

# Package ‘vpc’

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**Title** Create Visual Predictive Checks

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**Description** Visual predictive checks are a commonly used diagnostic plot in pharmacometrics, showing how certain statistics (percentiles) for observed data compare to those same statistics for data simulated from a model. The package can generate VPCs for continuous, categorical, censored, and (repeated) time-to-event data.

**Depends** R (>= 3.1.0)

**Imports** classInt, dplyr, MASS, survival, ggplot2, readr, stringr, tidyr

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**LazyData** true

**URL** <https://github.com/ronkeizer/vpc>

**Suggests** knitr, testit

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---

vpc-package

*VPC package*


---

### Description

Create Visual Predictive Checks in R

### Author(s)

Ron Keizer <ronkeizer@gmail.com>

---

add\_noise *Add noise / residual error to data*

---

### Description

Add noise / residual error to data

### Usage

```
add_noise(x, ruv = list(proportional = 0, additive = 0, exponential = 0))
```

### Arguments

x	data
ruv	list describing the magnitude of errors. List arguments: "proportional", "additive", "exponential".

### Examples

```
library(dplyr)
ipred <- c(10, 8, 6, 4, 2, 0) %>% add_noise(ruv = list(proportional = 0.1, additive = 0.2))
```

---

add\_sim\_index\_number *Add sim index number*

---

### Description

Add simulation index number to simulation when not present

### Usage

```
add_sim_index_number(sim, id = "id", sim_label = "sim")
```

### Arguments

sim	a data.frame containing the simulation data
id	character specifying the column name in the data.frame
sim_label	label to indicate simulation index (if available)

---

add_stratification	<i>Adds stratification to data set</i>
--------------------	--

---

**Description**

Adds stratification to data set

**Usage**

```
add_stratification(dat, strat, verbose = FALSE)
```

**Arguments**

dat	data.frame
strat	vector of stratification variables
verbose	verbosity ('TRUE' or 'FALSE')

---

auto_bin	<i>Calculate appropriate bin separators for vpc</i>
----------	---

---

**Description**

This function calculates bin separators either using R's native binning approaches available in the classInt library such as 'kmeans', 'jenks', 'pretty' etc. Alternatively, a custom approach is available which is based on finding the nadirs in the density functions for the independent variable. Default approach is k-means clustering.

**Usage**

```
auto_bin(dat, type = "kmeans", n_bins = 8, verbose = FALSE, ...)
```

```
## S3 method for class 'numeric'
```

```
auto_bin(dat, type = "kmeans", n_bins = 8, verbose = FALSE, ...)
```

```
## S3 method for class 'data.frame'
```

```
auto_bin(dat, type = "kmeans", n_bins = 8, verbose = FALSE, ...)
```

**Arguments**

dat	data frame
type	auto-binning type: "density", "time", or "data"
n_bins	number of bins to use; either a positive integer or "auto". For "density" the function might not return a solution with the exact number of bins.
verbose	show warnings and other messages (TRUE or FALSE)
...	arguments passed on to underlying binning functions

**Value**

A vector of bin separators

---

bin_data	<i>Function to bin data based on a vector of bin separators, e.g. for use in VPC</i>
----------	--

---

**Description**

Function to bin data based on a vector of bin separators, e.g. for use in VPC

**Usage**

```
bin_data(x, bins = c(0, 3, 5, 7), idv = "time", labeled = F)
```

**Arguments**

x	data
bins	numeric vector specifying bin separators
idv	variable in the data specifies the independent variable (e.g. "time")
labeled	whether a labeled factor instead of integers should be returned

---

check_stratification_columns_available	<i>Check whether stratification columns are available</i>
--	---

---

**Description**

Check whether stratification columns are available

**Usage**

```
check_stratification_columns_available(data, stratify, type = "observation")
```

**Arguments**

data	'data.frame' with observation or simulation data
stratify	vector of stratification columns
type	either 'observation' or 'simulation'

---

compute_kaplan	<i>Compute Kaplan-Meier statistics</i>
----------------	--

---

**Description**

Compute Kaplan-Meier statistics

**Usage**

```
compute_kaplan(
  dat,
  strat = "strat",
  reverse_prob = FALSE,
  rtte_conditional = TRUE,
  ci = NULL
)
```

