Package 'serodynamics'

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Title Modeling Longitudinal Antibody Responses to Infection

Version 0.1.0

Description Implements Bayesian hierarchical models for estimating antibody kinetic parameters from longitudinal serological data. Fits two-phase within-host models capturing antibody rise, peak, and decay following pathogen infection, using 'JAGS' for posterior inference. Designed as the upstream companion to the 'serocalculator' package for end-to-end seroepidemiological analysis. Methods are described in Teunis and colleagues (2016) <doi:10.1016/j.epidem.2016.04.001> and Teunis and van Eijkeren (2020) <doi:10.1002/sim.8578>.

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Contents

`as_case_data` *Convert data into* `case_data`

Description

Convert data into `case_data`

Usage

```
as_case_data(
  data,
  id_var = "index_id",
  biomarker_var = "antigen_iso",
  value_var = "value",
  time_in_days = "timeindays"
)
```

Arguments

data	a data.frame
id_var	a character string naming the column in data denoting participant ID
biomarker_var	a character string naming the column in data denoting which biomarker is being reported in value_var (e.g. "antigen_iso")
value_var	a character string naming the column in data with biomarker measurements
time_in_days	a character string naming the column in data with elapsed time since seroconversion

Value

a case_data object

Examples

```
set.seed(1)
serocalculator::typhoid_curves_nostrat_100 |>
  sim_case_data(n = 5) |>
  as_case_data(
    id_var = "id",
    biomarker_var = "antigen_iso",
    time_in_days = "timeindays",
    value_var = "value"
  )
```

---

autoplot.case_data *Plot case data*

Description

Plot case data

Usage

```
## S3 method for class 'case_data'
autoplot(object, log_y = TRUE, log_x = FALSE, ...)
```

Arguments

object	a case_data object
log_y	whether to log-transform the y-axis
log_x	whether to log-transform the x-axis
...	Arguments passed on to ggplot2::geom_point, ggplot2::geom_line

mapping Set of aesthetic mappings created by aes(). If specified and inherit.aes = TRUE (the default), it is combined with the default mapping at the top level of the plot. You must supply mapping if there is no plot mapping.

data The data to be displayed in this layer. There are three options:
If NULL, the default, the data is inherited from the plot data as specified in the call to ggplot().
A data.frame, or other object, will override the plot data. All objects will be fortified to produce a data frame. See fortify() for which variables will be created.
A function will be called with a single argument, the plot data. The return value must be a data.frame, and will be used as the layer data. A function can be created from a formula (e.g. ~ head(.x, 10)).

stat The statistical transformation to use on the data for this layer. When using a geom_*() function to construct a layer, the stat argument can be used to override the default coupling between geoms and stats. The stat argument accepts the following:

- A Stat ggproto subclass, for example StatCount.
- A string naming the stat. To give the stat as a string, strip the function name of the stat_ prefix. For example, to use stat_count(), give the stat as "count".
- For more information and other ways to specify the stat, see the layer stat documentation.

position A position adjustment to use on the data for this layer. This can be used in various ways, including to prevent overplotting and improving the display. The position argument accepts the following:

- The result of calling a position function, such as position_jitter(). This method allows for passing extra arguments to the position.
- A string naming the position adjustment. To give the position as a string, strip the function name of the position_ prefix. For example, to use position_jitter(), give the position as "jitter".
- For more information and other ways to specify the position, see the layer position documentation.

na.rm If FALSE, the default, missing values are removed with a warning. If TRUE, missing values are silently removed.

show.legend logical. Should this layer be included in the legends? NA, the default, includes if any aesthetics are mapped. FALSE never includes, and TRUE always includes. It can also be a named logical vector to finely select the aesthetics to display. To include legend keys for all levels, even when no data exists, use TRUE. If NA, all levels are shown in legend, but unobserved levels are omitted.

`inherit.aes` If `FALSE`, overrides the default aesthetics, rather than combining with them. This is most useful for helper functions that define both data and aesthetics and shouldn't inherit behaviour from the default plot specification, e.g. `annotation_borders()`.

`arrow` Arrow specification, as created by `grid::arrow()`.

`arrow.fill` fill colour to use for the arrow head (if closed). `NULL` means use `colour` aesthetic.

`lineend` Line end style (round, butt, square).

`linejoin` Line join style (round, mitre, bevel).

`linemitre` Line mitre limit (number greater than 1).

