# 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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**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 3.5.0)

**Suggests** testthat, knitr, rmarkdown, covr

**RoxygenNote** 7.1.0

**VignetteBuilder** knitr

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**Config/pak/sysreqs** libicu-dev libsodium-dev

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## Contents


beta_muvar2shape1shape2 . . . . . 2
beta_shape1shape22muvar . . . . . 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

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`beta_shape1shape22muvar` *Reparameterise Beta distributions*

---

## Description

Reparameterise Beta distributions

## Usage

```
beta_shape1shape22muvar(shape1, shape2)
```

### Arguments

| | |
|---|---|
| shape1 | positive |
| shape2 | positive |

### Value

A named list containing 'mu' and 'sigma2'

### Author(s)

Sangeeta Bhatia

---

## dmbeta *Modified beta distribution*

---

### 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/xmax where x/xmax is distributed according to a beta distribution.

### Value

modified density

### Author(s)

Sangeeta Bhatia

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`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 prmary 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 *Modififed beta cumulative probability distribution function*

### Description

Modififed 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-likelhood

## Usage

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

## Arguments

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

## Details

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

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

where $t_i$ is the ith 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

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

where $\nu_i$ is the delay from symptom onset in the primary case to their isolation. Finally, if asymptomatic infectiosuness 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

| | |
|---|---|
| `tobs` | observed serial interval |
| `nu` | isolation |
| `inf_params` | parameters of the infectious period |
| `ip_params` | parameters of the incubation period |
| `beta` | recall bias coefficient |

## Value

probability of observing tobs taking into account recall bias

## Author(s)

Sangeeta Bhatia

# Index

beta_muvar2shape1shape2, 2
beta_shape1shape22muvar, 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