**Arguments**

dat	data.frame with events
strat	vector of stratification variables
reverse_prob	reverse the probability (i.e. return '1-probability')?
rtte_conditional	'TRUE' (default) or 'FALSE'. Compute the probability for each event newly ('TRUE'), or calculate the absolute probability ('FALSE', i.e. the "probability of a 1st, 2nd, 3rd event etc" rather than the "probability of an event happening").
ci	confidence interval to calculate, numeric vector of length 2

---

compute_kmmc	<i>Compute KMMC statistics</i>
--------------	--------------------------------

---

**Description**

Kaplan-Meier Mean Covariate plots are a simulation-based diagnostic to study the influence of covariates and identify potential model misspecification.

**Usage**

```
compute_kmmc(dat, strat = NULL, reverse_prob = FALSE, kmmc = "DOSE")
```

**Arguments**

dat	data.frame with events
strat	vector of stratification variables
reverse_prob	reverse the probability (i.e. return '1-probability')?
kmmc	variable to create the KMMC plot for.

---

create_vpc_theme	<i>Create new vpc theme</i>
------------------	-----------------------------

---

**Description**

Create new vpc theme

**Usage**

```
create_vpc_theme(...)
```

**Arguments**

... pass arguments to 'new\_vpc\_theme'

---

define_data_columns	<i>Define data column defaults for various softwares</i>
---------------------	--

---

**Description**

Define data column defaults for various softwares

**Usage**

```
define_data_columns(sim, obs, sim_cols, obs_cols, software_type)
```

**Arguments**

sim	simulated data
obs	observed data
sim_cols	list for mapping simulation data columns, e.g. 'list(dv = "DV", id = "ID", idv = "TIME", pred="PRED)'
obs_cols	list for mapping observation data columns, e.g. 'list(dv = "DV", id = "ID", idv = "TIME", pred="PRED)'
software_type	software type, one of 'nonmem', 'phoenix', 'PKPDsim'

---

draw_params_mvr	<i>Draw parameters from multivariate distribution</i>
-----------------	---

---

**Description**

Draw parameters from multivariate distribution

**Usage**

```
draw_params_mvr(ids, n_sim, theta, omega_mat, par_names = NULL)
```

**Arguments**

ids	vector of id numbers
n_sim	number of simulations
theta	theta vector
omega_mat	omega matrix
par_names	parameter names vector

---

loq_perc	<i>Calculate percentiles below / above lloq / uloq</i>
----------	--

---

**Description**

Calculate percentiles below / above lloq / uloq

**Usage**

```
loq_perc(x, limit = 1, cens = "left")
```

**Arguments**

x	data
limit	censoring limit
cens	censoring direction (left/right)



---

new_vpc_theme	<i>Create a customized VPC theme</i>
---------------	--------------------------------------

---

## Description

Create a customized VPC theme

## Usage

```
new_vpc_theme(update = NULL)
```

## Arguments

`update` list containing the plot elements to be updated. Run 'new\_vpc\_theme()' with no arguments to show an overview of available plot elements.

## Details

This function creates a theme that customizes how the VPC looks, i.e. colors, fills, transparencies, linetypes and sizes, etc. The following arguments can be specified in the input list:

- `obs_color`: color for observations points
- `obs_size`: size for observation points
- `obs_median_color`: color for median observation line
- `obs_median_linetype`: linetype for median observation line
- `obs_median_size`: size for median observation line
- `obs_ci_fill`: color for observation CI fill
- `obs_ci_color`: color for observation CI lines
- `obs_ci_linetype`: linetype for observation CI lines
- `obs_ci_size`: size for observations CI lines
- `sim_pi_fill`: fill color for simulated prediction interval areas
- `sim_pi_alpha`: transparency for simulated prediction interval areas
- `sim_pi_color`: color for simulated prediction interval lines
- `sim_pi_linetype`: linetype for simulated prediction interval lines
- `sim_pi_size`: size for simulated prediction interval lines
- `sim_median_fill`: fill color for simulated median area
- `sim_median_alpha`: transparency for simulated median area
- `sim_median_color`: color for simulated median line
- `sim_median_linetype`: linetype for simulated median line
- `sim_median_size`: size for simulated median line
- `bin_separators_color`: color for bin separator lines, NA for don't plot
- `bin_separators_location`: where to plot bin separators ("t" for top, "b" for bottom)
- `loq_color`: color of line showing limit of quantification

