

# Package ‘isotracer’

September 27, 2021

**Type** Package

**Title** Isotopic Tracer Analysis Using MCMC

**Version** 1.0.4

**Description** Implements Bayesian models to analyze data from tracer addition experiments. The implemented method was originally described in the article “A New Method to Reconstruct Quantitative Food Webs and Nutrient Flows from Isotope Tracer Addition Experiments” by López-Sepulcre et al. (2020) <doi:10.1086/708546>.

**License** GPL-3

**URL** <https://gitlab.com/matthieu-bruneaux/isotracer>

**BugReports** <https://gitlab.com/matthieu-bruneaux/isotracer/-/issues>

**Depends** R (>= 3.6.0)

**Imports** coda (>= 0.19-3), data.table, dplyr (>= 0.8.5), latex2exp (>= 0.4.0), magrittr, methods (>= 3.6.0), pillar (>= 1.4.3), purrr (>= 0.3.3), Rcpp (>= 1.0.4), rlang (>= 0.4.5), rstan (>= 2.19.3), rstantools (>= 2.0.0), tibble (>= 3.0.0), tidyr (>= 1.0.2), tidyselect (>= 1.0.0)

**Suggests** bayesplot, covr, ggdist, ggplot2, ggraph, gridBase, gridExtra, here, igraph, knitr, lattice, readxl, rmarkdown, testthat, tidygraph, tidyverse, viridisLite

**LinkingTo** BH (>= 1.72.0), Rcpp (>= 1.0.4), RcppEigen (>= 0.3.3.7.0), StanHeaders (>= 2.19.2), rstan (>= 2.19.3)

**SystemRequirements** GNU make

**Encoding** UTF-8

**LazyData** true

**Biarch** true

**RoxygenNote** 7.1.2

**VignetteBuilder** knitr

**NeedsCompilation** yes

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**Repository** CRAN

**Date/Publication** 2021-09-27 08:50:02 UTC

## R topics documented:

isotracer-package	4
add_covariates	4
add_pulse_event	5
aquarium_mod	6
aquarium_run	7
as.mcmc.list.tidy_flows	7
as.mcmc.list.tidy_steady_states	8
as_tbl_graph	9
as_tbl_graph.topology	9
c.mcmc.list	10
calculate_steady_state	10
comps	11
constant	12
delta2prop	12
dic	13
eelgrass	14
filter	16
filter.ppcNetworkModel	16
filter_by_group	17
format.prior	17
ggflows	18
ggtopo	19
ggtopo.networkModel	19
ggtopo.topology	20
groups.networkModel	21
hcauchy	21
li2017	22
Math.mcmc.list	23
mcmc_heatmap	24
new_networkModel	24
normal	25
obj_sum.prior	25
Ops.mcmc.list	26
Ops.prior	27
Ops.topology	27
params	28
pillar_shaft.prior	29
plot.networkModel	29
plot.ready_for_unit_plot	30

posterior_predict . . . . .	30
posterior_predict.networkModelStanfit . . . . .	31
predict.networkModel . . . . .	31
print.networkModel . . . . .	32
print.prior . . . . .	33
print.topology . . . . .	33
priors . . . . .	34
project . . . . .	34
prop_family . . . . .	35
quick_sankey . . . . .	36
run_mcmc . . . . .	36
sample_from . . . . .	37
sample_from_prior . . . . .	38
sample_params . . . . .	39
sankey . . . . .	40
scaled_beta . . . . .	42
select.mcmc.list . . . . .	43
set_half_life . . . . .	44
set_init . . . . .	45
set_obs . . . . .	45
set_params . . . . .	46
set_prior . . . . .	47
set_prop_family . . . . .	47
set_size_family . . . . .	48
set_split . . . . .	49
set_steady . . . . .	50
set_topo . . . . .	50
tidy_data . . . . .	52
tidy_dpp . . . . .	52
tidy_flows . . . . .	53
tidy_mcmc . . . . .	54
tidy_posterior_predict . . . . .	55
tidy_steady_states . . . . .	56
tidy_trajectories . . . . .	56
topo . . . . .	58
traceplot . . . . .	58
trini_mod . . . . .	59
type_sum.prior . . . . .	60
uniform . . . . .	60
[.networkModelStanfit . . . . .	61

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isotracer-package      *The 'isotracer' package*

---

### Description

The isotracer package allows modelling of fluxes across a network of compartments. Parameters are estimated using a Bayesian MCMC approach.

### References

López-Sepulcre, A., M. Bruneaux, S. M. Collins, R. El-Sabaawi, A. S. Flecker, and S. A. Thomas. The American Naturalist (2020). "A New Method to Reconstruct Quantitative Food Webs and Nutrient Flows from Isotope Tracer Addition Experiments." <https://doi.org/10.1086/708546>.

Stan Development Team (2018). RStan: the R interface to Stan. R package version 2.18.2. <https://mc-stan.org>

---

add\_covariates      *Add fixed effects of one or several covariates to some parameters.*

---

### Description

New global parameters are given a default prior of `hcauchy(scale = 1)`

### Usage

```
add_covariates(nm, ..., use_regexpr = TRUE)
```

### Arguments

<code>nm</code>	A <code>networkModel</code> object.
<code>...</code>	One or several formulas defining the covariates.
<code>use_regexpr</code>	Boolean, use regular expression to match the parameters affected by the formulas?

### Value

A `networkModel` object.

---

add_pulse_event	<i>Register a pulse event on one of the compartment of a topology</i>
-----------------	---

---

### Description

When applied to a steady-state compartment, this is equivalent to changing the steady state. Negative values are allowed, so one can add a "pulse" to a steady-state compartment and then later add a similar but negative "pulse" to simulate a drip in a stream for example.

### Usage

```
add_pulse_event(nm, time, comp = NULL, unmarked, marked, which = NULL, pulses)
```

### Arguments

nm	A networkModel object.
time	Numeric, time at which the pulse is happening.
comp	One compartment name only.
unmarked	Numeric, quantity of unmarked marker added.
marked	Numeric, quantity of marked marker added.
which	Vector of integers giving the nm rows to update. Default is to update all rows.
pulses	Optionally, a tibble containing the pulse information in columns. If provided, 'comp', 'time', 'unmarked' and 'marked' must be strings giving the corresponding column names.

### Value

A networkModel object.

### Examples

```
m <- trini_mod
m$events <- NULL
pulses <- tibble::tribble(
  ~ stream, ~ transect, ~ comp, ~ time, ~ qty_14N, ~ qty_15N,
  "UL", "transect.1", "NH4", 11, 0, -0.00569,
  "UL", "transect.2", "NH4", 11, 0, -0.00264,
  "UL", "transect.3", "NH4", 11, 0, -0.000726,
  "UL", "transect.1", "NO3", 11, 0, -0.00851,
  "UL", "transect.2", "NO3", 11, 0, -0.01118,
  "UL", "transect.3", "NO3", 11, 0, -0.01244,
)
m <- add_pulse_event(m, pulses = pulses, comp = "comp", time = "time",
  unmarked = "qty_14N", marked = "qty_15N")
m
```

---

 aquarium\_mod

*A simple aquarium network model, ready to run*


---

## Description

This network model is the model used in the Quick Start tutorial vignette. It is ready to be run at once with [run\\_mcmc](#).

## Usage

```
aquarium_mod
```

## Format

An object of class `networkModel` (inherits from `tbl_df`, `tbl`, `data.frame`) with 1 rows and 4 columns.

## Details

The code used to built the model is given in the example section below.

The [aquarium\\_run](#) dataset is a corresponding MCMC run.

## Examples

```
library(tidyverse)
exp <- tibble::tribble(
  ~time.day, ~species, ~biomass, ~prop15N,
  0, "algae", 1.02, 0.00384,
  1, "algae", NA, 0.0534,
  1.5, "algae", 0.951, NA,
  2, "algae", 0.889, 0.0849,
  2.5, "algae", NA, 0.0869,
  3, "algae", 0.837, 0.0816,
  0, "daphnia", 1.74, 0.00464,
  1, "daphnia", NA, 0.00493,
  1.5, "daphnia", 2.48, NA,
  2, "daphnia", NA, 0.00831,
  2.5, "daphnia", 2.25, NA,
  3, "daphnia", 2.15, 0.0101,
  0, "NH4", 0.208, 0.79,
  1, "NH4", 0.227, NA,
  1.5, "NH4", NA, 0.482,
  2, "NH4", 0.256, 0.351,
  2.5, "NH4", NA, 0.295,
  3, "NH4", 0.27, NA
)
inits <- exp %>% filter(time.day == 0)
obs <- exp %>% filter(time.day > 0)
```

```
aquarium_mod <- new_networkModel() %>%  
  set_topo("NH4 -> algae -> daphnia -> NH4") %>%  
  set_init(inits, comp = "species", size = "biomass",  
          prop = "prop15N") %>%  
  set_obs(obs, comp = "species", size = "biomass",  
         prop = "prop15N", time = "time.day")
```

---

aquarium\_run

*An MCMC run from a simple aquarium network model*

---

### Description

This is an MCMC run on [aquarium\\_mod](#). The code used to run the MCMC is: `aquarium_run <-run_mcmc(aquarium_mod)`. The code used to build the model itself is given in the help page for [aquarium\\_mod](#).

