

Package ‘Household.Transmission.Chain.Data.Analysis’

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Title Household Transmission Chain Simulation and Estimation

Version 0.0.0.9000

Description This package provides a framework for household transmission chain analysis by a streamlined pipeline to simulate household transmission data and to estimate community and within-household infection risks from either synthetic or user-supplied data. The workflow builds person-day tables, impute infection timelines with Gamma-distributed delays, and fits penalized models with optional covariates. Post-processing summarizes mean estimates, uncertainty, bias, and relative bias, Two user functions cover the main tasks: GenSyn() to simulate data and run the full estimation pipeline (with optional summaries), and TransmissionChainAnalysis() to run the same estimation pipeline on user data.

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attach_vl_full_trajectory_from_long

Attach viral-load trajectories to person-level data

Description

Creates or fills a vl_full_trajectory list-column for each person over their infectious span using VL from a long table, simulated VL, or a sentinel.

Usage

```
attach_vl_full_trajectory_from_long(
  hh_long,
  hh_person,
  user_data,
  vl_source = c("column", "simulate", "none"),
  vl_column = NULL,
  start_date,
  end_date
)
```

Arguments

hh_long	Long test-day data (may be NULL if simulating); must include HH, individual_ID, test_date and the VL column when vl_source = "column".
hh_person	Person-level data frame with infection/imputation columns.
user_data	Original user input (not modified; passed for convenience).
vl_source	One of "column", "simulate", "none".
vl_column	Column name with log10 VL when vl_source = "column".
start_date, end_date	Study window (Date); used for alignment.

Value

hh_person with a vl_full_trajectory list-column added.

build_person_day_table

Construct person-day long data

Description

Expands individual timelines into daily rows and computes within-household infectious counts by infector role for likelihood-based estimation.

Usage

```
build_person_day_table(dt, tmax, cases_t, covariate_cols = character(0))
```

Arguments

dt	data.table from infectious_time_imputation .
tmax	Integer; maximum day index.
cases_t	Numeric of length tmax + 1; community intensity for days 0..tmax.
covariate_cols	Character; names of covariates to carry (scalars or day series).

Value

data.table with columns: agegrp2, agegrp3, agegrp4, n_inf, n_inf_infant, n_inf_sibling, n_inf_adult, n_inf_elder, cases, event, ID_indiv, ID_hh, day, and requested covariates.

```
build_stan_household_arrays
```

Assemble Stan data arrays for the household model

Description

Produces the data list for Stan from simulator households or a person-level frame, including infectious indicators, infection days, VL arrays, household membership, and seasonal forcing.

Usage

```
build_stan_household_arrays(
  households,
  T_max = 365,
  seasonal_forcing_list,
  alpha_comm_by_role = 0.005,
  beta1 = 0.2,
  beta2 = 0.6,
  V_ref = 1000,
  reference_phi = 1,
  reference_kappa = 1,
  g_peak_day = 2,
  g_width = 2
)
```

Arguments

households	Either a list of per-household data frames (each with <code>vl_full_trajectory</code>) or a single person-level data frame with <code>hh_id</code> , <code>role</code> , <code>infection_time</code> , <code>infectious_start</code> , <code>infectious_end</code> , <code>infection_resolved</code> , <code>vl_full_trajectory</code> .
T_max	Integer; time horizon (days).
seasonal_forcing_list	Named list of role-specific forcing series.
alpha_comm_by_role, beta1, beta2, V_ref, reference_phi, reference_kappa	Scalars controlling hazards and reference levels.
g_peak_day, g_width	Scalars controlling the infectivity profile.

Details

If VL is absent or sentinel-only, `V_term` is zero and the VL-mediated component is effectively disabled.

Value

A named list suitable for `data=` in Stan containing `N`, `T`, `H`, `R`, `delta`, `hh_id`, `role_id`, `Y`, `I`, `V`, `V_term`, `alpha_comm_by_role`, `max_infectious`, `hh_size`, `hh_max_size`, `hh_members`, `g_profile`, `V_ref`, `beta1`, `beta2`, `reference_phi`, `reference_kappa`, `seasonal_forcing_mat`.

dataframe_to_household_list

Convert a user data frame to a list of household tables

Description

Splits a long-format test table into a list of per-household data.frames, preserving the required columns and (optionally) any extra covariates.

Usage

```
dataframe_to_household_list(
  df,
  hh_col = "HH",
  id_col = "individual_ID",
  role_col = "role",
  date_col = "test_date",
  inf_col = "infection_status",
  comm_col = "community_risk",
  keep_extra_cols = TRUE
)
```

Arguments

df	Data frame with at least household ID, individual ID, role, test date, infection status, and community risk columns.
hh_col, id_col, role_col, date_col, inf_col, comm_col	Character. Column names for household ID (default "HH"), individual ID ("individual_ID"), role ("role"), test date ("test_date"), infection status ("infection_status"), and community risk ("community_risk").
keep_extra_cols	Logical; keep additional user columns (default TRUE).

Value

List of data.frames, one per household (household ID placed first).

data_summarization

Summarize infection episodes (one row per individual)

Description

Collapses long testing records to episode-level features and optional covariate summaries. Supply either a single data frame df with the six core columns, or provide all six vectors individually. An optional covariate frame can be merged.

Usage

```
data_summarization(
  df = NULL,
  Household_ID = NULL,
  Individual_ID = NULL,
  Household_role = NULL,
  Sample_test_days = NULL,
  Infectious_status = NULL,
  Community_rate_infection = NULL,
  Covariate_DataFrame = NULL,
  covariate_cols = NULL
)
```

Arguments

df Data frame with columns HH, individual_ID, role, test_date, infection_status, community_risk. Ignored when all six vector inputs are provided.

Household_ID, Individual_ID, Household_role, Sample_test_days, Infectious_status, Community_rate_infection Vectors used only when df is NULL.

Covariate_DataFrame Optional data frame to merge before summarizing; joined by available keys among c("HH", "individual_ID", "test_date") (at least individual_ID required).

covariate_cols Optional character vector restricting which covariates from Covariate_DataFrame are summarized.

Details

Records are ordered by HH, individual_ID, test_date. Episodes are runs of infection_status == 1; first-episode fields refer to the earliest run.

Value

A data frame with one row per individual including: HH, individual_ID, episode counts and timing fields (e.g., infection.detected.start, infection.detected.end, infection.true.duration, last_negative), infection.infectious.day (comma-separated days), community.risk, role, and (if present) basic summaries for covariates.