**Value**

A list with vpc theme specifiers

**Examples**

```
theme1 <- new_vpc_theme(update = list(
  obs_color = "red",
  obs_ci_color = "#aa0000",
  obs_alpha = .3,
  sim_pi_fill = "#cc8833",
  sim_pi_size = 2
))
vpc(simple_data$sim, simple_data$obs, vpc_theme = theme1)
```

---

pk\_iv\_1cmt

*Simulate PK data from a 1-compartment iv model*

---

**Description**

Simulate PK data from a 1-compartment iv model

**Usage**

```
pk_iv_1cmt(
  t,
  t_inf = 1,
  tau = 24,
  dose = 120,
  CL = 0.345,
  Vc = 1.75,
  ruv = NULL
)
```

**Arguments**

t	Time after dose
t_inf	Infusion length
tau	Dosing interval
dose	Dose
CL	Clearance
Vc	Volume of distribution
ruv	Residual variability

**Value**

A vector of predicted values, with or without added residual variability

**Examples**

```
dat1 <- vpc::pk_iv_1cmt(t = c(0:72), tau = 24, dose = 120,  
                      CL = 5, Vc = 50)  
dat2 <- vpc::pk_iv_1cmt(t = c(0:72), tau = 24, dose = 120,  
                      CL = 5, Vc = 50,  
                      ruv = list(proportional = 0.1, additive = 0.1))
```

---

pk\_oral\_1cmt

*Simulate PK data from a 1-compartment oral model*

---

**Description**

Simulate PK data from a 1-compartment oral model

**Usage**

```
pk_oral_1cmt(t, tau = 24, dose = 120, ka = 1, ke = 1, cl = 10, ruv = NULL)
```

**Arguments**

t	Time after dose
tau	Dosing interval
dose	Dose
ka	Absorption rate
ke	Elimination rate
cl	Clearance
ruv	Residual variability

**Value**

A vector of predicted values, with or without added residual variability

**Examples**

```
dat1 <- vpc::pk_oral_1cmt(t = c(0:72), tau = 24, dose = 120,  
                        ka = 1, ke = 1, cl = 10)  
dat2 <- vpc::pk_oral_1cmt(t = c(0:72), tau = 24, dose = 120,  
                        ka = 1, ke = 1, cl = 10,  
                        ruv = list(proportional = 0.1, additive = 0.1))
```

---

plot\_vpc                      *VPC plotting function*

---

### Description

This function performs no parsing of data, it just plots the already calculated statistics generated using one of the 'vpc' functions.

### Usage

```
plot_vpc(
  db,
  show = NULL,
  vpc_theme = NULL,
  smooth = TRUE,
  log_x = FALSE,
  log_y = FALSE,
  xlab = NULL,
  ylab = NULL,
  title = NULL,
  verbose = FALSE
)
```

### Arguments

db	object created using the 'vpc' function
show	what to show in VPC (obs_dv, obs_ci, pi, pi_as_area, pi_ci, obs_median, sim_median, sim_median_ci)
vpc_theme	theme to be used in VPC. Expects list of class vpc_theme created with function vpc_theme()
smooth	"smooth" the VPC (connect bin midpoints) or show bins as rectangular boxes. Default is TRUE.
log_x	Boolean indicting whether x-axis should be shown as logarithmic. Default is FALSE.
log_y	Boolean indicting whether y-axis should be shown as logarithmic. Default is FALSE.
xlab	label for x axis
ylab	label for y axis
title	title
verbose	verbosity (T/F)

### See Also

[sim\\_data](#), [vpc\\_cens](#), [vpc\\_tte](#), [vpc\\_cat](#)

**Examples**

```
## See vpc.ronkeizer.com for more documentation and examples

library(vpc)
vpc_db <- vpc(sim = simple_data$sim, obs = simple_data$obs, vpcdb = TRUE)
plot_vpc(vpc_db, title = "My new vpc", x = "Custom x label")
```

---

quantile_cens	<i>Calculate quantiles respecting the censored data</i>
---------------	---

