualID = 1:n_rows,
elem_child_ind = sample(0:1, n_rows, replace = TRUE)
)

compiled_data <- compile_epi(epidemic_new, individual_data)

# Evaluate alarm metrics
results <- eval_metrics(compiled_data, thres = seq(0.1,0.6,by = 0.05))

# Generate plots
plots <- plot(results$plot_data)

# Display the first plot
if(interactive()) print(plots[[1]])

```

plot.ssir_epidemic *Plot method for a single SSIR epidemic simulation*

Description

This function creates plots for a single SSIR (Stochastic Susceptible-Infectious-Removed) epidemic simulation. It generates two plots: one for new infections and one for reported cases.

Usage

```
## S3 method for class 'ssir_epidemic'
plot(x, ...)
```

Arguments

x	An object of class "ssir_epidemic", typically the result of calling ssir() with rep = NULL or 1.
...	Additional arguments passed to the underlying plotting function (currently unused).

Value

A grid arrangement of two ggplot objects: new infections and reported cases.

See Also

[plot_single_epidemic](#) for the underlying plotting function

Examples

```
# Run a single simulation
result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4, inf_init = 32,
report = 0.02, lag = 7)

# Plot the results
plot(result)
```

```
plot.ssir_epidemic_multi
```

Plot method for multiple SSIR epidemic simulations

Description

This function creates plots for multiple SSIR (Stochastic Susceptible-Infectious-Removed) epidemic simulations. It generates two plots (new infections and reported cases) for each simulation in the multi-simulation object.

Usage

```
## S3 method for class 'ssir_epidemic_multi'
plot(x, ...)
```

Arguments

x	An object of class "ssir_epidemic_multi", typically the result of calling ssir() with rep > 1.
...	Additional arguments passed to the underlying plotting function (currently unused).

Value

A list of grid arrangements, each containing two ggplot objects (new infections and reported cases) for each epidemic simulation.

See Also

[plot_single_epidemic](#) for the underlying plotting function

Examples

```
# Run multiple simulations
multi_result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4,
                    inf_init = 32, report = 0.02, lag = 7, rep = 5)

# Plot the results
plots <- plot(multi_result)

# Display the first simulation's plots
plots[[1]]
```

plot_single_epidemic *Plot a single epidemic simulation*

Description

This function creates two plots for a single epidemic simulation: one for new infections and one for reported cases.

Usage

```
plot_single_epidemic(epidemic, epidemic_num)
```

Arguments

epidemic A list containing the results of a single epidemic simulation, typically an element from an "ssir_epidemic_multi" object.

epidemic_num An integer indicating the epidemic number, used in the plot titles.

Value

A grid arrangement of two ggplot objects: new infections and reported cases.

Examples

```
# Assuming you have run a simulation:
result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4, inf_init = 32,
              report = 0.02, lag = 7)
plot_single_epidemic(result, 1)

# For multiple simulations:
multi_result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4, inf_init = 32,
                    report = 0.02, lag = 7, rep = 5)
plot_single_epidemic(multi_result[[1]], 1)
```

simulate_households *Simulate total households and individuals data*

Description

Creates two simulated populations, households and individuals

Usage

```
simulate_households(children_df, noChildren_df)
```

Arguments

children_df data frame output from house_children() function
noChildren_df data frame output from house_noChildren() function

Value

list of two data frames; simulated individuals data and simulated households data

Examples

```
# Simulate catchment areas
catch_df <- catchment_sim(4, 5, shape = 3.5, rate = 2.8)

# Simulate elementary schools using default gamma distribution
elementary_df <- elementary_pop(catch_df, shape = 5.1, rate = 0.015)

# Simulate households with children
house_children <- subpop_children(elementary_df, n = 2,
                                prop_parent_couple = 0.7,
                                prop_children_couple = c(0.3, 0.5, 0.2),
                                prop_children_lone = c(0.4, 0.4, 0.2),
                                prop_elem_age = 0.2)

# Simulate households without children using pre-specified proportions
house_nochildren <- subpop_noChildren(house_children, elementary_df,
                                     prop_house_size = c(0.2, 0.3, 0.25, 0.15, 0.1),
                                     prop_house_Children = 0.3)

# simulate households and individuals data
simulation <- simulate_households(house_children, house_nochildren)
```

 ssir

Stochastic SIR simulation

Description

This function runs a stochastic Susceptible-Infectious-Removed (SIR) epidemic simulation. It can run a single simulation or multiple replications. Also simulates laboratory confirmed cases

Usage