See Also

[summarize_individuals](#), [main_parameter_estimation_pipeline](#)

generate_household_roles

Generate a simple household role composition

Description

Samples a household (size 3–5) with at least one child and two adults, optionally adding elderly/toddler roles.

Usage

```
generate_household_roles()
```

Value

Character vector of role labels.

```
generate_synthetic_data_one
```

Generate standardized synthetic data for one household

Description

Simulates test-day observations for one household over a date window with community seasonality, within-household transmission, adaptive testing, baseline/partial immunity, and optional covariates.

Usage

```
generate_synthetic_data_one(
  household_id,
  hh.size = sample(3:7, 1),
  tests.per.week = 2,
  p.comm.base.infant.fix = 0.001,
  p.comm.multiplier.sibling = 1,
  p.comm.multiplier.parent = 1,
  p.comm.multiplier.elder = 1,
  p.hh.base.infant = 0.1,
  p.hh.multiplier.sibling = 1,
  p.hh.multiplier.parent = 1,
  p.hh.multiplier.elder = 1,
  p.imm.base.sibling = 1e-10,
  p.imm.base.parent = 1e-10,
  p.imm.base.elder = 1e-10,
  partial.immunity.infant = 1e-10,
  partial.immunity.sibling = 1e-10,
  partial.immunity.parent = 1e-10,
  partial.immunity.elder = 1e-10,
  duration.latent = 2,
  duration.infect.inf = 3,
  multiplier.dur.sibpar = 0.5,
  p.detect = 0.999,
  amplitude = 0,
  phase = -0.408,
  start_date = as.Date("2024-09-21"),
  end_date = as.Date("2025-04-17"),
  Covariates = FALSE,
  Covariates_list = c("Vaccination status", "Antibody Level"),
  Covariate_specifications = NULL
)
```

Arguments

`household_id` Integer; household identifier written to HH.
`hh.size` Integer; household size.
`tests.per.week` Integer; tests per person per week.
`p.comm.base.infant.fix` Numeric; baseline community infection prob/day (infant).
`p.comm.multiplier.sibling,` `p.comm.multiplier.parent,`
`p.comm.multiplier.elder` Numeric; community multipliers by role.
`p.hh.base.infant` Numeric; baseline within-household infection prob/day (infant source).
`p.hh.multiplier.sibling,` `p.hh.multiplier.parent,`
`p.hh.multiplier.elder` Numeric; within-household multipliers by source role.
`p.imm.base.sibling, p.imm.base.parent, p.imm.base.elder` Numeric; baseline immunity at day 1.
`partial.immunity.infant,` `partial.immunity.sibling,`
`partial.immunity.parent, partial.immunity.elder` Numeric; partial-immunity modifiers by role.
`duration.latent` Integer; mean latent period (days).
`duration.infect.inf` Integer; mean infectious duration for infants (days).
`multiplier.dur.sibpar` Numeric; infectious-duration multiplier for non-infants.
`p.detect` Numeric; detection probability if infected on a test day.
`amplitude, phase` Numeric; seasonality parameters for community risk.
`start_date, end_date` Date; simulation window.
`Covariates` Logical; generate additional covariates.
`Covariates_list` Character; covariate names.
`Covariate_specifications` List; optional per-covariate specs.

Value

Data frame with columns `HH`, `individual_ID`, `role`, `test_date` (1 = `start_date`), `infection_status`, `community_risk`, and optional covariates.

Description

Runs `main_parameter_estimation_pipeline()` to either simulate (or ingest) household data, fit via the legacy MLE path or the RSV/VL+Stan path, and assemble a "GenSynResult".

Usage

```
GenSyn(
  n_households = 10,
  n_runs = 10,
  data_summary = FALSE,
  print_plots = TRUE,
  plots = c("daily", "weekly", "timeline", "sar"),
  engine = c("legacy", "rsv_vl"),
  estimation_method = c("mle", "stan"),
  index_vl_column = "vl_test",
  user_data = NULL,
  synthetic_data = TRUE,
  hh.size = sample(3:7, 1),
  tests.per.week = 1,
  Covariates = FALSE,
  Covariates_list = c("Vaccination status", "Antibody Level"),
  Covariate_specifications = NULL,
  day_series_covariates = TRUE,
  series_cols = NULL,
  comm_covariate_cols = NULL,
  hh_covariate_cols = NULL,
  hh_by_role = FALSE,
  hh_role_covariate_cols = NULL,
  standardize_covariates = TRUE,
  lambda_comm = 0.01,
  lambda_hh = 0.01,
  p.comm.base.infant.fix = 0.002,
  p.comm.multiplier.sibling = 1,
  p.comm.multiplier.parent = 1,
  p.comm.multiplier.elder = 1,
  p.hh.base.infant = 0.2,
  p.hh.multiplier.sibling = 0.5267686,
  p.hh.multiplier.parent = 0.8008933,
  p.hh.multiplier.elder = 0.6008933,
  p.imm.base.sibling = 1e-10,
  p.imm.base.parent = 1e-10,
  p.imm.base.elder = 1e-10,
  partial.immunity.infant = 1e-10,
  partial.immunity.sibling = 1e-10,
  partial.immunity.parent = 1e-10,
  partial.immunity.elder = 1e-10,
  duration.latent = 1,
```

```

duration.infect.inf = 2,
multiplier.dur.sibpar = 0.5,
p.detect = 0.999,
amplitude = 2.6581 * 0,
phase = -0.408,
start_date = as.Date("2024-09-21"),
end_date = as.Date("2025-04-17"),
latent_par = list(shape = 2, scale = 1),
report_par = list(shape = 1, scale = 1.5),
infect_par = list(shape = 3, scale = 2),
start_par = c(-6, 0.02, -2, rep(0, 6)),
lambda = 0.01,
lambda0 = 0.2,
lambda_alpha = 5,
delta0_true = qlogis(0.002),
alpha0_true = qlogis(0.2),
seasonal_forcing_list = NULL,
max_days = 365,
stan_file = "../inst/stan/HH_parameter_estimation2.stan",
stan_chains = 1,
stan_iter = 100,
stan_warmup = 100,
stan_control = list(adapt_delta = 0.99, max_treedepth = 20),
stan_init = "random",
stan_refresh = 50,
stan_cores = 4
)