`orientation` The orientation of the layer. The default (`NA`) automatically determines the orientation from the aesthetic mapping. In the rare event that this fails it can be given explicitly by setting `orientation` to either `"x"` or `"y"`. See the *Orientation* section for more detail.

`direction` direction of stairs: 'vh' for vertical then horizontal, 'hv' for horizontal then vertical, or 'mid' for step half-way between adjacent x-values.

Value

a ggplot2::ggplot

Examples

```
set.seed(1)
sim_case_data <-
  serocalculator::typhoid_curves_nostrat_100 |>
  sim_case_data(n = 5, max_n_obs = 20, followup_interval = 14)

sim_case_data |>
  autoplot(alpha = .5)
```

---

initsfunction *JAGS chain initialization function*

Description

JAGS chain initialization function

Usage

```
initsfunction(chain)
```

Arguments

`chain`	an integer specifying which chain to initialize

Value

a list of RNG seeds and names

Examples

```
initsfunction(1)
```

`load_data` *load and format data*

Description

to add

Usage

```
load_data(
  datapath = "inst/extdata/",
  datafile = "TypoidCaseData_github_09.30.21.csv"
)
```

Arguments

`datapath`	path to data folder
`datafile`	data file name

Value

a list with the following elements:

- `smpl.t` = time since symptom/fever onset for each participant, max 7 visits
- `logy` = log antibody response at each time-point (max 7) for each of 7 biomarkers for each participant
- `ntest` is max number of biomarkers
- `nsmpl` = max number of samples per participant
- `nsubj` = number of study participants
- `ndim` = number of parameters to model(y0, y1, t1, alpha, shape)
- `my.hyp`, `prec.hyp`, `omega` and `wishdf` are all parameters to describe the shape of priors for (y0, y1, t1, alpha, shape)

nepal_sees *SEES Typhoid data*

Description

A subset of data from the SEES project highlighting Typhoid longitudinal data from Nepal.

Usage

```
nepal_sees
```

Format

`nepal_sees`**:**

A `base::data.frame()` with 904 rows and 8 columns:

Country Country name

person_id ID identifying a study participant

sample_id ID identifying sample taken

bldculres Pathogen participant tested positive for; Typhoid or paratyphoid

antigen_iso The antigen/antibody combination included in the assay

studyvisit Categorical estimated time frame for when sample was taken; 28 days, 3_months, 6_months, 12_months, baseline, or 18_months

dayssincefeveronset Continuous measurement showing how exact days since symptom onset

result Continuous variable describing ELISA result

Source

reference study: doi:10.1016/S26665247(22)001148

nepal_sees_jags_output *SEES Typhoid run_mod jags output*

Description

A `run_mod()` output using the nepal_sees example data set as input and stratifying by column `"bldculres"`, which is the diagnosis type (typhoid or paratyphoid). Keeping only IDs `"newperson"`, `"sees_npl_1"`, `"sees_npl_2"`.

Usage

```
nepal_sees_jags_output
```

Format

An S3 object of class `sr_model`: A tibble::tbl_df that contains the posterior predictive distribution of the person-specific parameters for a "new person" with no observed data (`Subject = "newperson"`) and posterior distributions of the person-specific parameters for two arbitrarily-chosen subjects (`"sees_npl_1"` and `"sees_npl_2"`). Contains 40,000 `rows`, 7 `columns`, and model `attributes`.

Iteration Number of sampling iterations: 500 iterations

Chain Number of MCMC chains run: 2 chains run

Parameter Parameter being estimated

Iso_type Antibody/antigen type combination being evaluated: `HlyE_IgA` and `HlyE_IgG`

Stratification The variable used to stratify jags model: `typhi` and `paratyphi`

Subject ID of subject being evaluated: `newperson`, `sees_npl_1`, `sees_npl_2`

value Estimated value of the parameter

attributes A list of `attributes` that summarize the jags inputs, priors, and optional jags_post mcmc object

Source

reference study: doi:10.1016/S26665247(22)001148

`plot_jags_dens` *Density Plot Diagnostics*

Description

plot_jags_dens() takes a list output from `run_mod()` to create density plots for each chain run in the mcmc estimation. Defaults will produce every combination of antigen/antibody, parameters, and stratifications, unless otherwise specified. Antigen/antibody combinations and stratifications will vary by analysis. The antibody dynamic curve includes the following parameters:

