

Package ‘matrixdist’

May 8, 2026

Type Package

Title Statistics for Matrix Distributions

Version 1.1.9

Date 2023-08-01

Maintainer Martin Bladt <martinbladt@gmail.com>

URL https://github.com/martinbladt/matrixdist_1.0

BugReports https://github.com/martinbladt/matrixdist_1.0/issues

Description Tools for phase-type distributions including the following variants: continuous, discrete, multivariate, in-homogeneous, right-censored, and regression. Methods for functional evaluation, simulation and estimation using the expectation-maximization (EM) algorithm are provided for all models. The methods of this package are based on the following references.
Asmussen, S., Nerman, O., & Olsson, M. (1996). Fitting phase-type distributions via the EM algorithm,
Olsson, M. (1996). Estimation of phase-type distributions from censored data,
Albrecher, H., & Bladt, M. (2019) <[doi:10.1017/jpr.2019.60](https://doi.org/10.1017/jpr.2019.60)>,
Albrecher, H., Bladt, M., & Yslas, J. (2022) <[doi:10.1111/sjos.12505](https://doi.org/10.1111/sjos.12505)>,
Albrecher, H., Bladt, M., Bladt, M., & Yslas, J. (2022) <[doi:10.1016/j.insmatheco.2022.08.001](https://doi.org/10.1016/j.insmatheco.2022.08.001)>,
Bladt, M., & Yslas, J. (2022) <[doi:10.1080/03461238.2022.2097019](https://doi.org/10.1080/03461238.2022.2097019)>,
Bladt, M. (2022) <[doi:10.1017/asb.2021.40](https://doi.org/10.1017/asb.2021.40)>,
Bladt, M. (2023) <[doi:10.1080/10920277.2023.2167833](https://doi.org/10.1080/10920277.2023.2167833)>,
Albrecher, H., Bladt, M., & Mueller, A. (2023) <[doi:10.1515/demo-2022-0153](https://doi.org/10.1515/demo-2022-0153)>,
Bladt, M. & Yslas, J. (2023) <[doi:10.1016/j.insmatheco.2023.02.008](https://doi.org/10.1016/j.insmatheco.2023.02.008)>.

Depends R (>= 4.2.0)

License GPL-3

Imports Rcpp, methods, nnet, reshape2

LinkingTo Rcpp, RcppArmadillo

Encoding UTF-8

RoxygenNote 7.2.3

NeedsCompilation yes

Author Martin Bladt [aut, cre],
 Jorge Yslas [aut],
 Alaric Müller [ctb]

Repository CRAN

Date/Publication 2023-08-08 11:00:02 UTC

Contents

matrixdist-package	8
+ ,dph,dph-method	9
+ ,ph,ph-method	10
a_rungekutta	10
bivdph	11
bivdph-class	11
bivdph_density	12
bivdph_tail	12
biviph	13
biviph-class	14
bivph	14
bivph-class	15
bivph_density	15
bivph_laplace	16
bivph_tail	16
cdf	17
cdf,dph-method	17
cdf,iph-method	18
cdf,miph-method	18
cdf,mph-method	19
cdf,ph-method	20
clone_matrix	20
clone_vector	21
coef,bivdph-method	21
coef,biviph-method	22
coef,bivph-method	22
coef,dph-method	23
coef,iph-method	23
coef,mdph-method	24
coef,ph-method	24
coef,sph-method	25
cor,bivdph-method	25
cor,biviph-method	26
cor,mdph-method	26
cor,mph-method	27
cor,MPHstar-method	28
cumulate_matrix	28
cumulate_vector	29
default_step_length	29