```

Arguments

n_households	Integer; number of households to simulate when synthetic_data=TRUE.
n_runs	Integer; number of repeated MLE runs (legacy path only).
data_summary	Logical (legacy+MLE only); if TRUE, per-individual summary is retained/printed.
print_plots	Logical; print plots if produced.
plots	Character vector of plot names ("daily", "weekly", "sar", "timeline") or "all".
engine	Character; one of c("legacy", "rsv_vl").
estimation_method	Character; one of c("mle", "stan").
index_vl_column	Character; viral-load column name for plotting on Stan path (default "vl_test").
user_data	Optional user data (see main_parameter_estimation_pipeline); ignored if synthetic_data=TRUE.
synthetic_data	Logical; simulate data internally.
hh.size	Integer; household size used in simulation.
tests.per.week	Integer; tests per person per week (legacy engine).
Covariates	Logical; include synthetic covariates (legacy).
Covariates_list	Character vector; names of covariates (legacy).

Covariate_specifications	Optional list describing covariate generation (legacy).
day_series_covariates	Logical; include day-series covariates (legacy+MLE).
series_cols	Optional character vector; selected day-series columns (legacy+MLE).
comm_covariate_cols, hh_covariate_cols	Optional character vectors; likelihood-level covariates (legacy+MLE).
hh_by_role	Logical; fit separate HH effects by role (legacy+MLE).
hh_role_covariate_cols	Optional named list of role-specific covariates (legacy+MLE).
standardize_covariates	Logical; standardize covariates (legacy+MLE).
lambda_comm, lambda_hh	Numeric; ridge penalties for community/household covariates (legacy+MLE).
p.comm.base.infant.fix, p.comm.multiplier.sibling, p.comm.multiplier.parent, p.comm.multiplier.elder	Numeric; community risk knobs (legacy simulator).
p.hh.base.infant, p.hh.multiplier.sibling, p.hh.multiplier.parent, p.hh.multiplier.elder	Numeric; within-HH knobs (legacy simulator).
p.imm.base.sibling, p.imm.base.parent, p.imm.base.elder, partial.immunity.infant, partial.immunity.sibling, partial.immunity.parent, partial.immunity.elder	Numeric; immunity knobs (legacy simulator).
duration.latent, duration.infect.inf, multiplier.dur.sibpar	Numeric; timing knobs (legacy simulator).
p.detect	Numeric; detection probability (legacy simulator).
amplitude, phase	Numeric; seasonality controls (legacy simulator).
start_date, end_date	Date; study window.
latent_par, report_par, infect_par	Lists of gamma parameters (shape, scale) for imputation (legacy+MLE).
start_par	Numeric vector; optimizer starting values (legacy+MLE).
lambda, lambda0, lambda_alpha	Numeric; optimizer penalties (legacy+MLE).
delta0_true, alpha0_true	Numeric; reference values on logit scale (legacy+MLE).
seasonal_forcing_list	Optional named list of role vectors; seasonal forcing (RSV/VL+Stan).
max_days	Integer; maximum simulated days (RSV/VL+Stan).
stan_file	Path to a Stan model file.
stan_chains, stan_iter, stan_warmup	Integers; Stan sampling controls.
stan_control	List; Stan control list.
stan_init	Character or function; Stan initialization.
stan_refresh	Integer; Stan refresh rate.
stan_cores	Integer; CPU cores for Stan.

Details

Arguments are forwarded to `main_parameter_estimation_pipeline()`; some are ignored depending on engine/estimation_method.

Value

A "GenSynResult" list with elements: \$call, \$engine, \$estimation_method, \$n_households, \$n_runs, \$results, \$postprocessing, \$plot_list.

See Also

`main_parameter_estimation_pipeline`, `postprocessing_estimates`

Examples

```
# Lightweight MLE example (no Stan):
set.seed(1)
fit <- GenSyn(
  n_households = 3,
  engine = "legacy", estimation_method = "mle",
  n_runs = 2, print_plots = FALSE
)
class(fit)

## Not run:
# Heavier Stan example (do not run on CRAN):
seasonal_forcing_list <- list(
  adult=rep(1,60), child=rep(1,60), elderly=rep(1,60), toddler=rep(1,60)
)
fit2 <- GenSyn(
  n_households=2,
  engine="rsv_v1", estimation_method="stan",
  seasonal_forcing_list=seasonal_forcing_list, max_days=60,
  stan_chains=1, stan_iter=200, stan_warmup=100, stan_cores=1
)

## End(Not run)
```

g_rescaled

Gaussian-like infectivity profile (normalized)

Description

Bell-shaped infectivity profile scaled to have maximum 1.

Usage

```
g_rescaled(t, peak_day, width)
```

Arguments

t	Integer vector of times (e.g., days since infectious onset).
peak_day	Integer; peak day.
width	Numeric; spread around the peak.

Value

Numeric vector in [0,1] of length t.

households_to_long_tests

Flatten simulator households to a long test-day table

Description

Expands simulator output to per-person per-day rows suitable for legacy processing and plotting.

Flattens simulator output (list of per-household data frames) into a long table with one row per person-day.

Usage

```
households_to_long_tests(households, seasonal_forcing_list = NULL)
```

```
households_to_long_tests(households, seasonal_forcing_list = NULL)
```

Arguments

households List of household data frames from the simulator (each may carry attributes such as `test_days` and per-person `viral_loads_test_days`).

seasonal_forcing_list Optional named list of role-specific forcing series (adult, child, elderly, toddler).

Details

If `test_days` is absent, the horizon is inferred from `infectious_end/infection_resolved` (fall-back to 1). Missing `infection_status` is treated as 0. Household index in the list is used for HH.

Value

Data frame with columns: HH, individual_ID, role, test_date, infection_status and (if available) community_risk.

A data frame with columns HH, individual_ID, role, test_date, infection_status, community_risk, vl_test.

infectious_time_imputation

Impute infection timelines from delay distributions

Description

Imputes infection date, infectious start/end, and component delays using gamma distributions, optionally scaled by covariate functions.

Usage

```
infectious_time_imputation(
  dt,
  study_start,
  latent_par,
  report_par,
  infect_par,
  latent_scale_fn = NULL,
  report_scale_fn = NULL,
  infect_scale_fn = NULL
)
```

Arguments

`dt` data.table from [summarize_individuals](#).

`study_start` Date origin for relative day indices.