```
ssir(
  N,
  T = 300,
  alpha,
  avg_start = 45,
  min_start = 20,
  inf_period = 4,
  inf_init = 32,
  report = 0.02,
  lag = 7,
  rep = NULL
)
```

Arguments

N	Numeric. The total population size.
T	Numeric. The duration of the simulation in time steps. Default is 300.
alpha	Numeric. The transmission rate. Must be a number between 0 and 1.
avg_start	Numeric. The average start day of the epidemic. Default is 45.
min_start	Numeric. The minimum start day of the epidemic. Default is 20.
inf_period	Numeric. The duration of the infectious period in time steps. Default is 4.
inf_init	Numeric. The initial number of infected individuals. Default is 32.
report	Numeric. The proportion of cases that are reported. Default is 0.02.
lag	Numeric. The average delay in reporting cases. Default is 7.
rep	Numeric or NULL. The number of simulation replications to run. If NULL or 1, a single simulation is run.

Value

If rep is NULL or 1, returns an object of class "ssir_epidemic" containing:

new_inf	Vector of new infections at each time step
reported_cases	Vector of reported cases at each time step
S	Vector of susceptible individuals at each time step

I Vector of infectious individuals at each time step
 R Vector of removed individuals at each time step
 parameters List of input parameters

If `rep > 1`, returns an object of class "ssir_epidemic_multi" containing multiple simulation results.

Examples

```
# Run a single simulation
result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4,
inf_init = 32, report = 0.02, lag = 7)

# Run multiple simulations
multi_result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4, inf_init = 32,
report = 0.02, lag = 7, rep = 100)
```

subpop_children *Simulate households with children*

Description

Simulation of households with children using specified random distributions. Number of observations is multiplied by a default value of five.

Usage

```
subpop_children(
  df,
  n = 5,
  prop_parent_couple = NULL,
  prop_children_couple = NULL,
  prop_children_lone = NULL,
  prop_elem_age = NULL,
  parent_dist = stats::runif,
  child_dist = stats::runif,
  age_dist = stats::runif,
  ...
)
```

Arguments

df simulated output data frame from elementary_pop function
 n population multiplier, default value = 5
 prop_parent_couple proportion of parents as a couple (optional)

<code>prop_children_couple</code>	vector of proportions for coupled parents with 1, 2, 3+ children (optional)
<code>prop_children_lone</code>	vector of proportions for single parents with 1, 2, 3+ children (optional)
<code>prop_elem_age</code>	proportion of children that are of elementary school age (optional)
<code>parent_dist</code>	distribution function for parent type, default is <code>stats::runif</code>
<code>child_dist</code>	distribution function for number of children, default is <code>stats::runif</code>
<code>age_dist</code>	distribution function for child age, default is <code>stats::runif</code>
<code>...</code>	additional arguments passed to the distribution functions

Details

This function can be used interactively or with pre-specified parameters. If proportions are not provided, the user will be prompted to enter them. Custom distribution functions can be specified for parent type, number of children, and child age. The total number of simulations ($n * \text{sum of school populations}$) is automatically passed as the first argument to each distribution function.

Value

A data frame representing the simulated population of households with children, including:

<code>schoolID</code>	Assigned school ID for the household
<code>houseID</code>	Unique identifier for each household
<code>num_parent</code>	Number of parents in the household (1 or 2)
<code>num_child</code>	Total number of children in the household
<code>num_elem_child</code>	Number of elementary school-aged children in the household
<code>catchID</code>	Assigned catchment ID for the household
<code>schoolPop</code>	Total population of elementary school assigned for the household
<code>xStart</code>	Starting X-coordindate for assigned catchment
<code>xEnd</code>	End X-coordindate for assigned catchment
<code>yStart</code>	Starting Y-coordindate for assigned catchment
<code>yEnd</code>	End Y-coordindate for assigned catchment
<code>schoolID</code>	Assigned school ID for the household
<code>num_people</code>	Total number of people in the household

Examples

```
# Simulate catchment area
catch_df <- catchment_sim(16, 5, shape = 3.5, rate = 2.8)

# Simulate elementary schools using default gamma distribution
elementary_df <- elementary_pop(catch_df, shape = 5.1, rate = 0.015)

# Simulate households with children
house_children <- subpop_children(elementary_df, n = 2,
```

```

prop_parent_couple = 0.7,
prop_children_couple = c(0.3, 0.5, 0.2),
prop_children_lone = c(0.4, 0.4, 0.2),
prop_elem_age = 0.6)

# Using custom distributions
house_children2 <- subpop_children(elementary_df, n = 3,
prop_parent_couple = 0.7,
prop_children_couple = c(0.3, 0.5, 0.2),
prop_children_lone = c(0.4, 0.4, 0.2),
prop_elem_age = 0.6,
parent_dist = stats::rnorm, mean = 0.5, sd = 0.1,
child_dist = stats::rbeta, shape1 = 2, shape2 = 2,
age_dist = stats::runif)

```

subpop_noChildren *Simulate households without children*

Description

Simulation of households without children using data frames from `elementary_pop()` and `subpop_children()` functions.

Usage