### Usage

```
aquarium_run
```

### Format

An object of class `networkModelStanfit` (inherits from `mcmc.list`) of length 4.

### Examples

```
plot(aquarium_run)  
summary(aquarium_run)
```

---

`as.mcmc.list.tidy_flows`

*Convert a tidy\_flows object to an mcmc.list*

---

### Description

Convert a `tidy_flows` object to an `mcmc.list`

### Usage

```
## S3 method for class 'tidy_flows'  
as.mcmc.list(x, ...)
```

**Arguments**

- x            A tidy flow object, as returned by `tidy_flows`. Note that all chains must have the same iterations extracted (i.e. you must use `n_per_chain` when calling `tidy_flows`).
- ...            Not used for now.

**Value**

A `mcmc.list` object, with ordered iterations.

---

```
as.mcmc.list.tidy_steady_states
```

*Convert a tidy\_steady\_states object to an mcmc.list*

---

**Description**

Convert a `tidy_steady_states` object to an `mcmc.list`

**Usage**

```
## S3 method for class 'tidy_steady_states'
as.mcmc.list(x, ...)
```

**Arguments**

- x            A tidy steady states object, as returned by `tidy_steady_states`. Note that all chains must have the same iterations extracted (i.e. you must use `n_per_chain` when calling `tidy_flows`).
- ...            Not used for now.

**Value**

A `mcmc.list` object, with ordered iterations.



---

as_tbl_graph	<i>Generic for as_tbl_graph()</i>
--------------	-----------------------------------

---

**Description**

Convert a compatible object to a tbl\_graph object (from the tidygraph package)

**Usage**

```
as_tbl_graph(x, ...)
```

**Arguments**

x	Object to convert to a tbl_graph.
...	Passed to the appropriate method.

**Value**

A tbl\_graph object.

---

as_tbl_graph.topology	<i>Convert a network topology to a tbl_graph</i>
-----------------------	--

---

**Description**

Convert a network topology to a tbl\_graph

**Usage**

```
## S3 method for class 'topology'  
as_tbl_graph(x, ...)
```

**Arguments**

x	A network topology.
...	Not used.

**Value**

A tbl\_graph object.

---

`c.mcmc.list`*Combine mcmc.list objects*

---

**Description**

Combine mcmc.list objects

**Usage**

```
## S3 method for class 'mcmc.list'  
c(...)
```

**Arguments**

... mcmc.list objects.

**Value**

A mcmc.list object.

---

`calculate_steady_state`*Calculate steady-state compartment sizes for a network*

---

**Description**

This is an experimental function. It attempts to calculate steady-state compartment sizes using the set parameter values and the initial compartment sizes. Use it with caution!

**Usage**

```
calculate_steady_state(nm)
```

**Arguments**

nm A network model, with set parameter values.

**Value**

A tibble containing steady-state compartment sizes.

**Examples**

```
m <- aquarium_mod
m <- set_prior(m, constant(0), "lambda")
m <- set_params(m, sample_params(m))
proj <- project(m, end = 40)
plot(proj)

z <- calculate_steady_state(m)
z
z$stable_sizes
```

---

comps

*Return the compartments of a network model*

---

**Description**

Return the compartments of a network model

**Usage**

```
comps(nm)
```

**Arguments**

nm                    A networkModel object.

**Value**

A list of character vectors, with one list element per row of the input network model (list elements are in the same order as the input network model rows). Each list element containing the names of the compartments in the topology defined in the corresponding row of the input network model.

**Examples**

```
comps(aquarium_mod)
comps(trini_mod)
```

---

constant	<i>Define a fixed-value prior</i>
----------	-----------------------------------

---

**Description**

This is equivalent to having a fixed parameter.

**Usage**

```
constant(value)
```

**Arguments**

value	The constant value of the parameter.
-------	--------------------------------------

**Value**

A list defining the prior.

**Examples**

```
constant(2)
```

---

delta2prop	<i>Convert delta notation to proportion of heavy isotope</i>
------------	--

---

**Description**

For details and references about quantities used in expressing isotopic ratios, see:

**Usage**

```
delta2prop(x = NULL, Rstandard = NULL)
```

**Arguments**

x	Vector of delta values
Rstandard	String describing the isotopic measurement, e.g. "d15N", "d13C" and used to set automatically Rstandards (see the Section "Ratios for reference standards" for more details). Alternatively, a numeric value to use for Rstandard, e.g. 0.0036765.

**Details**

- Figure 1 in Coplen, Tyler B. “Guidelines and Recommended Terms for Expression of Stable-Isotope-Ratio and Gas-Ratio Measurement Results.” *Rapid Communications in Mass Spectrometry* 25, no. 17 (September 15, 2011): 2538–60. <https://doi.org/10.1002/rcm.5129>.

- Table 2.1 in Fry, Brian. *Stable Isotope Ecology*. New York: Springer-Verlag, 2006. [//www.springer.com/gp/book/978038730](http://www.springer.com/gp/book/978038730)

**Value**

A vector of same length of  $x$ , containing the proportion (numeric between 0 and 1) of heavy isotope based on the delta values and the  $R_{\text{standard}}$  provided.

**Ratios for reference standards**

The ratios for reference standards are taken from the Table 2.1 from Fry 2006. Note that the values used for oxygen isotopes are from the standard mean ocean water (SMOW).

Standards recognized by this function are: `c("d15N", "d2H", "d13C", "d17O.SMOW", "d18O.SMOW", "d33S", "d34S", "d36S")`

**Examples**

```
deltas <- c(78, 5180, 263, 1065, NA, 153, 345)

# Rstandard can be specified with a string for some preset references
prop15N <- delta2prop(deltas, "d15N")
prop13C <- delta2prop(deltas, "d13C")

# Rstandard can also be specified manually for non-preset references
prop15N_manual <- delta2prop(deltas, 0.0036765)
prop13C_manual <- delta2prop(deltas, 0.011180)

# Call delta2prop() to get the detail of available references
delta2prop()
```

---

 dic

---

*Calculate DIC from a model output*


---

**Description**

Note that DIC might not be indicated for network models, as the posteriors are often not multinormal distributions.

**Usage**

```
dic(..., weight = TRUE)
```

**Arguments**

... One or several `mcmc.list` objects, output(s) from `run_mcmc`.

`weight` Boolean, if TRUE calculate DIC weights based on Link and Barker 2010 (Link, W. A., and R. J. Barker. 2010. Bayesian Inference With Ecological Applications. Amsterdam Boston Heidelberg London: Elsevier/Academic Press).

**Details**

LOO is probably not a good choice either since the data is akin to a time series (so data points are not independent). Maybe WAIC could be an option? (TODO: read about this.)

DIC is calculated as:

$$\text{DIC} = \text{Dbar} + \text{pD}$$

where D are deviance values calculated as  $-2 * \text{loglik}$  for each MCMC iteration, Dbar is the mean deviance value and pD is the effective number of parameters in the model and can be calculated as  $\text{var}(D)/2$  (Gelman 2003).

**Value**

A tibble with one row per `mcmc.list` object provided in ... This tibble is sorted by DIC, so the row order might be different from the `mcmc.list` objects order.

**Examples**

```
# Define two different models
m1 <- aquarium_mod
m2 <- set_topo(m1, c("NH4 -> algae -> daphnia -> NH4", "algae -> NH4"))
# Run the models
r1 <- run_mcmc(m1, chains = 2)
r2 <- run_mcmc(m2, chains = 2)
# Model comparison with DIC
dic(r1, r2)
```

---

eelgrass

*Eelgrass phosphate incorporation data (McRoy & Barsdate 1970)*

---

**Description**

Dataset built from the article "Phosphate absorption in eelgrass" by McRoy and Barsdate (1970)

**Usage**

```
eelgrass
```

## Format

Tibble with columns

**light\_treatment** Light treatment: "light" or "dark".

**addition\_site** The location where <sup>32</sup>P phosphate was added: in the "upper" water compartment or in the "lower" water compartment.

**compartment** Observed compartment, one of "leaves\_stem", "roots\_rhizome", "upper\_water", or "lower\_water".

**time\_min** Elapsed time in minutes since the <sup>32</sup>P addition.

**n\_32P\_per\_mg** Number of <sup>32</sup>P atoms per mg (estimated from Figure 2 of the original paper).

**mass\_mg** Compartment mass in mg (taken from Table 1 of the original paper). Assumed constant during the experiment.

**n\_32P** Number of <sup>32</sup>P atoms in the compartment. Calculated from the two previous columns.

## Details

In brief, the experimental setup consists in individual eelgrass plants placed in 250 ml containers. Each container is partitioned by a layer of paraffin into an upper water compartment (containing the leaves and stems) and a lower water compartment (containing the roots and rhizomes).

Radioactive phosphorus (<sup>32</sup>P) is added as phosphate either in the upper or lower water compartment in each container. Containers were incubated either in light or dark conditions.