- y0 = baseline antibody concentration
- y1 = peak antibody concentration
- t1 = time to peak
- r = shape parameter
- alpha = decay rate

Usage

```
plot_jags_dens(
  data,
  iso = unique(data$Iso_type),
  param = unique(data$Parameter),
  strat = unique(data$Stratification)
)
```

Arguments

`data`	A list outputted from run_mod().
`iso`	Specify character string to produce plots of only a specific antigen/antibody combination, entered with quotes. Default outputs all antigen/antibody combinations.
`param`	Specify character string to produce plots of only a specific parameter, entered with quotes. Options include: • `alpha` = posterior estimate of decay rate • `r` = posterior estimate of shape parameter • `t1` = posterior estimate of time to peak • `y0` = posterior estimate of baseline antibody concentration • `y1` = posterior estimate of peak antibody concentration
`strat`	Specify character string to produce plots of specific stratification entered in quotes.

Value

A `base::list()` of `ggplot2::ggplot()` objects producing density plots for all the specified input.

Author(s)

Sam Schildhauer

Examples

```
data <- serodynamics::nepal_sees_jags_output

# Specifying isotype and stratification for traceplot.
plot_jags_dens(
               data = data,
               iso = "HlyE_IgA",
               strat = "typhi")
```

`plot_jags_effect` *Plot Effective Sample Size Diagnostics*

Description

plot_jags_effect() takes a list output from `run_mod()` to create summary diagnostics for each chain run in the mcmc estimation. Defaults will produce every combination of antigen/antibody, parameters, and stratifications, unless otherwise specified. At least 2 chains are required to run function. Antigen/antibody combinations and stratifications will vary by analysis. The antibody dynamic curve includes the following parameters:

- y0 = baseline antibody concentration
- y1 = peak antibody concentration

- t1 = time to peak
- r = shape parameter
- alpha = decay rate

Usage

```
plot_jags_effect(
  data,
  iso = unique(data$Iso_type),
  param = unique(data$Parameter),
  strat = unique(data$Stratification)
)
```

Arguments

`data`	A list outputted from run_mod().
`iso`	Specify character string to produce plots of only a specific antigen/antibody combination, entered with quotes. Default outputs all antigen/antibody combinations.
`param`	Specify character string to produce plots of only a specific parameter, entered with quotes. Options include: • `y0` = posterior estimate of baseline antibody concentration • `y1` = posterior estimate of peak antibody concentration • `t1` = posterior estimate of time to peak • `r` = posterior estimate of shape parameter • `alpha` = posterior estimate of decay rate
`strat`	Specify character string to produce plots of specific stratification entered in quotes.

Value

A list of ggplot2::ggplot objects showing the proportion of effective samples taken/total samples taken for all parameter iso combinations. The estimate with the highest proportion of effective samples taken will be listed first.

Author(s)

Sam Schildhauer

Examples

```
data <- serodynamics::nepal_sees_jags_output

plot_jags_effect(data = data,
                 iso = "HlyE_IgA",
                 strat = "typhi")
```

plot_jags_Rhat *Rhat Plot Diagnostics*

Description

plot_jags_Rhat() takes a list output from `run_mod()` to produce dotplots of potential scale reduction factors (Rhat) for each chain run in the mcmc estimation. Rhat values analyze the spread of chains compared to pooled values with a goal of observing rhat < 1.10 for convergence. Defaults will produce every combination of antigen/antibody, parameters, and stratifications, unless otherwise specified. Antigen/antibody combinations and stratifications will vary by analysis. The antibody dynamic curve includes the following parameters:

- y0 = baseline antibody concentration
- y1 = peak antibody concentration
- t1 = time to peak
- r = shape parameter
- alpha = decay rate

Usage

```
plot_jags_Rhat(
  data,
  iso = unique(data$Iso_type),
  param = unique(data$Parameter),
  strat = unique(data$Stratification)
)
```

Arguments

`data`	A list outputted from run_mod().
`iso`	Specify character string to produce plots of only a specific antigen/antibody combination, entered with quotes. Default outputs all antigen/antibody combinations.
`param`	Specify character string to produce plots of only a specific parameter, entered with quotes. Options include: • `y0` = posterior estimate of baseline antibody concentration • `y1` = posterior estimate of peak antibody concentration • `t1` = posterior estimate of time to peak • `r` = posterior estimate of shape parameter • `alpha` = posterior estimate of decay rate
`strat`	Specify character string to produce plots of specific stratification entered in quotes.