---

**Description**

Calculate quantiles respecting the censored data

**Usage**

```
quantile_cens(x, p = 0.5, limit = 1, cens = "left")
```

**Arguments**

x	data
p	quantile
limit	censoring limit
cens	censoring direction (left/right)

---

read_table_nm	<i>NONMEM output table import function</i>
---------------	--

---

**Description**

Quickly import NONMEM output tables into R. Function taken from ‘modelviz’ package by Benjamin Guiastrennec. When both skip and header are NULL, read\_nmstab will automatically detect the optimal settings to import the tables. When more than one files are provided for a same NONMEM run, they will be combined into a single data.frame.

**Usage**

```
read_table_nm(
  file = NULL,
  skip = NULL,
  header = NULL,
  rm_duplicates = FALSE,
  nonmem_tab = TRUE
)
```

**Arguments**

file	full file name
skip	number of lines to skip before reading data
header	logical value indicating whether the file contains the names of the variables as its first line
rm_duplicates	logical value indicating whether duplicated columns should be removed
nonmem_tab	logical value indicating to the function whether the file is a table or a nonmem additional output file.

**Value**

A data.frame

**Examples**

```
## Not run:  
data <- read_table_nm(file = '../models/pk/sdtab101')  
  
## End(Not run)
```

---

replace\_list\_elements *Replace list elements by name*

---

**Description**

Replace list elements by name

**Usage**

```
replace_list_elements(list, replacement)
```

**Arguments**

list	original list
replacement	replacement list

**Details**

Finds and replaces list elements by name and throws an error if an element is not available in the original list. This is a local duplicate of the PKPDmisc copy for the VPC package to reduce dependency on PKPDmisc at this time.

**Examples**

```
## Not run:
list <- list(ipred = "ipred", dv = "dv", idv = "idv", "pred" = "pred")
replacement <- list(dv = "conc", idv = "time")
list <- replace_list_elements(list, replacement)

## End(Not run)
```

---

rtte_obs_nm	<i>Simulated RTTE data (1x)</i>
-------------	---------------------------------

---

**Description**

An example dataset with simulated repeated time-to-event data

**Usage**

```
rtte_obs_nm
```

**Format**

An object of class `data.frame` with 573 rows and 6 columns.

---

rtte_sim_nm	<i>Simulated RTTE data (100x)</i>
-------------	-----------------------------------

---

**Description**

An example dataset with simulated repeated time-to-event data (100 simulations)

**Usage**

```
rtte_sim_nm
```

**Format**

An object of class `data.frame` with 2000000 rows and 7 columns.

---

show_default	<i>Defaults for show argument</i>
--------------	-----------------------------------

---

**Description**

Defaults for show argument

**Usage**

show\_default

**Format**

An object of class list of length 11.

---

show_default_tte	<i>Defaults for show argument for TTE VPC</i>
------------------	---

---

**Description**

Defaults for show argument for TTE VPC

**Usage**

show\_default\_tte

**Format**

An object of class list of length 11.

---

simple_data	<i>A small rich dataset</i>
-------------	-----------------------------

---

**Description**

A small rich dataset

**Usage**

simple\_data

**Format**

An object of class list of length 2.



**Details**

a list containing the obs and sim data for an example dataset to run a simple vpc.

**Examples**

```
## Not run:
vpc(sim_data$sim, sim_data$obs)

## End(Not run)
```

---

sim\_data

*Simulate data based on a model and parameter distributions*


---

**Description**

Simulate data based on a model and parameter distributions

**Usage**

```
sim_data(
  design = cbind(id = c(1, 1, 1), idv = c(0, 1, 2)),
  model = function(x) { return(x$alpha + x$beta) },
  theta,
  omega_mat,
  par_names,
  par_values = NULL,
  draw_iiv = "mvrnorm",
  error = list(proportional = 0, additive = 0, exponential = 0),
  n = 100
)
```

**Arguments**

design	a design dataset. See example
model	A function with the first argument the simulation design, i.e. a dataset with the columns ... The second argument to this function is a dataset with parameters for every individual. This can be supplied by the user, or generated by this sim_data if theta and omega_mat are supplied.
theta	vector of fixed effect parameters
omega_mat	vector of between subject random effects, specified as lower triangle
par_names	A character vector linking the parameters in the model to the variables in the dataset. See example.
par_values	parameter values
draw_iiv	draw between subject random effects?
error	see example
n	number of simulations to perform

**Details**

This function generates the simulated dependent values for use in the VPC plotting function.