Tissue samples were collected and dried at various time points and <sup>32</sup>P activity was measured (Figure 2 in the original paper). Biomass estimates in initial conditions were given in Table 1 of the original paper.

## Data preparation

The data for <sup>32</sup>P abundance per mg is extracted from Figure 2 of the original article. Atom counts per mg were derived from cpm per mg using a half-life value of 14.268 days for <sup>32</sup>P.

For simplicity and in order to be able to match the <sup>32</sup>P data with the biomass data (see below), only four compartments are considered in the package dataset. Upper and lower water compartments match the compartments from the original article. "Leaf and stem" pools the original compartments "leaf tip", "leaf middle", "leaf base", and "stem". "Roots and rhizome" pools the original compartments "root" and "rhizome". Pooling is done by averaging the cpm per mg data, thereby making the rough approximation that each component of the pool contributes the same biomass as the other components.

The biomass data is taken from Table 1 in the original paper. Experimental containers had 160 cc of seawater in the upper compartment and 80 cc of seawater in the lower compartment. Based on comparison with data from Risgaard-Petersen 1998, I assumed that the biomasses for tissues were given in dry weight. I assumed that this was also the case for the cpm/mg data (i.e. cpm/mg of dry weight).

## Source

Data was taken from the figures and tables of the original paper. The original paper is: McRoy, C. Peter, and Robert J. Barsdate. "Phosphate Absorption in Eelgrass1." *Limnology and Oceanography* 15, no. 1 (January 1, 1970): 6–13. <https://doi.org/10.4319/lo.1970.15.1.0006>.

---

filter	<i>Filter (alias for filter function from dplyr)</i>
--------	--

---

**Description**

Filter (alias for filter function from dplyr)

**Arguments**

.data	Data to filter.
...	Passed to dplyr::filter.
preserve	Ignored.

**Value**

See the returned value for dplyr::filter.

---

filter.ppcNetworkModel	<i>Filter method for output of tidy_data_and_posterior_predict()</i>
------------------------	--

---

**Description**

Filter method for output of tidy\_data\_and\_posterior\_predict()

**Usage**

```
## S3 method for class 'ppcNetworkModel'
filter(.data, ..., .preserve = FALSE)
```

**Arguments**

.data	A ppcNetworkModel object.
...	Passed to dplyr::filter.
.preserve	Ignored.

**Value**

A ppcNetworkModel object filtered appropriately based on the [["vars"]] tibble.



---

filter_by_group	<i>Filter a tibble based on the "group" column</i>
-----------------	--

---

**Description**

This function can be used to filter any tibble (e.g. network model object) that has a "group" column. See the Examples for more details and syntax.

**Usage**

```
filter_by_group(.data, ...)
```

**Arguments**

.data	A tibble that has a 'group' column, such as a 'networkModel' object.
...	Conditional expressions for filtering (see the Examples).

**Value**

A tibble similar to the input object, but with rows filtered based on ...

**Examples**

```
trini_mod
trini_mod$group
groups(trini_mod)
filter_by_group(trini_mod, stream == "LL", transect == "transect.1")
filter_by_group(trini_mod, transect == "transect.1")
## Not run:
# The code below would raise an error because there is no "color" grouping variable.
filter_by_group(trini_mod, color == "red")

## End(Not run)
```

---

format.prior	<i>Pretty formatting of a prior object</i>
--------------	--

---

**Description**

Pretty formatting of a prior object

**Usage**

```
## S3 method for class 'prior'
format(x, ...)
```

**Arguments**

x                    An object of class prior.  
 ...                 Not used.

**Value**

A character string for pretty printing of a prior.

---

ggflows                    *A quick-and-dirty way of visualizing relative flows in a network*

---

**Description**

A quick-and-dirty way of visualizing relative flows in a network

**Usage**

```
ggflows(x, layout = "auto", edge = "fan", max_width, legend = TRUE, ...)
```

**Arguments**

x                    A tibble with the flow estimates, with columns "from", "to", and "flow".  
 layout             Optional, layout to use (e.g. "sugiyama", "kk", "stress")  
 edge                "curve" (the default), "line" or "fan".  
 max\_width         Optional, numeric giving the maximum edge width (minimum width is always 1).  
 legend             Boolean, display edge width legend?  
 ...                 Not used.

**Value**

A ggplot2 plot.

**Examples**

```
if (requireNamespace("ggraph")) {
  z <- tibble::tribble(
    ~from,           ~to,           ~flow,
    "leavesAndStem", "rootsAndRhizome", 333.929866077124,
    "lowerWater",   "rootsAndRhizome", 4425.15780019304,
    "rootsAndRhizome", "leavesAndStem", 525.208837577916,
    "upperWater",   "leavesAndStem", 11224.0814971855
  )
  ggflows(z)
  ggflows(z, max_width = 15)
}
```

---

ggtopo *Plot a topology*

---

**Description**

A quick plot using ggraph

**Usage**

```
ggtopo(x, layout = "auto", edge = "fan", ...)
```

**Arguments**

x	A network model or a topology matrix.
layout	Optional, layout to use (e.g. "sugiyama", "kk", "stress")
edge	"fan" (the default) or "line" or "curve".
...	Passed to the methods.

**Value**

A ggplot2 plot.

**Examples**

```
if (requireNamespace("ggraph")) {
  ggtopo(aquarium_mod, edge = "line")
}
```

---

ggtopo.networkModel *Plot a network topology*

---

**Description**

A quick plot using ggraph

**Usage**

```
## S3 method for class 'networkModel'
ggtopo(x, layout = "auto", edge = "fan", ...)
```

**Arguments**

x	A topology matrix.
layout	Optional, layout to use (e.g. "sugiyama", "kk", "stress")
edge	"curve" (the default) or "line".
...	Not used for now.

**Value**

A ggplot2 plot.

**Examples**

```
if (requireNamespace("ggraph")) {
  ggtopo(aquarium_mod, edge = "line")
  ggtopo(trini_mod)
}
```

---

ggtopo.topology	<i>Plot a topology</i>
-----------------	------------------------

---

**Description**

A quick plot using ggraph

**Usage**

```
## S3 method for class 'topology'
ggtopo(x, layout = "auto", edge = "fan", ...)
```

**Arguments**

x	A topology matrix.
layout	Optional, layout to use (e.g. "sugiyama", "kk", "stress")
edge	"curve" (the default), "line" or "fan".
...	Not used for now.

**Value**

A ggplot2 plot.

**Examples**

```
if (requireNamespace("ggraph")) {
  z <- topo(aquarium_mod)
  ggtopo(z)
  ggtopo(z, edge = "line")

  z <- topo(trini_mod)
  ggtopo(z)

  # For finer control, one can build a tbl_graph from the topology and
  # use ggraph directly
  x <- as_tbl_graph(z)
  library(ggraph)
```



**Value**

A list defining the prior.

**Examples**

```
hcauchy(scale = 0.5)
```

---

li2017

*Protein degradation in Arabidopsis plants (Li et al. 2017)*


---

**Description**

Dataset built from the Dryad depository entry associated with the article "Protein degradation rate in Arabidopsis thaliana leaf growth and development" by Li et al. (2017)

**Usage**

```
li2017
```

**Format**

li2017 is the main dataset and is a tibble with columns:

**prot\_id** Protein identifier. Can be matched to a more explicit protein description in li2017\_prots.

**sample** Sample identity. Different samples were used for relative abundance measurements and labelled fraction measurements.

**rel\_abundance** Relative abundance compared to a reference sample.

**labeled\_fraction** Proportion of 15N in the protein.

**time\_day** Time elapsed since growth medium switch to 15N, in days.

**leaf\_id** Leaf identity (3rd, 5th, or 7th leaf of individual plants).

li2017\_prots maps protein identifiers to protein descriptions and is a tibble with columns:

**prot\_id** Protein identifier. Can be matched with the same column in li2017.

**description** Protein description

li2017\_counts is a summary table counting the number of available data points for relative abundance and labelled fraction for each protein in li2017. It is a tibble with columns:

**prot\_id** Protein identifier. Can be matched with the same column in li2017.

**n\_abundance\_data** Number of relative abundance data points for a given protein.

**n\_labelling\_data** Number of labelled fraction data points for a given protein.

## Details

In this study, the authors used a growth medium containing  $^{15}\text{N}$  to grow 21-day old *Arabidopsis* plants which were grown on a natural  $^{14}\text{N}/^{15}\text{N}$  medium until that day. The third, fifth and seventh leaves were sampled from individuals at different time points after the medium switch (0, 1, 3 and 5 days). Proteins were identified and labelled fractions were measured using mass spectrometry. Relative protein abundances were determined in comparison with a reference sample.

The aim of the authors was to quantify *in vivo* degradation rates for as many proteins as possible (1228 proteins in the original paper) and examine which determinants had an effect or not on protein degradation rates (e.g. protein domains, protein complex membership, ...).

Three datasets were extracted from the large dataset available on Dryad for packaging inside isotracer: `li2017`, `li2017_prots`, and `li2017_counts`.