`latent_par, report_par, infect_par` Lists with shape and scale for latent, reporting, and infectious periods.

`latent_scale_fn, report_scale_fn, infect_scale_fn` Optional functions taking `dt[idx]` (infected rows) and returning numeric scale multipliers.

Value

The input `dt` with columns `latent_delay`, `report_delay`, `infect_period`, `inf_date`, `inf_start_date`, `inf_end_date`, and relative-day variants.

main_parameter_estimation_pipeline

Main parameter estimation pipeline (simulate or analyze)

Description

End-to-end workflow for household transmission estimation via legacy MLE or RSV/VL+Stan. Works with simulated or user-provided data.

Usage

```

main_parameter_estimation_pipeline(
  user_data = NULL,
  synthetic_data = TRUE,
  engine = c("legacy", "rsv_v1"),
  estimation_method = c("mle", "stan"),
  n_households = 10,
  n_runs = 10,
  hh.size = sample(3:7, 1),
  tests.per.week = 1,
  Covariates = FALSE,
  Covariates_list = c("Vaccination status", "Antibody Level"),
  Covariate_specifications = NULL,
  day_series_covariates = TRUE,
  series_cols = NULL,
  comm_covariate_cols = NULL,
  hh_covariate_cols = NULL,
  hh_by_role = FALSE,
  hh_role_covariate_cols = NULL,
  standardize_covariates = TRUE,
  lambda_comm = 0.01,
  lambda_hh = 0.01,
  p.comm.base.infant.fix = 0.002,
  p.comm.multiplier.sibling = 1,
  p.comm.multiplier.parent = 1,
  p.comm.multiplier.elder = 1,
  p.hh.base.infant = 0.2,
  p.hh.multiplier.sibling = 0.5267686,
  p.hh.multiplier.parent = 0.8008933,
  p.hh.multiplier.elder = 0.6008933,
  p.imm.base.sibling = 1e-10,
  p.imm.base.parent = 1e-10,
  p.imm.base.elder = 1e-10,
  partial.immunity.infant = 1e-10,
  partial.immunity.sibling = 1e-10,
  partial.immunity.parent = 1e-10,
  partial.immunity.elder = 1e-10,
  duration.latent = 1,
  duration.infect.inf = 2,
  multiplier.dur.sibpar = 0.5,
  p.detect = 0.999,
  amplitude = 2.6581 * 0,
  phase = -0.408,
  start_date = as.Date("2024-09-21"),
  end_date = as.Date("2025-04-17"),
  latent_par = list(shape = 2, scale = 1),
  report_par = list(shape = 1, scale = 1.5),
  infect_par = list(shape = 3, scale = 2),
  start_par = c(-6, 0.02, -2, rep(0, 6)),
  lambda = 0.01,
  lambda0 = 0.2,
  lambda_alpha = 5,

```

```

delta0_true = qlogis(0.002),
alpha0_true = qlogis(0.2),
seasonal_forcing_list = NULL,
max_days = 365,
stan_file = "HH_parameter_estimation2.stan",
stan_chains = 1,
stan_iter = 100,
stan_warmup = 100,
stan_control = list(adapt_delta = 0.99, max_treedepth = 20),
stan_init = "random",
stan_refresh = 50,
stan_cores = 4
)

```

Arguments

user_data Optional; data.frame or list of data.frames as described in [TransmissionChainAnalysis](#).
synthetic_data Logical; if TRUE, simulate data internally.
engine Character; "legacy" or "rsv_v1".
estimation_method Character; "mle" or "stan" (valid pairs: legacy+mle, rsv_v1+stan).
n_households, n_runs Integers; simulation size and number of repeated runs (MLE only).
hh.size, tests.per.week Integers; simulation controls (legacy).
Covariates Logical; include synthetic covariates (legacy).
Covariates_list Character vector; covariate names (legacy).
Covariate_specifications Optional list; covariate generation controls (legacy).
day_series_covariates Logical; include day-series covariates (legacy+MLE).
series_cols Optional character vector; day-series columns (legacy+MLE).
comm_covariate_cols, hh_covariate_cols Optional character vectors; likelihood-level covariates (legacy+MLE).
hh_by_role Logical; fit separate HH effects by role (legacy+MLE).
hh_role_covariate_cols Optional named list; role-specific covariates (legacy+MLE).
standardize_covariates Logical; standardize covariates (legacy+MLE).
lambda_comm, lambda_hh Numeric; ridge penalties (legacy+MLE).
p.comm.base.infant.fix, p.comm.multiplier.sibling,
p.comm.multiplier.parent, p.comm.multiplier.elder Numeric; community knobs (legacy).
p.hh.base.infant, p.hh.multiplier.sibling, p.hh.multiplier.parent,
p.hh.multiplier.elder Numeric; within-HH knobs (legacy).

p.imm.base.sibling, p.imm.base.parent, p.imm.base.elder,
 partial.immunity.infant, partial.immunity.sibling,
 partial.immunity.parent, partial.immunity.elder
 Numeric; immunity knobs (legacy).
 duration.latent, duration.infect.inf, multiplier.dur.sibpar
 Numeric; timing knobs (legacy).
 p.detect Numeric; detection probability (legacy).
 amplitude, phase
 Numeric; seasonality controls (legacy).
 start_date, end_date
 Date; analysis window.
 latent_par, report_par, infect_par
 Lists (shape, scale) for imputation (legacy+MLE).
 start_par Numeric; optimizer start (legacy+MLE).
 lambda, lambda0, lambda_alpha
 Numeric; optimizer penalties (legacy+MLE).
 delta0_true, alpha0_true
 Numeric; reference values on logit scale (legacy+MLE).
 seasonal_forcing_list
 Optional role-named list for seasonality (RSV/VL+Stan).
 max_days Integer; maximum days (RSV/VL+Stan).
 stan_file Path to a Stan model file.
 stan_chains, stan_iter, stan_warmup
 Integers; Stan sampling controls.
 stan_control List; Stan control list.
 stan_init Character or function; Stan initialization.
 stan_refresh Integer; Stan refresh.
 stan_cores Integer; CPU cores for Stan.

Details

Enforces valid engine/estimation pairs; other combinations error.

Value

For legacy+MLE: list with raw_simulation, summarized_data, person_day, estimates, and postprocessing. For RSV/VL+Stan: list with raw_simulation, stan_data, fit, posterior_summary (also in postprocessing), and NULL placeholders for summarized_data/person_day.