Value

A list of ggplot2::ggplot objects producing dotplots with rhat values for all the specified input.

Author(s)

Sam Schildhauer

Examples

```
data <- serodynamics::nepal_sees_jags_output

plot_jags_Rhat(data = data,
               iso = "HlyE_IgA",
               strat = "typhi")
```

`plot_jags_trace` *Trace Plot Diagnostics*

Description

plot_jags_trace() takes a list output from `run_mod()` to create trace plots for each chain run in the mcmc estimation. Defaults will produce every combination of antigen/antibody, parameters, and stratifications, unless otherwise specified. Antigen/antibody combinations and stratifications will vary by analysis. The antibody dynamic curve includes the following parameters:

- y0 = baseline antibody concentration
- y1 = peak antibody concentration
- t1 = time to peak
- r = shape parameter
- alpha = decay rate

Usage

```
plot_jags_trace(
  data,
  iso = unique(data$Iso_type),
  param = unique(data$Parameter),
  strat = unique(data$Stratification)
)
```

Arguments

`data`	A list outputted from `run_mod()`.
`iso`	Specify character string to produce plots of only a specific antigen/antibody combination, entered with quotes. Default outputs all antigen/antibody combinations.

`param` Specify character string to produce plots of only a specific parameter, entered with quotes. Options include:

- `alpha` = posterior estimate of decay rate
- `r` = posterior estimate of shape parameter
- `t1` = posterior estimate of time to peak
- `y0` = posterior estimate of baseline antibody concentration
- `y1` = posterior estimate of peak antibody concentration

`strat` Specify character string to produce plots of specific stratification entered in quotes.

Value

A list of ggplot2::ggplot objects producing trace plots for all the specified input.

Author(s)

Sam Schildhauer

Examples

```
data <- serodynamics::nepal_sees_jags_output

# Specifying isotype, parameter, and stratification for traceplot.
plot_jags_trace(
                data = data,
                iso = "HlyE_IgA",
                strat = "typhi")
```

---

plot_predicted_curve *Generate Predicted Antibody Response Curves (Median + 95% CI)*

Description

Plots a median antibody response curve with a 95% credible interval ribbon, using MCMC samples from the posterior distribution. Optionally overlays observed data, applies logarithmic spacing on the y- and x-axes, and shows all individual sampled curves.

Usage

```
plot_predicted_curve(
  model,
  ids,
  antigen_iso,
  dataset = NULL,
  legend_obs = "Observed data",
  legend_median = "Median prediction",
  show_quantiles = TRUE,
```

```
  log_y = FALSE,
  log_x = FALSE,
  show_all_curves = FALSE,
  alpha_samples = 0.3,
  xlim = NULL,
  ylab = NULL,
  facet_by_id = length(ids) > 1,
  ncol = NULL
)
```

Arguments

model	An sr_model object (returned by run_mod()) containing samples from the posterior distribution of the model parameters.
ids	The participant IDs to plot; for example, "sees_npl_128".
antigen_iso	The antigen isotype to plot; for example, "HlyE_IgA" or "HlyE_IgG".
dataset	(Optional) A tibble::tbl_df with observed antibody response data. Must contain: • timeindays • value • id • antigen_iso
legend_obs	Label for observed data in the legend.
legend_median	Label for the median prediction line.
show_quantiles	logical; if TRUE (default), plots the 2.5%, 50%, and 97.5% quantiles.
log_y	logical; if TRUE, applies a log10 transformation to the y-axis.
log_x	logical; if TRUE, applies a log10 transformation to the x-axis.
show_all_curves	logical; if TRUE, overlays all individual sampled curves.
alpha_samples	Numeric; transparency level for individual curves (default = 0.3).
xlim	(Optional) A numeric vector of length 2 providing custom x-axis limits.
ylab	(Optional) A string for the y-axis label. If NULL (default), the label is automatically set to "ELISA units" or "ELISA units (log scale)" based on the log_y argument.
facet_by_id	logical; if TRUE, facets the plot by 'id'. Defaults to TRUE when multiple IDs are provided.
ncol	integer; number of columns for faceting.

Value

A ggplot2::ggplot object displaying predicted antibody response curves with a median curve and a 95% credible interval band as default.