**Value**

a vector of simulated dependent variables (for use in the VPC plotting function)

**See Also**

[vpc](#)

---

theme_empty	<i>Empty ggplot2 theme</i>
-------------	----------------------------

---

**Description**

Empty ggplot2 theme

**Usage**

```
theme_empty()
```

**Examples**

```
vpc(simple_data$sim, simple_data$obs) + theme_empty()
```

---

theme_plain	<i>A nicer default theme for ggplot2</i>
-------------	--

---

**Description**

A nicer default theme for ggplot2

**Usage**

```
theme_plain()
```

**Examples**

```
vpc(simple_data$sim, simple_data$obs) + theme_plain()
```

---

triangle_to_full	<i>Lower to full triangle</i>
------------------	-------------------------------

---

**Description**

Convert the lower triangle of a covariance matrix to a full matrix object

**Usage**

```
triangle_to_full(vect)
```

**Arguments**

vect	the lower triangle of a covariance matrix
------	---

---

vpc	<i>VPC function</i>
-----	---------------------

---

**Description**

Creates a VPC plot from observed and simulation data

**Usage**

```
vpc(sim, ...)  
  
## Default S3 method:  
vpc(sim, ...)  
  
vpc_vpc(  
  sim = NULL,  
  obs = NULL,  
  psn_folder = NULL,  
  bins = "jenks",  
  n_bins = "auto",  
  bin_mid = "mean",  
  obs_cols = NULL,  
  sim_cols = NULL,  
  software = "auto",  
  show = NULL,  
  stratify = NULL,  
  pred_corr = FALSE,  
  pred_corr_lower_bnd = 0,  
  pi = c(0.05, 0.95),  
  ci = c(0.05, 0.95),
```

```

    uloq = NULL,
    lloq = NULL,
    log_y = FALSE,
    log_y_min = 0.001,
    xlab = NULL,
    ylab = NULL,
    title = NULL,
    smooth = TRUE,
    vpc_theme = NULL,
    facet = "wrap",
    scales = "fixed",
    labeller = NULL,
    vpcdb = FALSE,
    verbose = FALSE,
    ...
  )

```

### Arguments

sim	this is usually a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a> . However it can also be an object like a nlmixr or xpose object
...	Other arguments sent to other methods (like xpose or nlmixr); Note these arguments are not used in the default vpc and are ignored by the default method.
obs	a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a>
psn_folder	instead of specifying "sim" and "obs", specify a PsN-generated VPC-folder
bins	either "density", "time", or "data", "none", or one of the approaches available in classInterval() such as "jenks" (default) or "pretty", or a numeric vector specifying the bin separators.
n_bins	when using the "auto" binning method, what number of bins to aim for
bin_mid	either "mean" for the mean of all timepoints (default) or "middle" to use the average of the bin boundaries.
obs_cols	observation dataset column names (list elements: "dv", "idv", "id", "pred")
sim_cols	simulation dataset column names (list elements: "dv", "idv", "id", "pred", "sim")
software	name of software platform using (e.g. nonmem, phoenix)
show	what to show in VPC (obs_dv, obs_ci, pi, pi_as_area, pi_ci, obs_median, sim_median, sim_median_ci)
stratify	character vector of stratification variables. Only 1 or 2 stratification variables can be supplied.
pred_corr	perform prediction-correction?
pred_corr_lower_bnd	lower bound for the prediction-correction

pi	simulated prediction interval to plot. Default is c(0.05, 0.95),
ci	confidence interval to plot. Default is (0.05, 0.95)
uloq	Number or NULL indicating upper limit of quantification. Default is NULL.
lloq	Number or NULL indicating lower limit of quantification. Default is NULL.
log_y	Boolean indicating whether y-axis should be shown as logarithmic. Default is FALSE.
log_y_min	minimal value when using log_y argument. Default is 1e-3.
xlab	label for x axis
ylab	label for y axis
title	title
smooth	"smooth" the VPC (connect bin midpoints) or show bins as rectangular boxes. Default is TRUE.
vpc_theme	theme to be used in VPC. Expects list of class vpc_theme created with function vpc_theme()
facet	either "wrap", "columns", or "rows"
scales	either "fixed" (default), "free_y", "free_x" or "free"
labeller	ggplot2 labeller function to be passed to underlying ggplot object
vpcdb	Boolean whether to return the underlying vpcdb rather than the plot
verbose	show debugging information (TRUE or FALSE)