See Also

[TransmissionChainAnalysis](#), [postprocessing_estimates](#), [build_stan_household_arrays](#),
[run_household_stan](#)

normalize_roles	<i>Normalize role labels to child, toddler, adult, elderly</i>
-----------------	--

Description

Maps common synonyms (infant->toddler, sibling->child, parent->adult, elder->elderly) and returns a factor with consistent levels.

Usage

```
normalize_roles(x)
```

Arguments

x	Character vector of role labels.
---	----------------------------------

Value

A factor with levels c("child", "toddler", "adult", "elderly").

postprocessing_estimates	<i>Summarize and compare estimates against reference values</i>
--------------------------	---

Description

Computes mean, SD, SE across runs and (optionally) bias and relative bias versus supplied reference (true) values for each parameter.

Usage

```
postprocessing_estimates(theta_mat, true_values = NULL)
```

Arguments

theta_mat	Numeric matrix. Parameter estimates from multiple runs (e.g., output of running_parameter_estimates or a Stan summary). Must be non-empty.
true_values	Optional named numeric vector of reference values. Names should match columns in theta_mat. Unmatched names are ignored; missing references yield NA bias/relative bias.

Details

Rows with incomplete estimates are dropped using the first column as a sentinel. If theta_mat lacks column names, generic names "par1", "par2", ... are assigned. The number of retained runs is stored in the "n_runs" attribute of the returned table.

This helper understands both the legacy parameter naming (e.g., delta0, alpha0, gamma2, beta2, theta_comm_*, theta_hh_*) and the new RSV/seasonality framework parameters (e.g., phi_*, kappa_*).

Value

A data.table with one row per parameter and columns:

- Parameter: column name from theta_mat
- Estimate: mean across runs
- SD: standard deviation across runs
- SE: standard error ($SD / \sqrt{n_runs}$)
- True: supplied reference value (if any)
- Bias: Estimate - True
- RelBias: Bias / |True| (NA when True is 0 or missing)
- Block, Role: simple parameter grouping labels for readability

postprocess_stan_fit *Tidy posterior summary for role multipliers*

Description

Extracts posterior summaries for phi_by_role[] and kappa_by_role[] from a stanfit.

Usage

```
postprocess_stan_fit(fit)
```

Arguments

fit A stanfit object returned by [run_household_stan](#).

Value

A data frame with columns: Parameter, Estimate, SD, Lower CI, Median, Upper CI.

prepare_stan_households_from_user_data
Prepare per-household inputs for the Stan RSV/VL model

Description

Converts user data to a list of per-household data frames required by the Stan RSV/VL pipeline. Accepts either a long test-day table or a per-person episodes table.

Usage

```
prepare_stan_households_from_user_data(
  user_data,
  role_levels = c("adult", "child", "elderly", "toddler"),
  vl_mode = c("from_long", "auto"),
  vl_source = c("none", "column", "simulate"),
  vl_column = NULL,
  start_date = NULL,
  end_date = NULL
)
```

Arguments

user_data	Either: <ul style="list-style-type: none">• <i>Long format</i>: columns HH, individual_ID, role, test_date, infection_status (optionally a VL column); or• <i>Per-person format</i>: columns hh_id, person_id, role, infection_time, infectious_start, infectious_end (optionally vl_full_trajectory).
role_levels	Character vector of allowed roles after normalization, e.g., c("adult", "child", "elderly", "toddler")
vl_mode	Character; currently used only to trigger trajectory building from long data ("from_long").
vl_source	Character; one of "none", "column", "simulate" (applies to long-format input).
vl_column	Optional name of the VL column when vl_source = "column".
start_date, end_date	Optional Date bounds to convert test_date to day indices (long format).

Value

A named list of data frames (one per household) with columns hh_id, person_id, role, infection_time, infectious_start, infectious_end, detection_time, infection_resolved, and vl_full_trajectory (list-column).

<code>print.GenSynResult</code>	<i>Print method for GenSynResult</i>
---------------------------------	--------------------------------------

Description

Formats a `GenSynResult` for display. Prints engine/method, basic run info, any stored post-processing table, and (legacy+MLE only) a short individual-level preview when `x$data_summary` is `TRUE`.

Usage

```
## S3 method for class 'GenSynResult'
print(x, ...)
```

Arguments

x	A <code>GenSynResult</code> object (from GenSyn).
...	Unused.

Value

x, invisibly.

See Also

[GenSyn](#)

```
print.TransmissionChainResult
```

Print a TransmissionChainResult

Description

Nicely prints sections available in a `TransmissionChainResult` returned by [TransmissionChainAnalysis](#). For MLE, shows the post-processing table (if present) and, optionally, a preview of the individual-level summary. For Stan, shows the Stan posterior summary (or a preview) when available.

Usage

```
## S3 method for class 'TransmissionChainResult'
print(x, ...)
```

Arguments

`x` A `TransmissionChainResult` object.
`...` Passed to or from other methods (unused).

Value

`x`, returned invisibly.

See Also

[TransmissionChainAnalysis](#)

<code>p_transmission</code>	<i>Transmission potential as a function of viral load</i>
-----------------------------	---

Description

Computes a saturating transmission potential on [0,1] from log10 viral load.

Usage

```
p_transmission(VL, n, p_v, K, Vm, sai)
```

Arguments

`VL` Numeric vector; log10 viral load.
`n, p_v, K, Vm, sai` Numeric scalars; model constants.

Value

Numeric vector of transmission potentials.

running_parameter_estimation

Run penalized maximum likelihood parameter estimation

Description

Repeats optimization `n_runs` times from jittered starts to estimate community and household transmission parameters with optional covariate effects and quadratic penalties.