## Source

Data was taken from the following Dryad repository: Li, Lei, Clark J. Nelson, Josua Troesch, Ian Castleden, Shaobai Huang, and A. Harvey Millar. "Data from: Protein Degradation Rate in *Arabidopsis Thaliana* Leaf Growth and Development." Dryad, 2018. <https://doi.org/10.5061/DRYAD.Q3H85>.

The Dryad repository was associated with the following paper: Li, Lei, Clark J. Nelson, Josua Trösch, Ian Castleden, Shaobai Huang, and A. Harvey Millar. "Protein Degradation Rate in *Arabidopsis Thaliana* Leaf Growth and Development." *The Plant Cell* 29, no. 2 (February 1, 2017): 207–28. <https://doi.org/10.1105/tpc.16.00768>.

---

Math.mcmc.list

*Math generics for mcmc.list objects*

---

## Description

Math generics for mcmc.list objects

## Usage

```
## S3 method for class 'mcmc.list'  
Math(x, ...)
```

## Arguments

x                    `mcmc.list` object  
...                  Other arguments passed to corresponding methods

## Value

A `mcmc.list` object (with the added class `derived.mcmc.list`).

---

mcmc_heatmap	<i>Draw a heatmap based on the correlations between parameters</i>
--------------	--

---

### Description

Note that the colors represent the strength of the correlations (from 0 to 1), but do not inform about their sign. The method used to calculate correlation coefficients is Spearman's rho.

### Usage

```
mcmc_heatmap(x, col = NULL, ...)
```

### Arguments

x	A <code>coda::mcmc.list</code> object.
col	Optional, vectors of colors defining the color ramp. Default uses the divergent palette "Blue-Red 2" from the <code>colorspace</code> package.
...	Passed to <a href="#">heatmap</a> .

### Value

Called for side effect (plotting).

---

new_networkModel	<i>Create an empty network model</i>
------------------	--------------------------------------

---

### Description

The first step in building a network model is to create a new, empty `networkModel` object. This model can then be completed using functions such as `set_topo()`, `set_init()`, etc...

### Usage

```
new_networkModel(quiet = FALSE)
```

### Arguments

quiet	Boolean, if FALSE print a message indicating which distribution family is used for proportions.
-------	---

### Value

An empty `networkModel` object. It is basically a zero-row tibble with the appropriate columns.



**Examples**

```
m <- new_networkModel()
m
class(m)
```

---

normal	<i>Define a truncated normal prior (on [0;+Inf])</i>
--------	--

---

**Description**

Define a truncated normal prior (on [0;+Inf])

**Usage**

```
normal(mean, sd)
```

**Arguments**

mean	Mean of the untruncated normal.
sd	Standard deviation of the untruncated normal.

**Value**

A list defining the prior.

**Examples**

```
normal(mean = 0, sd = 4)
```

---

obj_sum.prior	<i>Function used for displaying prior object in tibbles</i>
---------------	---

---

**Description**

Function used for displaying prior object in tibbles

**Usage**

```
## S3 method for class 'prior'
obj_sum(x)
```

**Arguments**

x	An object of class prior.
---	---------------------------

**Value**

Input formatted with `format(x)`.

---

Ops.mcmc.list                      *Ops generics for mcmc.list objects*

---

**Description**

Ops generics for `mcmc.list` objects

**Usage**

```
## S3 method for class 'mcmc.list'
Ops(e1, e2)
```

**Arguments**

e1	First operand
e2	Second operand

**Value**

A `mcmc.list` object (with the added class `derived.mcmc.list`).

**Examples**

```
# aquarium_run is a coda::mcmc.list object shipped with the isotracer package
a <- aquarium_run
plot(a)
# The calculations below are just given as examples of mathematical
# operations performed on an mcmc.list object, and do not make any sense
# from a modelling point of view.
plot(a[, "upsilon_algae_to_daphnia"] - a[, "lambda_algae"])
plot(a[, "upsilon_algae_to_daphnia"] + a[, "lambda_algae"])
plot(a[, "upsilon_algae_to_daphnia"] / a[, "lambda_algae"])
plot(a[, "upsilon_algae_to_daphnia"] * a[, "lambda_algae"])
plot(a[, "upsilon_algae_to_daphnia"] - 10)
plot(a[, "upsilon_algae_to_daphnia"] + 10)
plot(a[, "upsilon_algae_to_daphnia"] * 10)
plot(a[, "upsilon_algae_to_daphnia"] / 10)
plot(10 - a[, "upsilon_algae_to_daphnia"])
plot(10 + a[, "upsilon_algae_to_daphnia"])
plot(10 * a[, "upsilon_algae_to_daphnia"])
plot(10 / a[, "upsilon_algae_to_daphnia"])
```

---

Ops.prior	<i>Implementation of the '==' operator for priors</i>
-----------	---

---

**Description**

Implementation of the '==' operator for priors

**Usage**

```
## S3 method for class 'prior'  
Ops(e1, e2)
```

**Arguments**

e1, e2            Objects of class "prior".

**Value**

Boolean (or throws an error for unsupported operators).

**Examples**

```
p <- constant(0)  
q <- constant(4)  
p == q  
  
p <- hcauchy(2)  
q <- hcauchy(2)  
p == q
```

---

Ops.topology	<i>Ops generics for topology objects</i>
--------------	--

---

**Description**

Ops generics for topology objects

**Usage**

```
## S3 method for class 'topology'  
Ops(e1, e2)
```

**Arguments**

e1            First operand  
e2            Second operand

**Value**

Boolean (or throws an error for unsupported operators).

**Examples**

```
topo(aquarium_mod) == topo(trini_mod)
topo(aquarium_mod) == topo(aquarium_mod)
```

---

params

*Return the parameters of a network model*

---

**Description**

Return the parameters of a network model

**Usage**

```
params(nm, tibble = FALSE, expand = FALSE)
```

**Arguments**

nm	A networkModel object.
tibble	If TRUE, return a tidy tibble with the parameter mapping.
expand	If TRUE, return a detailed tibble. The "tibble" argument is disregarded in this case.

**Value**

A sorted character vector containing the parameters names.

**Examples**

```
params(aquarium_mod)
params(trini_mod)
```

---

pillar\_shaft.prior      *Function used for displaying prior object in tibbles*

---

**Description**

Function used for displaying prior object in tibbles

**Usage**

```
## S3 method for class 'prior'  
pillar_shaft(x, ...)
```

**Arguments**

x                      An object of class prior.  
...                     Not used.

**Value**

An object prepared with pillar::new\_pillar\_shaft\_simple.

---

plot.networkModel      *Plot observations/trajectories/predictions from a network model*

---

**Description**

Plot observations/trajectories/predictions from a network model

**Usage**

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

**Arguments**

x                      A networkModel object.  
...                     Passed to plot\_nm.

**Value**

Called for side effect (plotting).

---

```
plot.ready_for_unit_plot
```

*Plot output from split\_to\_unit\_plot*

---

### Description

Plot output from split\_to\_unit\_plot

### Usage

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

### Arguments

x                    A ready\_for\_unit\_plot object.  
...                   Passed to plot\_nm.

### Value

Called for side effect (plotting).

---

```
posterior_predict
```

*Draw from the posterior predictive distribution of the model outcome*

---

### Description

Draw from the posterior predictive distribution of the model outcome

### Usage

```
posterior_predict(object, ...)
```

### Arguments

object                Model from which posterior predictions can be made.  
...                    Passed to the appropriate method.

### Value

Usually methods will implement a draw parameter, and the returned object is a "draw" by N matrix where N is the number of data points predicted per draw.

---

```
posterior_predict.networkModelStanfit
```

*Draw from the posterior predictive distribution of the model outcome*

---

### Description

Draw from the posterior predictive distribution of the model outcome

### Usage

```
## S3 method for class 'networkModelStanfit'
posterior_predict(object, newdata, draw = NULL, cores = NULL, ...)
```

### Arguments

object	A networkModelStanfit object.
newdata	Should be the model used to fit the networkStanfit object.
draw	Integer, number of draws to perform from the posterior. Default is 100.
cores	Number of cores to use for parallel calculations. Default is NULL, which means to use the value stored in options()[["mc.cores"]] (or 1 if this value is not set).
...	Not used for now.

### Value

A "draw" by N matrix where N is the number of data points predicted per draw.

---

```
predict.networkModel  Add a column with predictions from a fit
```

---

### Description

Add a column with predictions from a fit

### Usage

```
## S3 method for class 'networkModel'
predict(
  object,
  fit,
  draws = NULL,
  error.draws = 5,
  probs = 0.95,
  cores = NULL,
```

```

    dt = NULL,
    grid_size = NULL,
    at = NULL,
    end = NULL,
    ...
  )

```

**Arguments**

<code>object</code>	Network model
<code>fit</code>	Model fit (mcmc.list object)
<code>draws</code>	Integer, number of draws from the posteriors
<code>error.draws</code>	Integer, number of draws from the error distribution, for a given posterior draw.
<code>probs</code>	Credible interval (default 0.95).
<code>cores</code>	Number of cores to use for parallel calculations. Default is NULL, which means to use the value stored in <code>options()[["mc.cores"]]</code> (or 1 if this value is not set).
<code>dt, grid_size</code>	Time step size or grid points, respectively.
<code>at</code>	Timepoints at which the predictions should be returned.
<code>end</code>	Final timepoint used in the projections.
<code>...</code>	Not used.