**Value**

a list containing calculated VPC information (when vpcdb=TRUE), or a ggplot2 object (default)

**See Also**

[sim\\_data](#), [vpc\\_cens](#), [vpc\\_tte](#), [vpc\\_cat](#)

**Examples**

```
## See vpc.ronkeizer.com for more documentation and examples
library(vpc)

# Basic commands:
vpc(sim = simple_data$sim, obs = simple_data$obs)
vpc(sim = simple_data$sim, obs = simple_data$obs, lloq = 20)
```

vpc\_cat

*VPC function for categorical***Description**

Creates a VPC plot from observed and simulation data for categorical variables.

**Usage**

```
vpc_cat(
  sim = NULL,
  obs = NULL,
  psn_folder = NULL,
  bins = "jenks",
  n_bins = "auto",
  bin_mid = "mean",
  obs_cols = NULL,
  sim_cols = NULL,
  software = "auto",
  show = NULL,
  ci = c(0.05, 0.95),
  uloq = NULL,
  lloq = NULL,
  xlab = NULL,
  ylab = NULL,
  title = NULL,
  smooth = TRUE,
  vpc_theme = NULL,
  facet = "wrap",
  labeller = NULL,
  plot = TRUE,
  vpcdb = FALSE,
  verbose = FALSE
)
```

**Arguments**

sim	a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a>
obs	a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a>
psn_folder	instead of specifying "sim" and "obs", specify a PsN-generated VPC-folder
bins	either "density", "time", or "data", "none", or one of the approaches available in <code>classInterval()</code> such as "jenks" (default) or "pretty", or a numeric vector specifying the bin separators.

n_bins	when using the "auto" binning method, what number of bins to aim for
bin_mid	either "mean" for the mean of all timepoints (default) or "middle" to use the average of the bin boundaries.
obs_cols	observation dataset column names (list elements: "dv", "idv", "id", "pred")
sim_cols	simulation dataset column names (list elements: "dv", "idv", "id", "pred")
software	name of software platform using (e.g. nonmem, phoenix)
show	what to show in VPC (obs_ci, pi, pi_as_area, pi_ci, obs_median, sim_median, sim_median_ci)
ci	confidence interval to plot. Default is (0.05, 0.95)
uloq	Number or NULL indicating upper limit of quantification. Default is NULL.
lloq	Number or NULL indicating lower limit of quantification. Default is NULL.
xlab	label for x-axis
ylab	label for y-axis
title	title
smooth	"smooth" the VPC (connect bin midpoints) or show bins as rectangular boxes. Default is TRUE.
vpc_theme	theme to be used in VPC. Expects list of class vpc_theme created with function vpc_theme()
facet	either "wrap", "columns", or "rows"
labeller	ggplot2 labeller function to be passed to underlying ggplot object
plot	Boolean indicating whether to plot the ggplot2 object after creation. Default is FALSE.
vpcdb	boolean whether to return the underlying vpcdb rather than the plot
verbose	show debugging information (TRUE or FALSE)

**Value**

a list containing calculated VPC information (when vpcdb=TRUE), or a ggplot2 object (default)

**See Also**

[sim\\_data](#), [vpc](#), [vpc\\_tte](#), [vpc\\_cens](#)

**Examples**

```
## See vpc.ronkeizer.com for more documentation and examples
library(vpc)

# simple function to simulate categorical data for single individual
sim_id <- function(id = 1) {
  n <- 10
  logit <- function(x) exp(x) / (1+exp(x))
  data.frame(id = id, time = seq(1, n, length.out = n),
```

```

        dv = round(logit((1:n) - n/2 + rnorm(n, 0, 1.5))) )
    }
    ## simple function to simulate categorical data for a trial
    sim_trial <- function(i = 1, n = 20) { # function to simulate categorical data for a trial
      data.frame(sim = i, do.call("rbind", lapply(1:n, sim_id)))
    }

    ## simulate single trial for 20 individuals
    obs <- sim_trial(n = 20)

    ## simulate 200 trials of 20 individuals
    sim <- do.call("rbind", lapply(1:200, sim_trial, n = 20))

    ## Plot categorical VPC
    vpc_cat(sim = sim, obs = obs)

