

Package: hermione (via r-universe)

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Title Robust estimation of COVID-19 Serial Interval

Version 1.0.0

Description This package implements methods to robustly estimate COVID-19 Serial Interval accounting for biases introduced due to isolation of cases.

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Contents

beta_muvar2shape1shape2	2
beta_shape1shape2muvar	2
dmbeta	3
fast_probability_basic	4
fast_probability_isolation_offset	4
fast_probability_offset	5
pmbeta	6
probability_basic	6

probability_isolation	7
probability_isolation_offset	8
probability_offset	9
simulate_si	10
total_log_likelihood	11
with_recall_bias	12

Index	13
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beta_muvar2shape1shape2

Reparameterise Beta distributions

Description

Reparameterise Beta distributions

Usage

beta_muvar2shape1shape2(mu, sigma2)

Arguments

mu	Mean, should be less than 1
sigma2	variance, should be less than 1/12

Value

A named list containing 'shape1' and 'shape2'

Author(s)

Sangeeta Bhatia

beta_shape1shape2muvar

Reparameterise Beta distributions

Description

Reparameterise Beta distributions

Usage

beta_shape1shape2muvar(shape1, shape2)

Arguments

shape1	positive
shape2	positive

Value

A named list containing 'mu' and 'sigma2'

Author(s)

Sangeeta Bhatia

dmbeta	<i>Modified beta distribution</i>
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Description

Modified beta probability density function

Usage

```
dmbeta(x, shape1, shape2, xmax, ncp = 0, log = FALSE)
```

Arguments

x	numeric value for which density is required
shape1	non-negative parameter of the Beta distribution
shape2	non-negative parameter of the Beta distribution
xmax	Maximum possible value of x
ncp	non-centrality parameter.
log	logical; if TRUE, probabilities p are given as log(p)

Details

This function returns the probability density of the random variable x/x_{\max} where x/x_{\max} is distributed according to a beta distribution.

Value

modified density

Author(s)

Sangeeta Bhatia

fast_probability_basic

Probability of serial interval as a convolution of infectiousness distribution of primary case and incubation period of secondary case

Description

Probability of serial interval as a convolution of infectiousness distribution of primary case and incubation period of secondary case

Usage

```
fast_probability_basic(t, tmax, inf_params, ip_params)
```

Arguments

t	observed serial interval
tmax	the maximum time (from the onset of symptoms in the primary case) at which secondary case could have been infected
inf_params	list with components rate and shape for infectious period distribution
ip_params	list with components rate and shape for incubation period distribution

Value

numeric. Probability of observing the given serial interval given the parameters of infectious period distributions and incubation period distributions

Author(s)

Sangeeta Bhatia

fast_probability_isolation_offset

Probability of serial interval when primary case has been isolated and in the presence of asymptomatic infectiousness

Description

Probability of serial interval when primary case has been isolated and in the presence of asymptomatic infectiousness

Usage

```
fast_probability_isolation_offset(poffset, nu, offset, inf_params)
```

Arguments

poffset	Probability calculation with offset only
nu	onset to isolation of primary case
offset	days of asymptomatic infectiousness
inf_params	named list of arguments for infectious period distribution.

Value

numeric probability of observing the given serial interval with the given parameters of infectious period and incubation period distribution

Author(s)

Sangeeta Bhatia

fast_probability_offset

Probability of serial interval in the presence of asymptomatic infectiousness

Description

Probability of serial interval in the presence of asymptomatic infectiousness

Usage

```
fast_probability_offset(t, tmax, offset, inf_params, ip_params)
```

Arguments

t	observed serial interval
tmax	Max of observed serial interval and isolation if primary case has been isolated
offset	days of asymptomatic infectiousness
inf_params	named list of arguments for infectious period distribution.