Usage

```
running_parameter_estimation(
  long_dt,
  n_runs,
  start_par = NULL,
  lambda,
  lambda0,
  lambda_alpha,
  delta0_true,
  alpha0_true,
  comm_covariate_cols = NULL,
  hh_covariate_cols = NULL,
  hh_by_role = FALSE,
  hh_role_covariate_cols = NULL,
  standardize_covariates = FALSE,
  lambda_comm = lambda,
  lambda_hh = lambda,
  verbose = TRUE
)
```

Arguments

<code>long_dt</code>	data.table or data.frame. Person day data from build_person_day_table .
<code>n_runs</code>	Integer. Number of optimization runs for multi start.
<code>start_par</code>	Numeric vector or NULL. Initial parameters. If NULL, a vector of the correct length is initialized with <code>delta0_true</code> and <code>alpha0_true</code> in the intercept slots and zeros elsewhere.
<code>lambda</code>	Numeric. Base L2 penalty on gamma age effects and <code>z_*</code> role offsets.
<code>lambda0, lambda_alpha</code>	Numeric. Penalty strengths that pull <code>delta0</code> and <code>alpha0</code> toward <code>delta0_true</code> and <code>alpha0_true</code> .
<code>delta0_true, alpha0_true</code>	Numeric anchors for the intercept penalties on the logit scale.
<code>comm_covariate_cols</code>	Character vector of community risk covariate names with no intercept.
<code>hh_covariate_cols</code>	Character vector of household covariates shared across roles.
<code>hh_by_role</code>	Logical. If TRUE, allow role specific household covariates through <code>hh_role_covariate_cols</code> .

hh_role_covariate_cols	Named list with elements infant, sibling, adult, elder that give covariate names per role. Falls back to hh_covariate_cols if a role list is missing.
standardize_covariates	Logical. Z score non binary numeric columns in model matrices.
lambda_comm, lambda_hh	Numeric. L2 penalties for community and household covariate coefficients.
verbose	Logical. If TRUE, print notes on dropped or unknown covariates and initialization.

Value

A numeric matrix of dimension n_runs by n_parameters with column names that match the parameter layout, for example delta0, gamma2, alpha0, z_sib, and theta_*.

run_household_stan	<i>Run the Stan household model</i>
--------------------	-------------------------------------

Description

Thin wrapper around `rstan::stan()` (or compiled model via `rstan::stan_model()`) with reasonable defaults.

Usage

```
run_household_stan(
  stan_data,
  stan_file = "HH_parameter_estimation2.stan",
  chains = 4,
  iter = 2000,
  warmup = 1000,
  control = list(adapt_delta = 0.99, max_treedepth = 20),
  init = "random",
  refresh = 50,
  cores = 4,
  stan_code = NULL,
  package_name = NULL
)
```

Arguments

stan_data	Named list as returned by build_stan_household_arrays .
stan_file	Path to a Stan model file (or "builtin:<key>").
chains, iter, warmup	Stan MCMC settings.
control	List passed to <code>rstan::stan()</code> (e.g., <code>adapt_delta</code> , <code>max_treedepth</code>).
init, refresh, cores	Passed through to <code>rstan::sampling()</code> .
stan_code	Optional character string with Stan program code.
package_name	Optional package name for <code>system.file("stan", ...)</code> lookup.

Value

A stanfit object.

seasonal_cosine	<i>Cosine seasonal multiplier (non-negative)</i>
-----------------	--

Description

Cosine-based seasonal multiplier bounded below by 0.

Usage

```
seasonal_cosine(day, peak_day = 350, amplitude = 0.8, period = 365)
```

Arguments

day	Integer vector of days.
peak_day	Integer; day of maximum.
amplitude	Numeric; cosine amplitude.
period	Integer; period length.

Value

Numeric vector of multipliers.

seasonal_forcing_to_series	<i>Build a role-specific seasonal forcing matrix</i>
----------------------------	--

Description

Stacks role-specific forcing series into a $T \times 4$ matrix for Stan.

Usage

```
seasonal_forcing_to_series(seasonal_forcing_list, T_max = 365)
```

Arguments

seasonal_forcing_list	Named list with entries adult, child, elderly, toddler; each a numeric vector of length $\geq T_{\max}$.
T_max	Integer; number of rows (days).

Value

A numeric matrix with columns adult, child, elderly, toddler and T_max rows.

simulate_households	<i>Simulate households (legacy or RSV/VL engine)</i>
---------------------	--

Description

Generates synthetic household data for downstream MLE or RSV/VL–Stan pipelines. Returns per-household data frames (legacy) or a long test-day table with an attached per-household list (RSV/VL).

Usage

```
simulate_households(
  n_households,
  hh.size,
  tests.per.week = 1,
  engine = c("legacy", "rsv_vl"),
  simulation_function = generate_synthetic_data_one,
  Covariates = FALSE,
  Covariates_list = c("Vaccination status", "Antibody Level"),
  Covariate_specifications = NULL,
  amplitude = 0,
  phase = 0,
  start_date = as.Date("2024-09-21"),
  end_date = as.Date("2025-04-17"),
  max_days = NULL,
  p.comm.base.infant.fix = 0.002,
  p.comm.multiplier.sibling = 1,
  p.comm.multiplier.parent = 1,
  p.comm.multiplier.elder = 1,
  p.hh.base.infant = 0.2,
  p.hh.multiplier.sibling = 0.5267686,
  p.hh.multiplier.parent = 0.8008933,
  p.hh.multiplier.elder = 0.6008933,
  p.imm.base.sibling = 1e-10,
  p.imm.base.parent = 1e-10,
  p.imm.base.elder = 1e-10,
  partial.immunity.infant = 1e-10,
  partial.immunity.sibling = 1e-10,
  partial.immunity.parent = 1e-10,
  partial.immunity.elder = 1e-10,
  duration.latent = 1,
  duration.infect.inf = 2,
  multiplier.dur.sibpar = 0.5,
  p.detect = 0.999,
  seasonal_forcing_list = NULL
)
```

Arguments

n_households	Integer; number of households.
hh.size	Integer or vector; household size(s).