dens	30
dens,bivdph-method	30
dens,biviph-method	31
dens,bivph-method	31
dens,dph-method	32
dens,iph-method	32
dens,mdph-method	33
dens,miph-method	34
dens,mph-method	34
dens,ph-method	35
dph	35
dph-class	36
dphcdf	37
dphdensity	37
dph_pgf	38
embedded_mc	38
EMstep_bivdph	39
EMstep_bivdph_MoE	39
EMstep_bivph	40
EMstep_dph	40
EMstep_dph_MoE	41
EMstep_mdph	41
EMstep_mdph_MoE	42
EMstep_MoE_PADE	42
EMstep_PADE	43
EMstep_RK	43
EMstep_UNI	44
EM_step_mPH_rc	44
evaluate	45
evaluate,sph-method	45
expmat	46
expm_terms	46
find_n	47
find_weight	47
Fisher	48
Fisher,sph-method	48
fit	49
fit,bivdph-method	49
fit,bivph-method	50
fit,dph-method	51
fit,mdph-method	51
fit,mph-method	52
fit,MPHstar-method	53
fit,ph-method	54
haz	55
haz,ph-method	56
inf_norm	56
initial_state	57

iph	57
iph-class	58
laplace	59
laplace,bivph-method	59
laplace,mph-method	60
laplace,ph-method	60
linCom	61
linCom,bivph-method	61
linCom,MPHstar-method	62
linear_combination	62
logLik,ph-method	63
logLikelihoodbivDPH	64
logLikelihoodbivDPH_MoE	64
logLikelihoodbivPH	65
logLikelihoodDPH	65
logLikelihoodDPH_MoE	66
logLikelihoodmDPH	66
logLikelihoodmDPH_MoE	67
logLikelihoodMgev_PADE	67
logLikelihoodMgev_RK	68
logLikelihoodMgev_UNI	68
logLikelihoodMgompertz_PADE	69
logLikelihoodMgompertz_PADEs	69
logLikelihoodMgompertz_RK	70
logLikelihoodMgompertz_RKs	71
logLikelihoodMgompertz_UNI	72
logLikelihoodMgompertz_UNIs	72
logLikelihoodMloglogistic_PADE	73
logLikelihoodMloglogistic_PADEs	74
logLikelihoodMloglogistic_RK	75
logLikelihoodMloglogistic_RKs	75
logLikelihoodMloglogistic_UNI	76
logLikelihoodMloglogistic_UNIs	77
logLikelihoodMlognormal_PADE	78
logLikelihoodMlognormal_PADEs	78
logLikelihoodMlognormal_RK	79
logLikelihoodMlognormal_RKs	80
logLikelihoodMlognormal_UNI	81
logLikelihoodMlognormal_UNIs	81
logLikelihoodMpareto_PADE	82
logLikelihoodMpareto_PADEs	83
logLikelihoodMpareto_RK	84
logLikelihoodMpareto_RKs	84
logLikelihoodMpareto_UNI	85
logLikelihoodMpareto_UNIs	86
logLikelihoodMweibull_PADE	87
logLikelihoodMweibull_PADEs	87
logLikelihoodMweibull_RK	88

logLikelihoodMweibull_RKs	89
logLikelihoodMweibull_UNI	90
logLikelihoodMweibull_UNIs	90
logLikelihoodPH_MoE	91
logLikelihoodPH_PADE	92
logLikelihoodPH_PADEs	92
logLikelihoodPH_RK	93
logLikelihoodPH_RKs	94
logLikelihoodPH_UNI	94
logLikelihoodPH_UNIs	95
LRT	95
LRT,ph,ph-method	96
marginal	96
marginal,bivdph-method	97
marginal,biviph-method	97
marginal,bivph-method	98
marginal,mdph-method	99
marginal,miph-method	99
marginal,mph-method	100
marginal,MPHstar-method	100
marginal_expectation	101
matrix_exponential	102
matrix_inverse	102
matrix_power	103
matrix_product	103
matrix_vanloan	104
maximum	104
maximum,dph,dph-method	105
maximum,iph,iph-method	105
maximum,ph,ph-method	106
max_diagonal	107
mdph	107
mdph-class	108
mdphdensity	108
mean,bivdph-method	109
mean,bivph-method	109
mean,dph-method	110
mean,mdph-method	110
mean,mph-method	111
mean,MPHstar-method	111
mean,ph-method	112
merge_matrices	112
mgevcd	113
mgevdn	114
mgf	114
mgf,bivph-method	115
mgf,mph-method	115
mgf,ph-method	116