Value

numeric probability of observing the given serial interval with the given parameters of infectious period and incubation period distribution

Author(s)

Sangeeta Bhatia

pmbeta *Modified beta cumulative probability distribution function*

Description

Modified beta cumulative probability distribution function

Usage

```
pmbeta(x, shape1, shape2, xmax, ncp = 0, log = FALSE)
```

Arguments

x	numeric value for which density is required
shape1	non-negative parameter of the Beta distribution
shape2	non-negative parameter of the Beta distribution
xmax	Maximum possible value of x
ncp	non-centrality parameter.
log	logical; if TRUE, probabilities p are given as log(p)

Value

modified distribution

Author(s)

Sangeeta Bhatia

probability_basic *Probability of serial interval as a convolution of infectiousness distribution of primary case and incubation period of secondary case*

Description

Probability of serial interval

Usage

```
probability_basic(
  t,
  inf_distr = "dgamma",
  inc_distr = "dgamma",
  inf_params,
  inc_params
)
```

Arguments

t	observed serial interval
inf_distr	quoted name of the infectious period density function. Defaults to dgamma
inc_distr	quoted name of the incubation period density function. Defaults to dgamma
inf_params	named list of arguments for infectious period distribution.
inc_params	named list of arguments for incubation period distribution.

Details

Probability of observing a serial interval t is the convolution of the distributions of infectious profile and incubation period.

Value

numeric. Probability of observing the given serial interval given the parameters of infectious period distributions and incubation period distributions

Author(s)

Sangeeta Bhatia

Examples

```
probability_basic(  
  10,  
  inf_params = list(shape = 100, rate = 100),  
  inc_params = list(shape = 50, rate = 100)  
)
```

probability_isolation *Probability of serial interval*

Description

Probability of serial interval

Usage

```
probability_isolation(  
  t,  
  nu,  
  inf_distr = "dgamma",  
  inc_distr = "dgamma",  
  inf_params,  
  inc_params  
)
```

Arguments

t	observed serial interval
nu	onset to isolation of primary case
inf_distr	quoted name of the infectious period density function. Defaults to dgamma
inc_distr	quoted name of the incubation period density function. Defaults to dgamma
inf_params	named list of arguments for infectious period distribution.
inc_params	named list of arguments for incubation period distribution.

Value

numeric. Probability of observing the given serial interval given the delay from onset to isolation, the parameters of infectious period distributions and incubation period distributions.

Author(s)

Sangeeta Bhatia

probability_isolation_offset

Probability of serial interval when primary case has been isolated and in the presence of asymptomatic infectiousness

Description

Probability of serial interval when primary case has been isolated and in the presence of asymptomatic infectiousness

Usage

```
probability_isolation_offset(
  t,
  nu,
  offset,
  inf_distr = "dgamma",
  inc_distr = "dgamma",
  inf_params,
  inc_params
)
```

Arguments

t	observed serial interval
nu	onset to isolation of primary case
offset	days of asymptomatic infectiousness

inf_distr	quoted name of the infectious period density function. Defaults to dgamma
inc_distr	quoted name of the incubation period density function. Defaults to dgamma
inf_params	named list of arguments for infectious period distribution.
inc_params	named list of arguments for incubation period distribution.

Value

numeric probability of observing the given serial interval with the given parameters of infectious period and incubation period distributions

Author(s)

Sangeeta Bhatia

probability_offset *Probability of serial interval with asymptomatic infectiousness*

Description

Probability of serial interval with asymptomatic infectiousness

Usage

```
probability_offset(
  t,
  offset,
  inf_distr = "dgamma",
  inc_distr = "dgamma",
  inf_params,
  inc_params
)
```

Arguments

t	observed serial interval
offset	days of asymptomatic infectiousness
inf_distr	quoted name of the infectious period density function. Defaults to dgamma
inc_distr	quoted name of the incubation period density function. Defaults to dgamma
inf_params	named list of arguments for infectious period distribution.
inc_params	named list of arguments for incubation period distribution.