Examples

```
sees_model <- serodynamics::nepal_sees_jags_output |>
  dplyr::filter(Iteration <= 50)  # use 50 of 500 iterations for faster examples
sees_data <- serodynamics::nepal_sees

# Plot (linear axes) with all individual curves + median ribbon
p1 <- plot_predicted_curve(
  model              = sees_model,
  dataset            = sees_data,
  ids                = "sees_npl_128",
  antigen_iso        = "HlyE_IgA",
  show_quantiles     = TRUE,
  log_y              = FALSE,
  log_x              = FALSE,
  show_all_curves    = TRUE
)
print(p1)

# Plot (log10 y-axis) with all individual curves + median ribbon
p2 <- plot_predicted_curve(
  model              = sees_model,
  dataset            = sees_data,
  ids                = "sees_npl_128",
  antigen_iso        = "HlyE_IgA",
  show_quantiles     = TRUE,
  log_y              = TRUE,
  log_x              = FALSE,
  show_all_curves    = TRUE
)
print(p2)

# Plot with custom x-axis limits (0-600 days)
p3 <- plot_predicted_curve(
  model              = sees_model,
  dataset            = sees_data,
  ids                = "sees_npl_128",
  antigen_iso        = "HlyE_IgA",
  show_quantiles     = TRUE,
  log_y              = FALSE,
  log_x              = FALSE,
  show_all_curves    = TRUE,
  xlim               = c(0, 600)
)
print(p3)

# Multi-ID, faceted plot (single antigen):
p4 <- plot_predicted_curve(
  model           = sees_model,
  dataset         = sees_data,
  ids             = c("sees_npl_128", "sees_npl_131"),
  antigen_iso     = "HlyE_IgA",
  show_all_curves = TRUE,
```

```
  facet_by_id     = TRUE
)
print(p4)
```

`postprocess_jags_output` *Postprocess JAGS output*

Description

Postprocess JAGS output

Usage

```
postprocess_jags_output(jags_output, ids, antigen_isos)
```

Arguments

`jags_output`	output from `runjags::run.jags()`
`ids`	IDs of individuals being sampled (JAGS discards this information, so it has to be re-attached)
`antigen_isos`	names of biomarkers being modeled (JAGS discards this information, so it has to be re-attached)

Value

a tibble::tbl_df

Examples

```
set.seed(1)
raw_data <-
  serocalculator::typhoid_curves_nostrat_100 |>
  dplyr::filter(
    antigen_iso |> stringr::str_starts(pattern = "HlyE")
  ) |>
  sim_case_data(
    n = 5,
    antigen_isos = c("HlyE_IgA", "HlyE_IgG")
  )
prepped_data <- prep_data(raw_data)
priors <- prep_priors(max_antigens = prepped_data$n_antigen_isos)
nchains <- 2
# nr of MC chains to run simultaneously
nadapt <- 100
# nr of iterations for adaptation
nburnin <- 100
# nr of iterations to use for burn-in
nmc <- 100
```

```
# nr of samples in posterior chains
niter <- 100
# nr of iterations for posterior sample
nthin <- round(niter / nmc)
# thinning needed to produce nmc from niter

tomonitor <- c("y0", "y1", "t1", "alpha", "shape")

file_mod <- serodynamics_example("model.jags")

set.seed(11325)
jags_post <- runjags::run.jags(
  model = file_mod,
  data = c(prepped_data, priors),
  inits = initsfunction,
  method = "parallel",
  adapt = nadapt,
  burnin = nburnin,
  thin = nthin,
  sample = nmc,
  n.chains = nchains,
  monitor = tomonitor,
  summarise = FALSE
)

curve_params <- jags_post |> postprocess_jags_output(
  ids = attr(prepped_data, "ids"),
  antigen_isos = attr(prepped_data, "antigens")
)

print(curve_params)
```

---

post_summ *Summary Table of Jags Posterior Estimates*

Description

post_summ() takes a list output from run_mod() to summary table for parameter, antigen/antibody, and stratification combination. Defaults will produce every combination of antigen/antibody, parameters, and stratifications, unless otherwise specified. Antigen/antibody combinations and stratifications will vary by analysis. The antibody dynamic curve includes the following parameters:

- y0 = baseline antibody concentration
- y1 = peak antibody concentration
- t1 = time to peak
- r = shape parameter
- alpha = decay rate

Usage

```
post_summ(
  data,
  iso = unique(data$Iso_type),
  param = unique(data$Parameter),
  strat = unique(data$Stratification)
)
```

Arguments

data	A list outputted from `run_mod()`.
iso	Specify character string to produce tables of only a specific antigen/antibody combination, entered with quotes. Default outputs all antigen/antibody combinations.
param	Specify character string to produce tables of only a specific parameter, entered with quotes. Options include: • `alpha` = posterior estimate of decay rate • `r` = posterior estimate of shape parameter • `t1` = posterior estimate of time to peak • `y0` = posterior estimate of baseline antibody concentration • `y1` = posterior estimate of peak antibody concentration
strat	Specify character string to produce tables of specific stratification entered in quotes.