```

---

vpc\_cens

*VPC function for left- or right-censored data (e.g. BLOQ data)*


---

## Description

Creates a VPC plot from observed and simulation data for censored data. Function can handle both left- (below lower limit of quantification) and right-censored (above upper limit of quantification) data.

## Usage

```

vpc_cens(
  sim = NULL,
  obs = NULL,
  psn_folder = NULL,
  bins = "jenks",
  n_bins = 8,
  bin_mid = "mean",
  obs_cols = NULL,
  sim_cols = NULL,
  software = "auto",
  show = NULL,
  stratify = NULL,
  stratify_color = NULL,
  ci = c(0.05, 0.95),
  uloq = NULL,
  lloq = NULL,
  plot = FALSE,
  xlab = "Time",
  ylab = "Probability of <LOQ",
  title = NULL,
  smooth = TRUE,

```



```

    vpc_theme = NULL,
    facet = "wrap",
    labeller = NULL,
    vpcdb = FALSE,
    verbose = FALSE
  )

```

## Arguments

sim	a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a>
obs	a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a>
psn_folder	instead of specifying "sim" and "obs", specify a PsN-generated VPC-folder
bins	either "density", "time", or "data", or a numeric vector specifying the bin separators.
n_bins	number of bins
bin_mid	either "mean" for the mean of all timepoints (default) or "middle" to use the average of the bin boundaries.
obs_cols	observation dataset column names (list elements: "dv", "idv", "id", "pred")
sim_cols	simulation dataset column names (list elements: "dv", "idv", "id", "pred")
software	name of software platform using (e.g. nonmem, phoenix)
show	what to show in VPC (obs_ci, pi, pi_as_area, pi_ci, obs_median, sim_median, sim_median_ci)
stratify	character vector of stratification variables. Only 1 or 2 stratification variables can be supplied.
stratify_color	variable to stratify and color lines for observed data. Only 1 stratification variables can be supplied.
ci	confidence interval to plot. Default is (0.05, 0.95)
uloq	Number or NULL indicating upper limit of quantification. Default is NULL.
lloq	Number or NULL indicating lower limit of quantification. Default is NULL.
plot	Boolean indicating whether to plot the ggplot2 object after creation. Default is FALSE.
xlab	ylab as numeric vector of size 2
ylab	ylab as numeric vector of size 2
title	title
smooth	"smooth" the VPC (connect bin midpoints) or show bins as rectangular boxes. Default is TRUE.
vpc_theme	theme to be used in VPC. Expects list of class vpc_theme created with function vpc_theme()

facet	either "wrap", "columns", or "rows"
labeller	ggplot2 labeller function to be passed to underlying ggplot object
vpcdb	boolean whether to return the underlying vpcdb rather than the plot
verbose	show debugging information (TRUE or FALSE)

**Value**

a list containing calculated VPC information, and a ggplot2 object

**See Also**

[sim\\_data](#), [vpc](#), [vpc\\_tte](#), [vpc\\_cat](#)

**Examples**

```
## See vpc.ronkeizer.com for more documentation and examples
library(vpc)

vpc_cens(sim = simple_data$sim, obs = simple_data$obs, lloq = 30)
vpc_cens(sim = simple_data$sim, obs = simple_data$obs, uloq = 120)
```

---

vpc\_tte

*VPC function for time-to-event (survival) data*


---

**Description**

This function can be used for either single time-to-event (TTE) or repeated time-to-event (RTTE) data.