**Value**

A network model object with an added column "prediction".

---

```
print.networkModel    Print method for networkModel objects
```

---

**Description**

Print method for networkModel objects

**Usage**

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

**Arguments**

<code>x</code>	A networkModel object.
<code>...</code>	Passed to the next method.

**Value**

Called for the side effect of printing a network model object.



---

print.prior	<i>Pretty printing of a prior object</i>
-------------	--

---

**Description**

Pretty printing of a prior object

**Usage**

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

**Arguments**

x	An object of class prior.
...	Not used.

**Value**

Mostly called for its side effect of printing, but also returns its input invisibly.

---

print.topology	<i>Pretty printing of a topology object</i>
----------------	---

---

**Description**

Pretty printing of a topology object

**Usage**

```
## S3 method for class 'topology'  
print(x, help = TRUE, ...)
```

**Arguments**

x	An object of class topology.
help	If TRUE, display a short help after the topology object explaining e.g. the steady state or the split compartment symbols.
...	Not used.

**Value**

Mostly called for its side effect (printing).

---

priors *Return the tibble containing the priors of a networkModel*

---

### Description

Return the tibble containing the priors of a networkModel

### Usage

```
priors(nm, fix_set_params = FALSE, quiet = FALSE)
```

### Arguments

nm                    A networkModel object.  
 fix\_set\_params    If TRUE, parameters for which a value is set are given a fixed value (i.e. their prior is equivalent to a point value).  
 quiet                Boolean to control verbosity.

### Value

A tibble giving the current priors defined for the input network model.

### Examples

```
priors(aquarium_mod)
priors(trini_mod)
```

---

project *Calculate the trajectories of a network model*

---

### Description

Calculate the trajectories of a network model

### Usage

```
project(
  nm,
  dt = NULL,
  grid_size = NULL,
  at = NULL,
  end = NULL,
  flows = "no",
  cached_ts = NULL,
  cached_ee = NULL
)
```

**Arguments**

nm	A networkModel object.
dt, grid_size	Either the time step size for trajectory calculations (dt) or the number of points for the calculation (grid_size) can be provided. If none is provided, then a default grid size of 256 steps is used.
at	Optional, vector of time values at which the trajectory must be evaluated.
end	Time value for end point. If not provided, the last observation or event is used.
flows	Return flow values? The default is "no" and no flows are calculated. Other values are "total" (total flows summed up from beginning to end timepoint), "average" (average flows per time unit, equal to total flows divided by the projection duration), and "per_dt" (detailed flow values are returned for each interval dt of the projection).
cached_ts, cached_ee	Used for optimization by other functions, not for use by the package user.

**Value**

A network model object with a "trajectory" column.

**Examples**

```
m <- aquarium_mod
m <- set_params(m, sample_params(m))
z <- project(m)
z <- project(m, flows = "per_dt")
z <- project(m, flows = "total")
z <- project(m, flows = "average")
```

---

prop\_family

*Return the distribution family for observed proportions*


---

**Description**

Return the distribution family for observed proportions

**Usage**

```
prop_family(nm)
```

**Arguments**

nm	A networkModel object.
----	------------------------

**Value**

A character string describing the distribution family used to model observed proportions

**Examples**

```
prop_family(aquarium_mod)
prop_family(trini_mod)
```

---

quick_sankey	<i>Draw a Sankey plot with basic defaults</i>
--------------	---

---

**Description**

Draw a Sankey plot with basic defaults

**Usage**

```
quick_sankey(flows, ...)
```

**Arguments**

flows	A tibble containing flows (output from <a href="#">tidy_flows</a> ). For now it should have an "average_flow" column in the tibbles of the "flows" list column.
...	Passed to <a href="#">sankey</a> .

**Value**

Mostly called for its side effect (plotting), but also returns invisible the scene object describing the Sankey plot. Note that the structure of this object is experimental and might change in the future!

---

run_mcmc	<i>Run a MCMC sampler on a network model using Stan</i>
----------	---

---

**Description**

Run a MCMC sampler on a network model using Stan

**Usage**

```
run_mcmc(model, iter = 2000, chains = 4, cores = NULL, stanfit = FALSE, ...)
```

**Arguments**

model	A networkModel.
iter	A positive integer specifying the number of iterations for each chain (including warmup). The default is 2000.
chains	A positive integer specifying the number of Markov chains. The default is 4.
cores	Number of cores to sue for parallel use. Default is NULL, which means to use the value stored in options()[["mc.cores"]] (or 1 if this value is not set).
stanfit	If TRUE, returns a 'stanfit' object instead of the more classical 'mcmc.list' object.
...	Arguments passed to 'rstan::sampling' (e.g. iter, chains).

**Value**

An object of class 'stanfit' returned by 'rstan::sampling'.

---

sample_from	<i>Generate samples from a network model</i>
-------------	--

---

**Description**

Generate samples from a network model

**Usage**

```
sample_from(
  nm,
  at,
  dt = NULL,
  grid_size = NULL,
  end = NULL,
  error.draws = 1,
  cached_ts = NULL,
  cached_ee = NULL
)
```

**Arguments**

nm	A networkModel object.
at	Vector of time values at which the samples should be taken.
dt, grid_size	Time step size or grid points, respectively.
end	Final timepoint used in the projections.
error.draws	Integer, number of draws from the error distribution for each sample (default: 1).
cached_ts, cached_ee	Used for optimization by other functions, not for use by the package user.

**Value**

A tibble containing the generated samples.

**Examples**

```
library(magrittr)
mod <- new_networkModel() %>%
  set_topo("NH4 -> algae -> daphnia -> NH4")
inits <- tibble::tribble(
  ~comps, ~sizes, ~props, ~treatment,
  "NH4", 0.2, 0.8, "light",
  "algae", 1, 0.004, "light",
  "daphnia", 2, 0.004, "light",
  "NH4", 0.5, 0.8, "dark",
  "algae", 1.2, 0.004, "dark",
  "daphnia", 1.3, 0.004, "dark")
mod <- set_init(mod, inits, comp = "comps", size = "sizes",
  prop = "props", group_by = "treatment")
mod <- add_covariates(mod, epsilon_NH4_to_algae ~ treatment)
mod <- mod %>%
  set_params(c("eta" = 0.2, "lambda_algae" = 0, "lambda_daphnia" = 0,
    "lambda_NH4" = 0, "epsilon_NH4_to_algae|light" = 0.3,
    "epsilon_NH4_to_algae|dark" = 0.1,
    "epsilon_algae_to_daphnia" = 0.13,
    "epsilon_daphnia_to_NH4" = 0.045, "zeta" = 0.1))
spl <- mod %>% sample_from(at = 1:10)
spl
```

---

sample\_from\_prior      *Sample from a prior object*

---

**Description**

Sample from a prior object

**Usage**

```
sample_from_prior(x, n = 1)
```

**Arguments**

x                    A prior object.  
n                    Integer, number of samples to draw.

**Value**

A numeric vector of length n.

**Examples**

```
sample_from_prior(constant(1))
sample_from_prior(constant(1), 10)
sample_from_prior(hcauchy(0.5), 1)
hist(sample_from_prior(hcauchy(0.5), 20))
hist(sample_from_prior(uniform(0, 3), 1000))
hist(sample_from_prior(scaled_beta(3, 7, 2), 1e4))
```

---

sample\_params

*Sample parameter values from priors*

---

**Description**

Sample parameter values from priors

**Usage**

```
sample_params(nm)
```

**Arguments**

nm                    A networkModel object.

**Value**

A named vector containing parameter values.

**Examples**

```
library(magrittr)

p <- sample_params(aquarium_mod)
p

proj <- aquarium_mod %>% set_params(p) %>% project(end = 10)
plot(proj)
```

sankey

*Draw a Sankey plot for a network and estimated flows***Description**

Draw a Sankey plot for a network and estimated flows

**Usage**

```
sankey(
  topo,
  nodes = NULL,
  flows = NULL,
  layout = NULL,
  new = TRUE,
  debug = FALSE,
  node_f = 1,
  edge_f = 1,
  node_s = "auto",
  edge_n = 32,
  cex_lab = NULL,
  cex.lab = NULL,
  fit = TRUE
)
```

**Arguments**

topo	A topology.
nodes	Optional, a tibble containing the properties of the nodes. It should have a 'comp' column with the same entries as the topology. It cannot have 'x' and 'y' entries. If it has a 'label' entry, it will replace the 'comp' values for node labels.
flows	A tibble containing the values of the flows in the topology. If NULL (the default), all flows have same width in the plot.
layout	String, node-placing algorithm to use from the ggraph package (e.g. "stress"). The ggraph package itself uses some algorithms from the igraph package. See the Details in the help of <a href="#">layout_tbl_graph_igraph</a> for available algorithms. The ggraph package must be installed for this argument to be taken into account. Currently, only the "left2right" and "stress" layout are implemented in detail, and any other layout will use rough defaults for the aesthetic adjustments. Other layouts which are kind of working are "kk", "lgl", "fr", "dh", "mds". Some of those produce non-reproducible node locations (at least I haven't managed to reproduce them even by setting the RNG seed before calling the function).
new	Boolean, create a new page for the plot?
debug	Boolean, if TRUE then draw a lot of shapes to help with debugging.
node_f, edge_f	Multiplicative factor to adjust node and edge size.