mgompertzcdf	117
mgompertzden	117
minimum	118
minimum,dph,dph-method	118
minimum,iph,iph-method	119
minimum,ph,ph-method	119
miph	120
miph-class	121
mixture	121
mixture,dph,dph-method	122
mixture,ph,ph-method	122
mloglogisticcdf	123
mloglogisticden	124
mlognormalcdf	124
mlognormalden	125
MoE	125
MoE,bivdph-method	126
MoE,dph-method	127
MoE,mdph-method	128
MoE,mph-method	129
MoE,ph-method	130
moment	131
moment,bivdph-method	132
moment,bivph-method	132
moment,dph-method	133
moment,mdph-method	133
moment,mph-method	134
moment,ph-method	134
mparetocdf	135
mparetoden	136
mph	136
mph-class	137
MPHstar	137
MPHstar-class	138
MPHstar_data_aggregation	138
MPHstar_EMstep_UNI	139
mweibullcdf	139
mweibullden	140
m_exp_sum	140
new_state	141
Nfold	141
Nfold,dph-method	142
n_pos	142
pgf	143
pgf,bivdph-method	143
pgf,dph-method	144
pgf,mdph-method	144
ph	145

ph-class	146
phcdf	146
phdensity	147
ph_laplace	147
plus_states	148
pow2_matrix	148
quan	149
quan,ph-method	149
random_reward	150
random_structure	150
random_structure_bivph	151
rdphasetype	151
reg	152
reg,ph-method	152
revers_data_trans	153
rew_sanity_check	154
riph	154
rmatrixgev	155
rMDPHstar	156
rMIPHstar	156
rMPHstar	157
rphasetype	157
runge_kutta	158
show,bivdph-method	158
show,biviph-method	159
show,bivph-method	159
show,dph-method	159
show,iph-method	160
show,mdph-method	160
show,miph-method	161
show,mph-method	161
show,MPHstar-method	162
show,ph-method	162
show,sph-method	162
sim	163
sim,bivdph-method	163
sim,biviph-method	164
sim,bivph-method	164
sim,dph-method	165
sim,iph-method	165
sim,mdph-method	166
sim,miph-method	167
sim,mph-method	167
sim,MPHstar-method	168
sim,ph-method	169
sph	169
sph-class	170
sum_dph	170

sum_ph	171
TVR	171
TVR,dph-method	172
TVR,ph-method	172
tvr_dph	173
tvr_ph	173
var,bivdph-method	174
var,bivph-method	174
var,dph-method	175
var,mdph-method	175
var,mph-method	176
var,MPHstar-method	176
var,ph-method	177
vector_of_matrices	177
vector_of_matrices_2	178
vector_of_powers	178

Index	179
--------------	------------

matrixdist-package *Statistics for Matrix Distributions*

Description

This package implements tools which are useful for the statistical analysis of discrete, continuous, multivariate, right-censored or regression variants of phase-type distributions. These distributions are absorption times of Markov jump processes, and thus the maximization of their likelihood for statistical estimation is best dealt with using the EM algorithm.

Author(s)

Martin Bladt and Jorge Yslas.

Maintainer: Martin Bladt <martinbladt@gmail.com>

References

Asmussen, S., Nerman, O., & Olsson, M. (1996). Fitting phase-type distributions via the EM algorithm. *Scandinavian Journal of Statistics*, 23(4),419-441.

Olsson, M. (1996). Estimation of phase-type distributions from censored data. *Scandinavian journal of statistics*, 24(4), 443-460.

Albrecher, H., & Bladt, M. (2019). Inhomogeneous phase-type distributions and heavy tails. *Journal of Applied Probability*, 56(4), 1044-1064.