Value

numeric probability of observing the given serial interval with the given parameters of infectious period and incubation period distribution

Author(s)

Sangeeta Bhatia

simulate_si

*Simulate serial interval***Description**

Simulate serial interval

Usage

```
simulate_si(
  mean_ip,
  sd_ip,
  mean_inf,
  sd_inf,
  mean_iso = NULL,
  sd_iso = NULL,
  offset = 0,
  nsim = 50
)
```

Arguments

mean_ip	Mean Incubation Period
sd_ip	Standard deviation of the incubation period
mean_inf	Infectious Period
sd_inf	Standard deviation of the infectious period
mean_iso	Mean delay from symptom onset to case isolation. If this is null, then isolation is not simulated.
sd_iso	Standard deviation of the delay from symptom onset to case isolation
offset	Numeric - days before symptom onset that infectiousness is assumed to begin. If offset is NULL, then asymptomatic infectiousness is assumed to be absent.
nsim	Number of transmission pairs to simulate

Details

This function simulates serial interval with or without case isolation, and with or without pre-symptomatic infectiousness. At the moment, infectious period, incubation period and onset to isolation distributions are assumed to be gamma distributed.

Value

a data frame with columns `t_1`, `t_2`, `si` `t_1` corresponds to draws from the infectious period, `t_2` corresponds to draws from the incubation period, and `si` is the serial interval (`t_1 + t_2`). If `mean_iso` and `sd_iso` are not `NULL`, then the output also contains a column `nu` corresponding to draws from the distribution of onset to isolation.

Author(s)

Sangeeta Bhatia

total_log_likelihood *Total log likelihood*

Description

Total log-likelihood

Usage

```
total_log_likelihood(
  tvec,
  nu_vec = NULL,
  offset_vec = NULL,
  inf_params,
  ip_params
)
```

Arguments

<code>tvec</code>	Vector of observed serial intervals
<code>nu_vec</code>	Vector of delays from onset to isolation
<code>offset_vec</code>	Vector specifying the pre-symptomatic infectiousness
<code>inf_params</code>	named list of arguments for infectious period distribution.

Details

This function returns the total log-likelihood of the observed serial interval. In the absence of isolation, the likelihood is

$$L(\text{rate}, \text{shape} \mid \text{tvec}) = \prod_{i=1}^n \int_0^{t_i} f(t_1)g(t_i - t_1)dt_1$$

where t_i is the i th observation, t_1 is the delay between symptom onset in a primary case to the infection of a secondary case, and f and g are the infectious and incubation period distributions respectively. If isolation is included via non-null `nu_vec`, the likelihood is

$$L(\text{rate}, \text{shape} \mid \text{tvec}) = \prod_{i=1}^n \int_0^{t_i} (f(t_1)/F(\nu_i))g(t_i - t_1)dt_1$$

where ν_i is the delay from symptom onset in the primary case to their isolation. Finally, if asymptomatic infectiousness is included (non-null `offset_vec`) the infectiousness profile is a gamma distribution with offset.

Value

total log-likelihood

Author(s)

Sangeeta Bhatia

with_recall_bias *Probability of observing serial interval taking into account recall bias*

Description

Probability of observing serial interval taking into account recall bias

Usage

```
with_recall_bias(tobs, nu, inf_params, ip_params, beta)
```

Arguments

<code>tobs</code>	observed serial interval
<code>nu</code>	isolation
<code>inf_params</code>	parameters of the infectious period
<code>ip_params</code>	parameters of the incubation period
<code>beta</code>	recall bias coefficient

Value

probability of observing `tobs` taking into account recall bias

Author(s)

Sangeeta Bhatia

Index

[beta_muvar2shape1shape2](#), 2

[beta_shape1shape2muvar](#), 2

[dmbeta](#), 3

[fast_probability_basic](#), 4

[fast_probability_isolation_offset](#), 4

[fast_probability_offset](#), 5

[pmbeta](#), 6

[probability_basic](#), 6

[probability_isolation](#), 7

[probability_isolation_offset](#), 8

[probability_offset](#), 9

[simulate_si](#), 10

[total_log_likelihood](#), 11

[with_recall_bias](#), 12