**Usage**

```
vpc_tte(
  sim = NULL,
  obs = NULL,
  psn_folder = NULL,
  rtte = FALSE,
  rtte_calc_diff = TRUE,
  rtte_conditional = TRUE,
  events = NULL,
  bins = FALSE,
  n_bins = 10,
  software = "auto",
  obs_cols = NULL,
  sim_cols = NULL,
  kmcc = NULL,
```

```

reverse_prob = FALSE,
stratify = NULL,
stratify_color = NULL,
ci = c(0.05, 0.95),
plot = FALSE,
xlab = "Time",
ylab = "Survival (%)",
show = NULL,
as_percentage = TRUE,
title = NULL,
smooth = FALSE,
vpc_theme = NULL,
facet = "wrap",
labeller = NULL,
verbose = FALSE,
vpcdb = FALSE
)

```

### Arguments

sim	a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a>
obs	a data.frame with observed data, containing the independent and dependent variable, a column indicating the individual, and possibly covariates. E.g. load in from NONMEM using <a href="#">read_table_nm</a>
psn_folder	instead of specifying "sim" and "obs", specify a PsN-generated VPC-folder
rtte	repeated time-to-event data? Default is FALSE (treat as single-event TTE)
rtte_calc_diff	recalculate time (T/F)? When simulating in NONMEM, you will probably need to set this to TRUE to recalculate the TIME to relative times between events (unless you output the time difference between events and specify that as independent variable to the vpc_tte() function.
rtte_conditional	'TRUE' (default) or 'FALSE'. Compute the probability for each event newly ('TRUE'), or calculate the absolute probability ('FALSE', i.e. the "probability of a 1st, 2nd, 3rd event etc" rather than the "probability of an event happening").
events	numeric vector describing which events to show a VPC for when repeated TTE data, e.g. c(1:4). Default is NULL, which shows all events.
bins	either "density", "time", or "data", or a numeric vector specifying the bin separators.
n_bins	number of bins
software	name of software platform using (e.g. nonmem, phoenix)
obs_cols	observation dataset column names (list elements: "dv", "idv", "id", "pred")
sim_cols	simulation dataset column names (list elements: "dv", "idv", "id", "pred", "sim")
kmmc	either NULL (for regular TTE vpc, default), or a variable name for a KMMC plot (e.g. "WT")

<code>reverse_prob</code>	reverse the probability scale (i.e. plot 1-probability)
<code>stratify</code>	character vector of stratification variables. Only 1 or 2 stratification variables can be supplied.
<code>stratify_color</code>	character vector of stratification variables. Only 1 stratification variable can be supplied, cannot be used in conjunction with 'stratify'.
<code>ci</code>	confidence interval to plot. Default is (0.05, 0.95)
<code>plot</code>	Boolean indicating whether to plot the ggplot2 object after creation. Default is FALSE.
<code>xlab</code>	label for x-axis
<code>ylab</code>	label for y-axis
<code>show</code>	what to show in VPC (obs_ci, obs_median, sim_median, sim_median_ci)
<code>as_percentage</code>	Show y-scale from 0-100 percent? TRUE by default, if FALSE then scale from 0-1.
<code>title</code>	title
<code>smooth</code>	"smooth" the VPC (connect bin midpoints) or show bins as rectangular boxes. Default is TRUE.
<code>vpc_theme</code>	theme to be used in VPC. Expects list of class vpc_theme created with function vpc_theme()
<code>facet</code>	either "wrap", "columns", or "rows"
<code>labeller</code>	ggplot2 labeller function to be passed to underlying ggplot object
<code>verbose</code>	TRUE or FALSE (default)
<code>vpcdb</code>	Boolean whether to return the underlying vpcdb rather than the plot

### Details

Creates a VPC plot from observed and simulation survival data

### Value

a list containing calculated VPC information, and a ggplot2 object

### See Also

[sim\\_data](#), [vpc](#), [vpc\\_tte](#), [vpc\\_cens](#)

### Examples

```
## See vpc-docs.ronkeizer.com for more documentation and examples.
```

```
## Example for repeated) time-to-event data
## with NONMEM-like data (e.g. simulated using a dense grid)
```

```
data(rtte_obs_nm)
data(rtte_sim_nm)
```

```
# treat RTTE as TTE, no stratification
vpc_tte(sim = rtte_sim_nm[rtte_sim_nm$sim <= 20,],
        obs = rtte_obs_nm,
        rtte = FALSE,
        sim_cols=list(dv = "dv", idv = "t"), obs_cols=list(idv = "t"))
```

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