Albrecher, H., Bladt, M., & Yslas, J. (2022). Fitting inhomogeneous Phase-Type distributions to data: The univariate and the multivariate case. *Scandinavian Journal of Statistics*, 49(1), 44-77

Albrecher, H., Bladt, M., Bladt, M., & Yslas, J. (2020). Mortality modeling and regression with matrix distributions. *Insurance: Mathematics and Economics*, 107, 68-87.

Bladt, M., & Yslas, J. (2022). Phase-type mixture-of-experts regression for loss severities. *Scandinavian Actuarial Journal*, 1-27.

Bladt, M. (2022). Phase-type distributions for claim severity regression modeling. *ASTIN Bulletin: The journal of the IAA*, 52(2), 417-448.

Bladt, M. (2023). A tractable class of Multivariate Phase-type distributions for loss modeling. *North American Actuarial Journal*, to appear.

Albrecher, H., Bladt, M., & Mueller, A. (2023). Joint lifetime modelling with matrix distributions. *Dependence Modeling*, 11(1), 1-22.

Bladt, M. & Yslas, J. (2023). Robust claim frequency modeling through phase-type mixture-of-experts regression. *Insurance: Mathematics and Economics*, 111, 1-22.

+, dph, dph-method *Sum method for discrete phase-type distributions*

Description

Sum method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph,dph'  
e1 + e2
```

Arguments

e1 An object of class [dph](#).
e2 An object of class [dph](#).

Value

An object of class [dph](#).

Examples

```
dph1 <- dph(structure = "general", dimension = 3)  
dph2 <- dph(structure = "general", dimension = 5)  
dph_sum <- dph1 + dph2  
dph_sum
```

+,ph,ph-method	<i>Sum method for phase-type distributions</i>
----------------	--

Description

Sum method for phase-type distributions

Usage

```
## S4 method for signature 'ph,ph'
e1 + e2
```

Arguments

e1	An object of class ph .
e2	An object of class ph .

Value

An object of class [ph](#).

Examples

```
ph1 <- ph(structure = "general", dimension = 3)
ph2 <- ph(structure = "gcoxian", dimension = 5)
ph_sum <- ph1 + ph2
ph_sum
```

a_rungekutta	<i>Runge-Kutta for the calculation of the a vector in a EM step</i>
--------------	---

Description

Runge-Kutta for the calculation of the a vector in a EM step

Usage

```
a_rungekutta(avector, dt, h, S)
```

Arguments

avector	The a vector.
dt	Increment.
h	Step-length.
S	Sub-intensity matrix.

bivdph	<i>Constructor function for bivariate discrete phase-type distributions</i>
--------	---

Description

Constructor function for bivariate discrete phase-type distributions

Usage

```
bivdph(alpha = NULL, S11 = NULL, S12 = NULL, S22 = NULL, dimensions = c(3, 3))
```

Arguments

alpha	A probability vector.
S11	A sub-transition matrix.
S12	A matrix.
S22	A sub-transition matrix.
dimensions	The dimensions of the bivariate discrete phase-type (if no parameters are provided).

Value

An object of class `bivdph`.

Examples

```
bivdph(dimensions = c(3, 3))
S11 <- matrix(c(0.1, .5, .5, 0.1), 2, 2)
S12 <- matrix(c(.2, .3, .2, .1), 2, 2)
S22 <- matrix(c(0.2, 0, 0.1, 0.1), 2, 2)
bivdph(alpha = c(.5, .5), S11, S12, S22)
```

bivdph-class	<i>Bivariate discrete phase-type distributions</i>
--------------	--

Description

Class of objects for bivariate discrete phase-type distributions.

Value

Class object.

Slots

name Name of the discrete phase-type distribution.

pars A list comprising of the parameters.

fit A list containing estimation information.

bivdph_density	<i>Bivariate discrete phase-type joint density of the feed forward type</i>
----------------	---

Description

Bivariate discrete phase-type joint density of the feed forward type

Usage