Value

A data.frame summarizing estimate mean, standard deviation (SD), median, and quantiles (2.5%, 25.0%, 50.0%, 75.0%, 97.5%).

Author(s)

Sam Schildhauer

Examples

```
post_summ(data = serodynamics::nepal_sees_jags_output)
```

`prep_data` *prepare data for JAGs*

Description

prepare data for JAGs

Usage

```
prep_data(
  dataframe,
  biomarker_column = get_biomarker_names_var(dataframe),
  verbose = FALSE,
  add_newperson = TRUE
)
```

Arguments

dataframe	a data.frame containing ...
biomarker_column	character string indicating which column contains antigen-isotype names
verbose	whether to produce verbose messaging
add_newperson	whether to add an extra record with missing data

Value

a prepped_jags_data object (a list with extra attributes ...)

Examples

```
set.seed(1)
raw_data <-
  serocalculator::typhoid_curves_nostrat_100 |>
  sim_case_data(n = 5)
prepped_data <- prep_data(raw_data)
```

---

prep_priors *Prepare priors*

Description

Takes multiple vector inputs to allow for modifiable priors. Priors can be specified as an option in run_mod.

Usage

```
prep_priors(
  max_antigens,
  mu_hyp_param = c(1, 7, 1, -4, -1),
  prec_hyp_param = c(1, 1e-05, 1, 0.001, 1),
  omega_param = c(1, 50, 1, 10, 1),
  wishdf_param = 20,
  prec_logy_hyp_param = c(4, 1)
)
```

Arguments

`max_antigens` An integer specifying how many antigen-isotypes (biomarkers) will be modeled.

`mu_hyp_param` A numeric vector of 5 values representing the prior mean for the population level parameters parameters (y0, y1, t1, r, alpha) for each biomarker. If specified, must be 5 values long, representing the following parameters:

- y0 = baseline antibody concentration (default = 1.0)
- y1 = peak antibody concentration (default = 7.0)
- t1 = time to peak (default = 1.0)
- r = shape parameter (default = -4.0)
- alpha = decay rate (default = -1.0)

`prec_hyp_param` A numeric vector of 5 values corresponding to hyperprior diagonal entries for the precision matrix (i.e. inverse variance) representing prior covariance of uncertainty around `mu_hyp_param`. If specified, must be 5 values long:

- defaults: y0 = 1.0, y1 = 0.00001, t1 = 1.0, r = 0.001, alpha = 1.0

`omega_param` A numeric vector of 5 values corresponding to the diagonal entries representing the Wishart hyperprior distributions of `prec_hyp_param`, describing how much we expect parameters to vary between individuals. If specified, must be 5 values long:

- defaults: y0 = 1.0, y1 = 50.0, t1 = 1.0, r = 10.0, alpha = 1.0

`wishdf_param` An integer vector of 1 value specifying the degrees of freedom for the Wishart hyperprior distribution of `prec_hyp_param`. If specified, must be 1 value long.

- default = 20.0
- The value of `wishdf_param` controls how informative the Wishart prior is. Higher values lead to tighter priors on individual variation. Lower values (e.g., 5–10) make the prior more weakly informative, which can help improve convergence if the model is over-regularized.

`prec_logy_hyp_param`
A numeric vector of 2 values corresponding to hyperprior diagonal entries on the log-scale for the precision matrix (i.e. inverse variance) representing prior beliefs of individual variation. If specified, must be 2 values long:

- defaults = 4.0, 1.0

Value

A "curve_params_priors" object (a subclass of list with the inputs to `prep_priors()` attached as attributes entry named `"used_priors"`), containing the following elements:

- "n_params": Corresponds to the 5 parameters being estimated.
- "mu.hyp": A matrix of hyperpriors with dimensions `max_antigens` x 5 (# of parameters), representing the mean of the hyperprior distribution for the five seroresponse parameters: y0, y1, t1, r, and alpha).
- "prec.hyp": A three-dimensional numeric array with dimensions `max_antigens` x 5 (# of parameters), containing the precision matrices of the hyperprior distributions of `mu.hyp`, for each biomarker.