tests.per.week Integer; testing frequency (legacy).
 engine Character; one of c("legacy", "rsv_vl").
 simulation_function
 Function used by the legacy engine to simulate one household (defaults to generate_synthetic_data).
 Covariates Logical; include synthetic covariates (legacy).
 Covariates_list
 Character vector; names of covariates (legacy).
 Covariate_specifications
 Optional list; covariate generation controls (legacy).
 amplitude, phase
 Numeric seasonality knobs (legacy/upstream only).
 start_date, end_date
 Date study window (RSV/VL path and inference).
 max_days Optional integer; horizon to stamp as attribute "test_days" on each household.
 p.comm.base.infant.fix
 Numeric; base community risk (infant; legacy).
 p.comm.multiplier.sibling
 Numeric; community multiplier (sibling; legacy).
 p.comm.multiplier.parent
 Numeric; community multiplier (parent; legacy).
 p.comm.multiplier.elder
 Numeric; community multiplier (elder; legacy).
 p.hh.base.infant
 Numeric; base HH transmission (infant; legacy).
 p.hh.multiplier.sibling
 Numeric; HH multiplier (sibling; legacy).
 p.hh.multiplier.parent
 Numeric; HH multiplier (parent; legacy).
 p.hh.multiplier.elder
 Numeric; HH multiplier (elder; legacy).
 p.imm.base.sibling
 Numeric; baseline immunity (sibling; legacy).
 p.imm.base.parent
 Numeric; baseline immunity (parent; legacy).
 p.imm.base.elder
 Numeric; baseline immunity (elder; legacy).
 partial.immunity.infant
 Numeric; partial immunity (infant; legacy).
 partial.immunity.sibling
 Numeric; partial immunity (sibling; legacy).
 partial.immunity.parent
 Numeric; partial immunity (parent; legacy).
 partial.immunity.elder
 Numeric; partial immunity (elder; legacy).
 duration.latent
 Integer; latent duration (legacy).

duration.infect.inf
Integer; infectious duration (legacy).

multiplier.dur.sibpar
Numeric; duration multiplier for sibling/parent (legacy).

p.detect
Numeric; detection probability per test (legacy).

seasonal_forcing_list
Optional named list (adult, child, elderly, toddler) for RSV/VL downstream use.

Value

If engine="legacy": a list of per-household data frames (each may carry attr(., "test_days")).
If engine="rsv_vl": a long test-day data frame with attribute "households" holding the per-household list.

simulate_multiple_households_comm

Simulate multiple households (RSV/VL engine)

Description

Runs [simulate_one_household_comm](#) across households and returns both the stacked data frame and the per-household list.

Usage

```
simulate_multiple_households_comm(
  n_households = 200,
  alpha_comm_by_role = 0.005,
  beta1 = 0.06,
  beta2 = 1e-07,
  delta = 1,
  rho = 3,
  V_ref = 1e+07,
  phi_by_role = c(adult = 1, child = 1.1, elderly = 0.8, toddler = 1.2),
  kappa_by_role = c(adult = 1, child = 1.1, elderly = 0.7, toddler = 1.2),
  latent_shape = 2,
  latent_scale = 1,
  infectious_shape = 2,
  infectious_scale = 2,
  peak_day = 2,
  width = 2,
  max_days = 40,
  verbose = FALSE,
  seasonal_forcing_list = NULL
)
```

Arguments

n_households Integer; number of households.
alpha_comm_by_role Numeric; baseline community hazard (scalar).
beta1, beta2, delta, rho, V_ref Numeric; transmission constants.
phi_by_role, kappa_by_role Named numeric vectors; susceptibility and infectivity multipliers by role.
latent_shape, latent_scale, infectious_shape, infectious_scale Numeric; gamma parameters for latent/infectious durations.
peak_day, width Numeric; infectivity profile controls.
max_days Integer; simulation horizon (days).
verbose Logical; print progress.
seasonal_forcing_list Optional list of length 4 with role-specific seasonal multipliers (length max_days).

Value

A list with:
hh_df Stacked data frame across households.
households List of per-household data frames.

simulate_one_household_comm
Simulate one household (RSV/VL engine)

Description

Simulates infection events, infectious periods, detection, and VL trajectories for a single household over a fixed horizon.

Usage

```

simulate_one_household_comm(
  hh_id,
  roles,
  alpha_comm_by_role,
  beta1 = 0.06,
  beta2 = 1e-07,
  delta = 1,
  rho = 3,
  V_ref = 1e+07,
  phi_by_role = c(adult = 1, child = 1.1, elderly = 0.8, toddler = 1.2),
  kappa_by_role = c(adult = 1, child = 1.1, elderly = 0.7, toddler = 1.2),
  latent_shape = 2,
  latent_scale = 1,
  infectious_shape = 2,
  infectious_scale = 2,

```

```

    peak_day = 2,
    width = 2,
    max_days = 40,
    test_weekly_before_detection = TRUE,
    perfect_detection = TRUE,
    contact_mat = NULL,
    verbose = FALSE,
    seasonal_forcing_list = NULL
  )

```

Arguments

hh_id	Household identifier.
roles	Character vector of roles (one per person).
alpha_comm_by_role	Numeric; baseline community hazard (scalar).
beta1, beta2, delta, rho, V_ref	Numeric; transmission constants.
phi_by_role, kappa_by_role	Named numeric vectors; susceptibility and infectivity multipliers by role.
latent_shape, latent_scale, infectious_shape, infectious_scale	Numeric; gamma parameters for latent/infectious durations.
peak_day, width	Numeric; infectivity profile controls.
max_days	Integer; simulation horizon (days).
test_weekly_before_detection	Logical; weekly testing before first detection.
perfect_detection	Logical; perfect detection on test days.
contact_mat	Optional square contact matrix (no self-contact).
verbose	Logical; print progress.
seasonal_forcing_list	Optional list of length 4 with role-specific seasonal multipliers (length max_days).

Value

A data frame with columns hh_id, person_id, role, infection_time, infectious_start, infectious_end, detection_time, infection_resolved, plus list-columns vl_full_trajectory, viral_loads_test_days. Attributes test_days and params are attached.

```
simulate_viral_load_trajectory
```

Simulate a log10 viral-load trajectory

Description

Generates a unimodal log10 viral-load curve given peak level/day and growth/decay rates.

Usage

```
simulate_viral_load_trajectory(t, v_p, t_p, lambda_g, lambda_d)
```

Arguments

`t` Integer vector; days relative to infection.
`v_p` Numeric; peak log10 VL.
`t_p` Integer; day of peak.
`lambda_g, lambda_d` Numeric; growth/decay rates.

Value

Numeric vector of log10 VL at times `t`.

`summarize_individuals` *Summarize individual-level infection data*

Description

Produces one row per individual with detection windows, inferred infectious windows (relative days), index-case flags, observation bounds, role/age classification, and aggregated covariates. Optionally builds day-series list-columns for selected covariates.

Usage

```
summarize_individuals(  
  raw_dt,  
  study_start,  
  study_end,  
  day_series_covariates = TRUE,  
  series_cols = NULL  
)
```

Arguments

`raw_dt` List of household-level data frames/tables.
`study_start, study_end` Date. Analysis window defining day indices.
`day_series_covariates` Logical; add day-series list-columns (default TRUE).
`series_cols` Character or NULL; covariates to series-encode (default NULL = all).