<code>node_s</code>	String defining how node size is calculated. The effect of the string also depends on the chosen layout.
<code>edge_n</code>	Integer, number of interpolation points along each edge.
<code>cex_lab, cex.lab</code>	Expansion factor for label size (both arguments are synonyms).
<code>fit</code>	Boolean, if TRUE try to fit all the graphical elements inside the canvas.

### Value

Mostly called for its side effect (plotting), but also returns invisible the scene object describing the Sankey plot. Note that the structure of this object is experimental and might change in the future!

### Examples

```
library(magrittr)

topo <- topo(trini_mod)
sankey(topo, debug = TRUE)
sankey(topo, layout = "stress")
sankey(topo(aquarium_mod), layout = "stress", edge_f = 0.5)

m <- new_networkModel() %>%
  set_topo(c("subs -> NH3 -> subs",
            "NH3 -> Q, E", "E -> Q -> E",
            "E -> D, M")) %>%
  set_steady("subs") %>%
  set_prop_family("normal_sd")
ggtopo(m)
sankey(topo(m), layout = "stress")

# Debug visualization

## Helper functions
flows_from_topo <- function(x) {
  x <- unclass(x) # Remove the "topo" class to treat it as a matrix
  n_comps <- ncol(x)
  links <- which(x > 0)
  from <- links %% n_comps + 1
  to <- links %% n_comps
  links <- tibble::tibble(from = from, to = to)
  for (i in seq_len(nrow(links))) {
    if (links$to[i] == 0) {
      links$from[i] <- links$from[i] - 1
      links$to[i] <- n_comps
    }
    stopifnot(x[links$to[i], links$from[i]] > 0)
  }
  flows <- tibble::tibble(from = colnames(x)[links$from],
                        to = rownames(x)[links$to])
  return(flows)
}
```

```

nodes_from_topo <- function(x) {
  nodes <- tibble::tibble(comp = colnames(x),
                          label = colnames(x))
  return(nodes)
}

t <- topo(trini_mod)
nodes <- nodes_from_topo(t)
nodes$label <- as.list(nodes$label)
nodes$label[[2]] <- latex2exp::TeX("$\\beta$")
nodes$size <- runif(nrow(nodes), 1, 2)
flows <- flows_from_topo(t)
flows$width <- runif(nrow(flows), 0.2, 2)
z <- sankey(t, nodes = nodes, flows = flows, layout = "left2right",
           debug = TRUE, node_f = 1, edge_f = 0.9, edge_n = 32,
           cex_lab = 1.5)

# Stress layout
y <- new_networkModel() %>%
  set_topo(c("subs -> NH3 -> subs",
            "NH3 -> Q, E", "E -> Q -> E",
            "E -> D, M")) %>%
  set_steady("subs") %>%
  set_prop_family("normal_sd")
y <- topo(y)
nodes <- nodes_from_topo(y)
nodes$size <- runif(nrow(nodes), 1, 10)
ggtopo(y, edge = "fan")
flows <- flows_from_topo(y)
flows$width <- runif(nrow(flows), 0.2, 5)
z <- sankey(y, nodes = nodes, flows = flows, debug = FALSE, edge_n = 32,
           edge_f = 0.4, node_s = "prop")

# Another example
r <- new_networkModel() %>%
  set_topo("infusion -> plasma -> body -> plasma") %>%
  set_steady(c("infusion", "body"))
r <- topo(r)
ggtopo(r, edge = "fan")
sankey(r, debug = TRUE, edge_f = 0.2)

```

---

scaled\_beta

*Define a beta prior (on [0;scale])*


---

### Description

If a random variable  $X$  follows a scaled beta distribution with parameters (alpha, beta, scale), then  $X/\text{scale}$  follows a beta distribution with parameters (alpha, beta).

**Usage**

```
scaled_beta(alpha, beta, scale = 1)
```

**Arguments**

alpha	Alpha parameter of the unscaled beta distribution.
beta	Beta parameter of the unscaled beta distribution.
scale	The upper boundary of the prior.

**Value**

A list defining the prior.

**Examples**

```
scaled_beta(0.8, 20, scale = 10)
```

---

select.mcmc.list	<i>Select parameters based on their names</i>
------------------	---

---

**Description**

Select parameters based on their names

**Usage**

```
## S3 method for class 'mcmc.list'  
select(.data, ...)
```

**Arguments**

.data	A coda::mcmc.list object.
...	Strings used to select variables using pattern matching with grepl.

**Value**

An mcmc.list object, with the same extra class(es) as .data (if any).

---

set_half_life	<i>Set the half-life for radioactive tracers</i>
---------------	--

---

### Description

Indicating a non-zero value for half-life will add a decay to the marked portion of the tracer element. The decay constant is calculated from the half-life value as:

### Usage

```
set_half_life(nm, hl, quiet = FALSE)
```

### Arguments

nm	A networkModel object.
hl	Half-life value, in the same time unit as the observations are (or will be) given. Setting half-life to zero is equivalent to using a stable isotope (no decay used in the model).
quiet	Boolean for verbosity.

### Details

$$\lambda_{\text{decay}} = \log(2) / \text{half\_life}$$

Note that for correct calculations the half-life value should be given in the same time unit (e.g. hour, day) that the time unit used for observations.

### Value

A networkModel object.

### Examples

```
library(magrittr)
x <- new_networkModel() %>%
  set_topo("32P -> root -> leaf") %>%
  set_half_life(hl = 14.268)
x
```

---

set_init	<i>Set initial conditions in a network model</i>
----------	--

---

**Description**

Set initial conditions in a network model

**Usage**

```
set_init(nm, data, comp, size, prop, group_by = NULL)
```

**Arguments**

nm	A networkModel object (e.g. output from <a href="#">new_networkModel</a> )
data	A tibble containing the initial conditions
comp	String, name of the data column with the compartment names
size	String, name of the data column with the compartment sizes
prop	String, name of the data column with the compartment proportions of marked tracer
group_by	Optional vector of string giving the names of the columns to use for grouping the data into replicates

**Value**

A networkModel object.

---

set_obs	<i>Set observations in a network model</i>
---------	--

---

**Description**

Set observations in a network model

**Usage**

```
set_obs(nm, data, comp, size, prop, time, group_by)
```

**Arguments**

nm	A networkModel object (e.g. output from <a href="#">new_networkModel</a> )
data	A tibble containing the observations. If NULL, remove observations from the model.
comp	String, name of the data column with the compartment names
size	String, name of the data column with the compartment sizes
prop	String, name of the data column with the compartment proportions of heavy tracer
time	String, name of the data column with the sampling times
group_by	Optional vector of string giving the names of the columns to use for grouping the data into replicates

**Value**

A networkModel object.

---

set\_params

*Set the parameters in a network model*

---

**Description**

Set the parameters in a network model

**Usage**

```
set_params(nm, params, force = TRUE, quick = FALSE)
```

**Arguments**

nm	A networkModel object.
params	A named vector or a tibble with columns c("parameter", "value") containing the (global) parameter values.
force	Boolean, if FALSE will not overwrite already set parameters.
quick	Boolean, if TRUE take some shortcuts for faster parameter settings when called by another function. This should usually be left to the default (FALSE) by a regular package user.

**Value**

A networkModel object.

**Examples**

```
m <- aquarium_mod
p <- sample_params(m)
m2 <- set_params(m, p)
m2$parameters
```

---

set_prior	<i>Set prior(s) for a network model</i>
-----------	---

---

**Description**

Set prior(s) for a network model

**Usage**

```
set_prior(x, prior, param, use_regexp = TRUE, quiet = FALSE)
```

**Arguments**

x	A networkModel object.
prior	A prior built with e.g. uniform() or hcauchy().
param	String, target parameter or regexp to target several parameters
use_regexp	Boolean, if TRUE (the default) then param is used as a regular expression to match one or several parameter names.
quiet	Boolean, if FALSE print a message indicating which parameters had their prior modified.

**Value**

A networkModel object.

---

set_prop_family	<i>Set the distribution family for observed proportions</i>
-----------------	---

---

**Description**

Set the distribution family for observed proportions

**Usage**

```
set_prop_family(nm, family, quiet = FALSE)
```

**Arguments**

nm	A networkModel object (output from <a href="#">new_networkModel</a> ).
family	Allowed values are "gamma_cv", "beta_phi", "normal_cv", and "normal_sd".
quiet	Boolean, if FALSE print a message indicating which distribution family is used for proportions.