- "omega" : A three-dimensional numeric array with 5 matrix,each with dimensions `max_antigens` x 5 (# of parameters), representing the precision matrix of Wishart hyper-priors for `prec.hyp`.
- "wishdf": A vector of 2 values specifying the degrees of freedom for the Wishart distribution used in the subject-level precision prior.
- "prec.logy.hyp": A matrix of hyper-parameters for the precision (inverse variance) of individual variation measuring `max_antigens` x 2, on the log-scale.
- `used_priors` = inputs to `prep_priors()` attached as attributes.

Examples

```
prep_priors(max_antigens = 2,
            mu_hyp_param = c(1.0, 7.0, 1.0, -4.0, -1.0),
            prec_hyp_param = c(1.0, 0.00001, 1.0, 0.001, 1.0),
            omega_param = c(1.0, 50.0, 1.0, 10.0, 1.0),
            wishdf_param = 20,
            prec_logy_hyp_param = c(4.0, 1.0))

prep_priors(max_antigens = 2)
```

`run_mod` *Run Jags Model*

Description

`run_mod()` takes a data frame and adjustable MCMC inputs to `runjags::run.jags()` as an MCMC Bayesian model to estimate antibody dynamic curve parameters. The `rjags::jags.model()` models seroresponse dynamics to an infection. The antibody dynamic curve includes the following parameters:

- y0 = baseline antibody concentration
- y1 = peak antibody concentration
- t1 = time to peak
- shape = shape parameter
- alpha = decay rate

Usage

```
run_mod(
  data,
  file_mod = serodynamics_example("model.jags"),
  nchain = 4,
  nadapt = 0,
  nburn = 0,
  nmc = 100,
  niter = 100,
  strat = NA,
```

```
  with_post = FALSE,
  ...
)
```

Arguments

data	A base::data.frame() with the following columns.
file_mod	The name of the file that contains model structure.
nchain	An integer between 1 and 4 that specifies the number of MCMC chains to be run per jags model.
nadapt	An integer specifying the number of adaptations per chain.
nburn	An integer specifying the number of burn ins before sampling.
nmc	An integer specifying the number of samples in posterior chains.
niter	An integer specifying the number of iterations.
strat	A character string specifying the stratification variable, entered in quotes.
with_post	A logical value specifying whether a raw jags.post component should be included as an element of the list object returned by run_mod() (see Value section below for details). Note: These objects can be large.
...	Arguments passed on to prep_priors

max_antigens An integer specifying how many antigen-isotypes (biomarkers) will be modeled.

mu_hyp_param A numeric vector of 5 values representing the prior mean for the population level parameters parameters (y0, y1, t1, r, alpha) for each biomarker. If specified, must be 5 values long, representing the following parameters:

- y0 = baseline antibody concentration (default = 1.0)
- y1 = peak antibody concentration (default = 7.0)
- t1 = time to peak (default = 1.0)
- r = shape parameter (default = -4.0)
- alpha = decay rate (default = -1.0)

prec_hyp_param A numeric vector of 5 values corresponding to hyperprior diagonal entries for the precision matrix (i.e. inverse variance) representing prior covariance of uncertainty around mu_hyp_param. If specified, must be 5 values long:

- defaults: y0 = 1.0, y1 = 0.00001, t1 = 1.0, r = 0.001, alpha = 1.0

omega_param A numeric vector of 5 values corresponding to the diagonal entries representing the Wishart hyperprior distributions of prec_hyp_param, describing how much we expect parameters to vary between individuals. If specified, must be 5 values long:

- defaults: y0 = 1.0, y1 = 50.0, t1 = 1.0, r = 10.0, alpha = 1.0

wishdf_param An integer vector of 1 value specifying the degrees of freedom for the Wishart hyperprior distribution of prec_hyp_param. If specified, must be 1 value long.

- default = 20.0

- The value of `wishdf_param` controls how informative the Wishart prior is. Higher values lead to tighter priors on individual variation. Lower values (e.g., 5–10) make the prior more weakly informative, which can help improve convergence if the model is over-regularized.