```

subpop_noChildren(
  df,
  df2,
  prop_house_size = NULL,
  prop_house_Children = NULL,
  house_size = NULL
)

```

Arguments

<code>df</code>	simulated output data frame from <code>subpop_children</code> function
<code>df2</code>	simulated output data frame from <code>elementary_pop</code> function
<code>prop_house_size</code>	vector of proportions for households with 1, 2, 3, 4, 5+ members (optional)
<code>prop_house_Children</code>	proportion of households with children (optional)
<code>house_size</code>	vector of random numbers for household size simulation (optional)

Details

This function can be used interactively or with pre-specified parameters. If proportions are not provided, the user will be prompted to enter them. The function calculates the number of households without children for each catchment area based on the proportion of households with children.

Value

A data frame representing the simulated population of households without children, including:

catchID	Catchment area ID
houseID	Unique identifier for each household
num_people	Number of people in the household
schoolPop	Total population of elementary school assigned for the household
xStart	Starting X-coordindate for assigned catchment
xEnd	End X-coordindate for assigned catchment
yStart	Starting Y-coordindate for assigned catchment
yEnd	End Y-coordindate for assigned catchment

Examples

```
# Simulate catchment areas
catch_df <- catchment_sim(16, 5, shape = 3.5, rate = 2.8)

# Simulate elementary schools using default gamma distribution
elementary_df <- elementary_pop(catch_df, shape = 5.1, rate = 0.015)

# Simulate households with children
house_children <- subpop_children(elementary_df, n = 3,
                                  prop_parent_couple = 0.7,
                                  prop_children_couple = c(0.3, 0.5, 0.2),
                                  prop_children_lone = c(0.4, 0.4, 0.2),
                                  prop_elem_age = 0.6)

# Simulate households without children using pre-specified proportions
house_noChild <- subpop_noChildren(house_children, elementary_df,
                                    prop_house_size = c(0.2, 0.3, 0.25, 0.15, 0.1),
                                    prop_house_Children = 0.3)
```

```
summary.alarm_metrics_summary
```

Summary of Alarm Metrics

Description

This function provides a summary of the alarm metrics, including mean and variance for each metric, the best lag and threshold values, and lists of reference dates and best prediction dates.

Usage

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

Arguments

object A list of class alarm_metrics_summary containing the alarm metrics summary data.

... Additional arguments passed to the function (currently unused).

Value

A printed summary of the alarm metrics.

Examples

```
set.seed(123)

# Generate sample metrics
generate_metric_matrix <- function() {
  matrix(runif(15 * 11), nrow = 15, ncol = 11,
         dimnames = list(paste("Lag", 1:15),
                         paste("Threshold", seq(0.1, 0.6, by = 0.05))))
}

sample_metrics <- list(
  FAR = generate_metric_matrix(),
  ADD = generate_metric_matrix(),
  AATQ = generate_metric_matrix(),
  FATQ = generate_metric_matrix(),
  WAATQ = generate_metric_matrix(),
  WFATQ = generate_metric_matrix()
)

metrics <- structure(sample_metrics, class = c("alarm_metrics", "list"))

# Generate sample best models
generate_best_model <- function() {
  data.frame(
    ScYr = rep(1:3, each = 100),
    Date = rep(1:100, 3),
    Alarm = sample(c(0, 1), 300, replace = TRUE, prob = c(0.9, 0.1)),
    lag = sample(1:15, 300, replace = TRUE),
    thres = runif(300, 0.1, 0.6)
  )
}

best_models <- list(
  best.FAR = generate_best_model(),
  best.ADD = generate_best_model(),
  best.AATQ = generate_best_model(),
  best.FATQ = generate_best_model(),
  best.WAATQ = generate_best_model(),
  best.WFATQ = generate_best_model()
)
```

```
# Generate sample epidemic data
epidemic_data <- data.frame(
  ScYr = rep(1:3, each = 365),
  Date = rep(1:365, 3),
  ref_date = c(rep(0, 364), 1)
)

# Create alarm metrics summary
data <- create_alarm_metrics_summary(metrics, best_models, epidemic_data)

# Print summary
summary(data)
```

summary.ssir_epidemic *S3 Summary method for epidemic Simulation*

Description

This function provides a summary of SSIR epidemic simulation. It calculates and displays the statistics.

Usage

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

Arguments

object	An object of class "ssir_epidemic", typically the result of calling ssir() with rep = 1 or NULL.
...	Additional arguments affecting the summary produced.

Value

No return value, called for side effects.

Examples

```
# Run multiple simulations
result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4,
              inf_init = 32, report = 0.02, lag = 7)

# Display summary
summary(result)
```

`summary.ssir_epidemic_multi`*S3 Summary method for multiple epidemic simulations*

Description

This function provides a summary of multiple SSIR epidemic simulations. It calculates and displays average statistics across all simulations.

Usage

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

Arguments

<code>object</code>	An object of class "ssir_epidemic_multi", typically the result of calling <code>ssir()</code> with <code>rep > 1</code> .
<code>...</code>	Additional arguments affecting the summary produced.

Value

No return value, called for side effects.

Examples

```
# Run multiple simulations  
multi_result <- ssir(N = 10000, T = 300, alpha = 0.3, inf_period = 4,  
                    inf_init = 32, report = 0.02, lag = 7, rep = 100)  
  
# Display summary  
summary(multi_result)
```

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