**Value**

A networkModel object.

**Examples**

```
library(magrittr)

m <- new_networkModel() %>%
  set_topo(links = "NH4, NO3 -> epi -> pseph, tricor")
m <- m %>% set_prop_family("beta_phi")
m
attr(m, "prop_family")
```

---

set\_size\_family      *Set the distribution family for observed sizes*

---

**Description**

Set the distribution family for observed sizes

**Usage**

```
set_size_family(nm, family, by_compartment, quiet = FALSE, quiet_reset = FALSE)
```

**Arguments**

nm	A networkModel object (output from <a href="#">new_networkModel</a> ).
family	Allowed values are "normal_cv" and "normal_sd".
by_compartment	Boolean, if TRUE then zeta is compartment-specific.
quiet	Boolean, if FALSE print a message indicating which distribution family is used for proportions.
quiet_reset	Boolean, write a message when model parameters (and covariates and priors) are reset?

**Value**

A networkModel object.



**Examples**

```
library(magrittr)

m <- new_networkModel() %>%
  set_topo(links = "NH4, NO3 -> epi -> pseph, tricor")
m <- m %>% set_size_family("normal_sd")
m
attr(m, "size_family")

m <- m %>% set_size_family(by_compartment = TRUE)
attr(m, "size_zeta_per_compartment")
```

---

**set\_split***Flag some network compartments as being split compartments*

---

**Description**

Flag some network compartments as being split compartments

**Usage**

```
set_split(nm, comps = NULL, which = NULL)
```

**Arguments**

nm	A networkModel object.
comps	Vector of strings, the names of the compartments to set split.
which	Vector of integers giving the nm rows to update. Default is to update all rows.

**Value**

A networkModel object.

**Examples**

```
library(magrittr)
x <- new_networkModel() %>%
  set_topo("NH4 -> algae -> daphnia") %>%
  set_split("algae")
topo(x)
```

---

set_steady	<i>Flag some network compartments as being in a steady state</i>
------------	--

---

**Description**

Flag some network compartments as being in a steady state

**Usage**

```
set_steady(nm, comps = NULL, which = NULL)
```

**Arguments**

nm	A networkModel object.
comps	Vector of strings, names of the compartments to set steady.
which	Vector of integers giving the nm rows to update. Default is to update all rows.

**Value**

A networkModel object.

**Examples**

```
library(magrittr)
x <- new_networkModel() %>%
  set_topo("NH4 -> algae -> daphnia") %>%
  set_steady("NH4")
topo(x)
```

---

set_topo	<i>Set the topology in a network model.</i>
----------	---

---

**Description**

Set the topology in a network model.

**Usage**

```
set_topo(nm, ..., from = NULL, to = NULL)
```

**Arguments**

nm	A networkModel object (output from <code>new_networkModel</code> ).
...	One or more strings describing the links defining the network topology. Optionally, links can be given as a data frame. See the examples for more details about acceptable input formats.
from	Optional, string containing the column name for sources if links are provided as a data frame.
to	Optional, string containing the column name for destinations if links are provided as a data frame.

**Value**

A networkModel object.

**Examples**

```
library(magrittr)

# A single string can describe several links in one go.
m <- new_networkModel() %>%
  set_topo("NH4, N03 -> epi -> pseph, tricor")
m
topo(m)

# Several strings can be given as distinct arguments.
m2 <- new_networkModel() %>%
  set_topo("NH4, N03 -> epi -> pseph, tricor",
           "NH4 -> FBOM, CBOM", "CBOM <- N03")
m2
topo(m2)

# Multiple strings can be also be combined into a single argument with `c()`.
links <- c("NH4, N03 -> epi -> pseph, tricor", "NH4 -> FBOM, CBOM",
           "CBOM <- N03")
m3 <- new_networkModel() %>%
  set_topo(links)
m3
topo(m3)

# A data frame can be used to specify the links.
links <- data.frame(source = c("NH4", "N03", "epi"),
                   consumer = c("epi", "epi", "petro"))
links
m4 <- new_networkModel() %>%
  set_topo(links, from = "source", to = "consumer")
m4
m4$topology[[1]]
```

---

tidy_data	<i>Extract data from a networkModel object into a tidy tibble.</i>
-----------	--

---

**Description**

Extract data from a networkModel object into a tidy tibble.

**Usage**

```
tidy_data(x)
```

**Arguments**

x                    A networkModel object.

**Value**

A tibble (note: row ordering is not the same as in the input).

**Examples**

```
tidy_data(aquarium_mod)
tidy_data(trini_mod)
```

---

tidy_dpp	<i>Prepare tidy data and posterior predictions</i>
----------	--

---

**Description**

This function prepares both tidy data from a model and tidy posterior predictions from a model fit. Having those two tibbles prepared at the same time allows to merge them to ensure that observed data, predicted data and original variables other than observations are all in sync when using y and y\_rep objects for bayesplot functions.

**Usage**

```
tidy_dpp(model, fit, draw = NULL, cores = NULL)
```

**Arguments**

model                A networkModel object.  
fit                    A networkModelStanfit object.  
draw                  Integer, number of draws to sample from the posterior.  
cores                 Number of cores to use for parallel calculations. Default is NULL, which means to use the value stored in options()[["mc.cores"]] (or 1 if this value is not set).

**Value**

A list with y, y\_rep and vars.

---

tidy_flows	<i>Build a tidy table with the flows for each iteration</i>
------------	---

---

**Description**

If neither n\_per\_chain and n are provided, all iterations are used.

**Usage**

```
tidy_flows(
  nm,
  mcmc,
  n_per_chain = NULL,
  n = NULL,
  n_grid = 64,
  steady_state = FALSE,
  dt = NULL,
  grid_size = NULL,
  at = NULL,
  end = NULL,
  use_cache = TRUE,
  cores = NULL
)
```

**Arguments**

nm	A networkModel object.
mcmc	The corresponding output from run_mcmc.
n_per_chain	Integer, number of iterations randomly drawn per chain. Note that iterations are in sync across chains (in practice, random iterations are chosen, and then parameter values extracted for those same iterations from all chains).
n	Integer, number of iterations randomly drawn from mcmc. Note that iterations are <i>not</i> drawn in sync across chains in this case (use n_per_chain if you need to have the same iterations taken across all chains).
n_grid	Size of the time grid used to calculate trajectories
steady_state	Boolean (default: FALSE). If TRUE, then steady state compartment sizes are calculated for each iteration and steady state flows are calculated from those compartment sizes.
dt, grid_size	Time step size or grid points, respectively.
at	Timepoints at which the predictions should be returned.
end	Final timepoint used in the projections.

use_cache	Boolean, use cache for faster calculations?
cores	Number of cores to use for parallel calculations. Default is NULL, which means to use the value stored in options()[["mc.cores"]] (or 1 if this value is not set).

### Details

Warning: This function is still maturing and its interface and output might change in the future.

### Value

A tidy table containing the mcmc iterations (chain, iteration, parameters), the grouping variables from the network model and the flows. The returned flow values are the average flow per unit of time over the trajectory calculations (or steady state flows if steady\_state is TRUE).

### Examples

```
tf <- tidy_flows(aquarium_mod, aquarium_run, n_per_chain = 25, cores = 2)
tf
tfmcmc <- as.mcmc.list(tf)
plot(tfmcmc)
```

---

tidy\_mcmc

*Extract a tidy output from an mcmc.list*

---

### Description

Extract a tidy output from an mcmc.list

### Usage

```
tidy_mcmc(x, spread = FALSE, include_constant = TRUE)
```

### Arguments

x	An mcmc.list object
spread	Boolean, spread the parameters into separate columns?
include_constant	Boolean, include constant parameters as proper parameter traces?

### Value

A tidy table containing one iteration per row

## Examples

```
fit <- lapply(1:4, function(i) {  
  z <- matrix(rnorm(200), ncol = 2)  
  colnames(z) <- c("alpha", "beta")  
  coda::as.mcmc(z)  
})  
fit <- coda::as.mcmc.list(fit)  
tidy_mcmc(fit)  
tidy_mcmc(fit, spread = TRUE)
```

---

tidy\_posterior\_predict

*Draw from the posterior predictive distribution of the model outcome*

---

## Description

Draw from the posterior predictive distribution of the model outcome

## Usage

```
tidy_posterior_predict(object, newdata, draw = NULL, cores = NULL, ...)
```

## Arguments

object	A networkModelStanfit object.
newdata	The original model used to fit the networkStanfit object.
draw	Integer, number of draws to sample from the posterior. Default is 100.
cores	Number of cores to use for parallel calculations. Default is NULL, which means to use the value stored in options()[["mc.cores"]] (or 1 if this value is not set).
...	Not used for now.

## Value

A tidy table.

---

tidy\_steady\_states      *Build a tidy table with the calculated steady states for each iteration*

---

### Description

If neither `n_per_chain` and `n` are provided, all iterations are used.