Value

`data.table` with one row per individual containing detection and infectious windows, flags, observation bounds, role/age, and covariate summaries.

TransmissionChainAnalysis

TransmissionChainAnalysis: analyze user-supplied household data

Description

Runs the end-to-end workflow on *user-provided* data using either the legacy MLE path (`estimation_method = "mle"`) or the RSV/VL Stan path (`estimation_method = "stan"`). This function does not simulate data; it expects input in tabular form (see Details).

Usage

```
TransmissionChainAnalysis(
  user_data,
  estimation_method = c("mle", "stan"),
  data_summary = FALSE,
  postprocessing = TRUE,
  plots = c("daily", "weekly", "timeline", "sar"),
  print_plots = FALSE,
  index_vl_column = "vl_test",
  n_runs = 10,
  day_series_covariates = TRUE,
  series_cols = NULL,
  comm_covariate_cols = NULL,
  hh_covariate_cols = NULL,
  hh_by_role = FALSE,
  hh_role_covariate_cols = NULL,
  standardize_covariates = TRUE,
  lambda_comm = 0.01,
  lambda_hh = 0.01,
  start_date = as.Date("2024-09-21"),
  end_date = as.Date("2025-04-17"),
  latent_par = list(shape = 2, scale = 1),
  report_par = list(shape = 1, scale = 1.5),
  infect_par = list(shape = 3, scale = 2),
  start_par = c(-6, 0.02, -2, rep(0, 6)),
  lambda = 0.01,
  lambda0 = 0.2,
  lambda_alpha = 5,
  delta0_true = qlogis(0.002),
  alpha0_true = qlogis(0.2),
  true_values = NULL,
  seasonal_forcing_list = NULL,
  max_days = 365,
  stan_file = "../inst/stan/HH_parameter_estimation2.stan",
  stan_chains = 1,
  stan_iter = 100,
  stan_warmup = 100,
  stan_control = list(adapt_delta = 0.99, max_treedepth = 20),
  stan_init = "random",
  stan_refresh = 50,
```

```

stan_cores = 4,
vl_mode = c("auto", "from_long"),
vl_source = c("column", "simulate", "none"),
vl_column = NULL,
role_levels = c("adult", "child", "elderly", "toddler")
)

```

Arguments

<code>user_data</code>	A data.frame or a list of data.frames describing household testing or episode data (see Details for accepted shapes). Lists are row-bound internally.
<code>estimation_method</code>	One of <code>c("mle", "stan")</code> . Valid pairs are legacy+MLE (<code>"mle"</code>) and RSV/VL+Stan (<code>"stan"</code>).
<code>data_summary</code>	Logical; print/retain a brief summary in print methods (see Value).
<code>postprocessing</code>	Logical; for MLE, compute a post-processing table; for Stan, this is an alias of the posterior summary.
<code>plots</code>	Character vector of plot names to build when compatible data are present: <code>c("daily", "weekly", "ti", "all")</code> .
<code>print_plots</code>	Logical; print plots if produced.
<code>index_vl_column</code>	Optional character; name of the viral-load column used by SAR-by-VL plotting. Defaults to <code>"vl_test"</code> when present.
<code>n_runs</code>	Integer; number of repeated estimation runs (MLE path only).
<code>day_series_covariates</code>	Logical; include day-series covariates (MLE path).
<code>series_cols</code>	Optional character vector; selected day-series columns (MLE path).
<code>comm_covariate_cols, hh_covariate_cols</code>	Optional character vectors of likelihood-level covariates (MLE path).
<code>hh_by_role</code>	Logical; fit separate household effects by role (MLE path).
<code>hh_role_covariate_cols</code>	Optional named list of role-specific covariates (MLE path).
<code>standardize_covariates</code>	Logical; standardize covariates (MLE path).
<code>lambda_comm, lambda_hh</code>	Numeric; ridge penalties for community and household covariates (MLE path).
<code>start_date, end_date</code>	Date study window.
<code>latent_par, report_par, infect_par</code>	Lists of gamma parameters (shape, scale) used by imputation (MLE path).
<code>start_par</code>	Numeric vector; optimizer starting values (MLE path).
<code>lambda, lambda0, lambda_alpha</code>	Numeric; optimizer penalties (MLE path).
<code>delta0_true, alpha0_true</code>	Numeric anchors on the logit scale (MLE path).
<code>true_values</code>	Optional named numeric vector of reference/true values for post-processing (MLE path).

seasonal_forcing_list	Optional named list of role vectors for forcing (Stan path).
max_days	Integer; maximum modeled days (Stan path).
stan_file	Path to a Stan model file.
stan_chains, stan_iter, stan_warmup	Integers; Stan sampling controls.
stan_control	List; passed to <code>rstan::sampling(..., control = ...)</code> .
stan_init	Character or function; Stan initialization.
stan_refresh	Integer; Stan refresh rate.
stan_cores	Integer; CPU cores for Stan.
vl_mode	One of <code>c("auto", "from_long")</code> indicating how to derive VL for Stan path.
vl_source	One of <code>c("column", "simulate", "none")</code> indicating the VL source for Stan path.
vl_column	Optional character; the VL column when <code>vl_source="column"</code> (Stan path).
role_levels	Character vector; canonical role levels for normalization on the Stan path.

Details

Accepted input shapes:

- Long testing table with columns like HH, individual_ID, role, test_date, infection_status, and optionally a VL column.
- Per-person episode table with hh_id, person_id, role, infection_time, infectious_start, infectious_end, and optionally a viral-load trajectory.

Only two engine/method pairs are supported: legacy+MLE and RSV/VL+Stan.

Value

An object of class "TransmissionChainResult" containing:

- `$results`: engine-specific internals (MLE: summaries/person-day/estimates; Stan: stan_data, fit, posterior_summary).
- `$postprocessing`: MLE summary table or Stan posterior summary.
- `$plot_list`: named list of ggplot objects when built.
- `$data_summary`: flag indicating whether print methods preview summaries.

See Also

[main_parameter_estimation_pipeline](#), [postprocessing_estimates](#)

Examples

```
## Not run:
# MLE path requires full legacy preprocessing; shown here schematically:
# res <- TransmissionChainAnalysis(user_data = your_long_df, estimation_method = "mle")

## End(Not run)
```

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