`prec_logy_hyp_param` A numeric vector of 2 values corresponding to hyper-prior diagonal entries on the log-scale for the precision matrix (i.e. inverse variance) representing prior beliefs of individual variation. If specified, must be 2 values long:

- defaults = 4.0, 1.0

Value

An `sr_model` class object: a subclass of tibble::tbl_df that contains MCMC samples from the joint posterior distribution of the model parameters, conditional on the provided input `data`, including the following:

- `iteration` = Number of sampling iterations
- `chain` = Number of MCMC chains run; between 1 and 4
- `Parameter` = Parameter being estimated. Includes the following:
  - `y0` = Posterior estimate of baseline antibody concentration
  - `y1` = Posterior estimate of peak antibody concentration
  - `t1` = Posterior estimate of time to peak
  - `shape` = Posterior estimate of shape parameter
  - `alpha` = Posterior estimate of decay rate
- `Iso_type` = Antibody/antigen type combination being evaluated
- `Stratification` = The variable used to stratify jags model
- `Subject` = ID of subject being evaluated
- `value` = Estimated value of the parameter
- The following attributes are included in the output:
  - `class`: Class of the output object.
  - `nChain`: Number of chains run.
  - `nParameters`: The amount of parameters estimated in the model.
  - `nIterations`: Number of iteration specified.
  - `nBurnin`: Number of burn ins.
  - `nThin`: Thinning number (niter/nmc).
  - `priors`: A list that summarizes the input priors, including:
    - `mu_hyp_param`
    - `prec_hyp_param`
    - `omega_param`
    - `wishdf`
    - `prec_logy_hyp_param`
  - `fitted_residuals`: A data.frame containing fitted and residual values for all observations.
  - An optional `"jags.post"` attribute, included when argument `with_post` = TRUE.

Author(s)

Sam Schildhauer

Examples

```
data(nepal_sees_jags_output, package = "serodynamics")
post_summ(nepal_sees_jags_output)

if (interactive() && !is.element(runjags::findjags(), c("", NULL))) {
  set.seed(1)
  strat1 <- serocalculator::typhoid_curves_nostrat_100 |>
    sim_case_data(n = 100) |>
    dplyr::mutate(strat = "stratum 2")
  strat2 <- serocalculator::typhoid_curves_nostrat_100 |>
    sim_case_data(n = 100) |>
    dplyr::mutate(strat = "stratum 1")

  dataset <- dplyr::bind_rows(strat1, strat2)

  fitted_model <- run_mod(
    data = dataset, # The data set input
    file_mod = serodynamics_example("model.jags"),
    nchain = 4, # Number of mcmc chains to run
    nadapt = 100, # Number of adaptations to run
    nburn = 100, # Number of unrecorded samples before sampling begins
    nmc = 1000,
    niter = 2000, # Number of iterations
    strat = "strat"
  ) # Variable to be stratified
}
```

---

serodynamics_example *Get path to an example file*

Description

The serodynamics package comes bundled with a number of sample files in its `inst/extdata` directory. This `serodynamics_example()` function make those sample files easy to access.

Usage

```
serodynamics_example(file = NULL)
```

Arguments

`file`	Name of file. If `NULL`, the example files will be listed.

Details

Adapted from readr::readr_example() following the guidance in https://r-pkgs.org/data.html#sec-data-example-path-helper.

Value

a character string providing the path to the file specified by file, or a vector or available files if file = NULL.

Examples

```
serodynamics_example()
serodynamics_example(
  "SEES_Case_Nepal_ForSeroKinetics_02-13-2025.csv")
```

---

sim_case_data *Simulate longitudinal case follow-up data from a homogeneous population*

Description

Simulate longitudinal case follow-up data from a homogeneous population

Usage

```
sim_case_data(
  n,
  curve_params,
  antigen_isos = get_biomarker_levels(curve_params),
  max_n_obs = 10,
  dist_n_obs = tibble::tibble(n_obs = 1:max_n_obs, prob = 1/max_n_obs),
  followup_interval = 7,
  followup_variance = 1
)
```

Arguments

n	integer number of cases to simulate
curve_params	a curve_params object from serocalculator::as_curve_params, assumed to be unstratified
antigen_isos	character vector: which antigen isotypes to simulate
max_n_obs	maximum number of observations
dist_n_obs	distribution of number of observations (tibble::tbl_df)
followup_interval	integer
followup_variance	integer

Value

a case_data object

Examples

```
set.seed(1)
serocalculator::typhoid_curves_nostrat_100 |>
  sim_case_data(n = 100)
```

Index