### Usage

```
tidy_steady_states(nm, mcmc, n_per_chain = NULL, n = NULL)
```

### Arguments

<code>nm</code>	A <code>networkModel</code> object.
<code>mcmc</code>	The corresponding output from <code>run_mcmc</code> .
<code>n_per_chain</code>	Integer, number of iterations randomly drawn per chain. Note that iterations are in sync across chains (in practice, random iterations are chosen, and then parameter values extracted for those same iterations from all chains).
<code>n</code>	Integer, number of iterations randomly drawn from <code>mcmc</code> . Note that iterations are <i>not</i> drawn in sync across chains in this case (use <code>n_per_chain</code> if you need to have the same iterations taken across all chains).

### Value

A tidy table containing the `mcmc` iterations (chain, iteration, parameters), the grouping variables from the network model and the steady state sizes.

---

tidy\_trajectories      *Build a tidy table with the trajectories for each iteration*

---

### Description

If neither `n_per_chain` and `n` are provided, all iterations are used.

### Usage

```
tidy_trajectories(
  nm,
  mcmc,
  n_per_chain = NULL,
  n = NULL,
  n_grid = 64,
  dt = NULL,
  grid_size = NULL,
  at = NULL,
```



```

    end = NULL,
    use_cache = TRUE,
    cores = NULL
  )

```

### Arguments

nm	A networkModel object.
mcmc	The corresponding output from run_mcmc.
n_per_chain	Integer, number of iterations randomly drawn per chain. Note that iterations are in sync across chains (in practice, random iterations are chosen, and then parameter values extracted for those same iterations from all chains).
n	Integer, number of iterations randomly drawn from mcmc. Note that iterations are <i>not</i> drawn in sync across chains in this case (use n_per_chain if you need to have the same iterations taken across all chains).
n_grid	Size of the time grid used to calculate trajectories
dt, grid_size	Time step size or grid points, respectively.
at	Timepoints at which the predictions should be returned.
end	Final timepoint used in the projections.
use_cache	Boolean, use cache for faster calculations?
cores	Number of cores to use for parallel calculations. Default is NULL, which means to use the value stored in options()[["mc.cores"]] (or 1 if this value is not set).

### Details

Warning: This function is still maturing and its interface and output might change in the future.

### Value

A tidy table containing the mcmc iterations (chain, iteration, parameters), the grouping variables from the network model and the trajectories.

### Examples

```

tt <- tidy_trajectories(aquarium_mod, aquarium_run, n = 10, cores = 2)
tt

```

---

topo	<i>Return the list of topologies, or a unique topology if all identical</i>
------	---

---

**Description**

Return the list of topologies, or a unique topology if all identical

**Usage**

```
topo(nm, simplify = TRUE)
```

**Arguments**

nm	A networkModel object.
simplify	Boolean, return only a unique topology if all topologies are identical or if there is only one? Default is TRUE.

**Value**

A list of the networkModel topologies or, if all topologies are identical (or if there is only one) and simplify is TRUE, a single topology (not wrapped into a single-element list).

---

traceplot	<i>Plot mcmc.list objects</i>
-----------	-------------------------------

---

**Description**

Plot mcmc.list objects

**Usage**

```
traceplot(x, ...)
```

**Arguments**

x	A coda::mcmc.list object.
...	Passed to plot_traces.

**Value**

Called for side effect (plotting).

---

trini_mod	<i>Network model for nitrogen fluxes in Trinidadian streams (Collins et al. 2016)</i>
-----------	---

---

## Description

This model is used in the package case study about Trinidadian streams and is based on an original dataset taken from Collins et al. (2016).

## Usage

```
trini_mod
```

## Format

An object of class `networkModel` (inherits from `tbl_df`, `tbl`, `data.frame`) with 6 rows and 6 columns.

## Details

The model is complete, with topology, initial conditions, observations, covariates and priors.

It is ready for an MCMC run as shown in the example. Note that it might be a good idea to relax the priors for uptake rates from seston to *Leptonema* (e.g. using `hcauchy(10)`), seston being a compartment that is flowing with the stream water and that can be replenished from upstream.

## Source

This network model contains data from the original article: Collins, Sarah M., Steven A. Thomas, Thomas Heatherly, Keeley L. MacNeill, Antoine O.H.C. Leduc, Andrés López-Sepulcre, Bradley A. Lamphere, et al. 2016. “Fish Introductions and Light Modulate Food Web Fluxes in Tropical Streams: A Whole-Ecosystem Experimental Approach.” *Ecology*, <doi:10.1002/ecy.1530>.

This dataset was also used in the paper: López-Sepulcre, Andrés, Matthieu Bruneaux, Sarah M. Collins, Rana El-Sabaawi, Alexander S. Flecker, and Steven A. Thomas. 2020. “A New Method to Reconstruct Quantitative Food Webs and Nutrient Flows from Isotope Tracer Addition Experiments.” *The American Naturalist* 195 (6): 964–85. <doi:10.1086/708546>.

## Examples

```
trini_mod
ggtopo(trini_mod)

## Not run:
# Warning: the run below can take quite a long time!
# (about 15 min with 4 cores at 3.3 Ghz).
run <- run_mcmc(trini_mod, iter = 500, chains = 4, cores = 4)

## End(Not run)
```

---

type_sum.prior	<i>Function used for displaying prior object in tibbles</i>
----------------	---

---

**Description**

Function used for displaying prior object in tibbles

**Usage**

```
## S3 method for class 'prior'  
type_sum(x)
```

**Arguments**

x                    An object of class prior.

**Value**

Input formatted with `format(x)`.

---

uniform	<i>Define a uniform prior</i>
---------	-------------------------------

---

**Description**

Define a uniform prior

**Usage**

```
uniform(min, max)
```

**Arguments**

min, max            Minimum and maximum boundaries for the uniform prior.

**Value**

A list defining the prior.

**Examples**

```
uniform(min = 0, max= 1)
```

---

[.networkModelStanfit *Subset method for networkModelStanfit objects*

---

### **Description**

Subset method for networkModelStanfit objects

### **Usage**

```
## S3 method for class 'networkModelStanfit'  
x[i, j, drop = TRUE]
```

### **Arguments**

x	A networkModelStanfit object.
i	A vector of iteration indices.
j	A vector of parameter names or indices.
drop	Boolean.

### **Value**

A networkModelStanfit object.

# Index

- \* **datasets**
  - aquarium\_mod, 6
  - aquarium\_run, 7
  - eelgrass, 14
  - li2017, 22
  - trini\_mod, 59
- [.networkModelStanfit, 61
  
- add\_covariates, 4
- add\_pulse\_event, 5
- aquarium\_mod, 6, 7
- aquarium\_run, 6, 7
- as.mcmc.list.tidy\_flows, 7
- as.mcmc.list.tidy\_steady\_states, 8
- as\_tbl\_graph, 9
- as\_tbl\_graph.topology, 9
  
- c.mcmc.list, 10
- calculate\_steady\_state, 10
- comps, 11
- constant, 12
  
- delta2prop, 12
- dic, 13
  
- eelgrass, 14
  
- filter, 16
- filter.ppcNetworkModel, 16
- filter\_by\_group, 17
- format.prior, 17
  
- ggflows, 18
- ggtopo, 19
- ggtopo.networkModel, 19
- ggtopo.topology, 20
- groups.networkModel, 21
  
- hcauchy, 21
- heatmap, 24
  
- isotracer (isotracer-package), 4
- isotracer-package, 4
  
- layout\_tbl\_graph\_igraph, 40
- li2017, 22
- li2017\_counts (li2017), 22
- li2017\_prots (li2017), 22
  
- Math.mcmc.list, 23
- mcmc.list, 23, 26
- mcmc\_heatmap, 24
  
- new\_networkModel, 24, 45, 46, 48, 51
- normal, 25
  
- obj\_sum.prior, 25
- Ops.mcmc.list, 26
- Ops.prior, 27
- Ops.topology, 27
  
- params, 28
- pillar\_shaft.prior, 29
- plot.networkModel, 29
- plot.ready\_for\_unit\_plot, 30
- posterior\_predict, 30
- posterior\_predict.networkModelStanfit, 31
- predict.networkModel, 31
- print.networkModel, 32
- print.prior, 33
- print.topology, 33
- priors, 34
- project, 34
- prop\_family, 35
  
- quick\_sankey, 36
  
- run\_mcmc, 6, 14, 36
  
- sample\_from, 37
- sample\_from\_prior, 38

sample\_params, 39  
sankey, 36, 40  
scaled\_beta, 42  
select.mcmc.list, 43  
set\_half\_life, 44  
set\_init, 45  
set\_obs, 45  
set\_params, 46  
set\_prior, 47  
set\_prop\_family, 47  
set\_size\_family, 48  
set\_split, 49  
set\_steady, 50  
set\_topo, 50  
  
tidy\_data, 52  
tidy\_dpp, 52  
tidy\_flows, 8, 36, 53  
tidy\_mcmc, 54  
tidy\_posterior\_predict, 55  
tidy\_steady\_states, 8, 56  
tidy\_trajectories, 56  
topo, 58  
traceplot, 58  
trini\_mod, 59  
type\_sum.prior, 60  
  
uniform, 60