```
bivdph_density(x, alpha, S11, S12, S22)
```

Arguments

x	Matrix of values.
alpha	Vector of initial probabilities.
S11	Sub-transition matrix.
S12	Matrix.
S22	Sub-transition matrix.

Value

Joint density at x.

bivdph_tail	<i>Bivariate discrete phase-type joint tail of the feed forward type</i>
-------------	--

Description

Bivariate discrete phase-type joint tail of the feed forward type

Usage

```
bivdph_tail(x, alpha, S11, S12, S22)
```

Arguments

x	Matrix of values.
alpha	Vector of initial probabilities.
S11	Sub-transition matrix.
S12	Matrix.
S22	Sub-transition matrix.

Value

Joint tail at x.

biviph	<i>Constructor function for bivariate inhomogeneous phase-type distributions</i>
--------	--

Description

Constructor function for bivariate inhomogeneous phase-type distributions

Usage

```
biviph(
  bivph = NULL,
  gfun = NULL,
  gfun_pars = NULL,
  alpha = NULL,
  S11 = NULL,
  S12 = NULL,
  S22 = NULL,
  dimensions = c(3, 3)
)
```

Arguments

bivph	An object of class bivph .
gfun	Vector of inhomogeneity transforms.
gfun_pars	List of parameters for the inhomogeneity functions.
alpha	A probability vector.
S11	A sub-intensity matrix.
S12	A matrix.
S22	A sub-intensity matrix.
dimensions	The dimensions of the bivariate phase-type (if no parameters are provided).

Value

An object of class `biviph`.

Examples

```
under_bivph <- bivph(dimensions = c(3, 3))
biviph(under_bivph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
```

biviph-class	<i>Bivariate inhomogeneous phase-type distributions</i>
--------------	---

Description

Class of objects for bivariate inhomogeneous phase-type distributions.

Value

Class object.

Slots

name Name of the phase type distribution.
 gfun A list comprising of the parameters.

bivph	<i>Constructor function for bivariate phase-type distributions</i>
-------	--

Description

Constructor function for bivariate phase-type distributions

Usage

```
bivph(alpha = NULL, S11 = NULL, S12 = NULL, S22 = NULL, dimensions = c(3, 3))
```

Arguments

alpha	A probability vector.
S11	A sub-intensity matrix.
S12	A matrix.
S22	A sub-intensity matrix.
dimensions	The dimensions of the bivariate phase-type (if no parameters are provided).

Value

An object of class `bivph`.

Examples

```
bivph(dimensions = c(3, 3))
S11 <- matrix(c(-1, .5, .5, -1), 2, 2)
S12 <- matrix(c(.2, .4, .3, .1), 2, 2)
S22 <- matrix(c(-2, 0, 1, -1), 2, 2)
bivph(alpha = c(.5, .5), S11, S12, S22)
```

bivph-class
Bivariate phase-type distributions

Description

Class of objects for bivariate phase-type distributions.

Value

Class object.

Slots

`name` Name of the phase-type distribution.
`pars` A list comprising of the parameters.
`fit` A list containing estimation information.

bivph_density
Bivariate phase-type joint density of the feed forward type

Description

Bivariate phase-type joint density of the feed forward type

Usage

```
bivph_density(x, alpha, S11, S12, S22)
```

Arguments

`x` Matrix of values.
`alpha` Vector of initial probabilities.
`S11` Sub-intensity matrix.
`S12` Matrix.
`S22` Sub-intensity matrix.

Value

Joint density at x.

bivph_laplace	<i>Bivariate phase-type joint Laplace</i>
---------------	---

Description

Bivariate phase-type joint Laplace

Usage

```
bivph_laplace(r, alpha, S11, S12, S22)
```

Arguments

r	Matrix of values.
alpha	Vector of initial probabilities.
S11	Sub-intensity matrix.
S12	Matrix.
S22	Sub-intensity matrix.

Value

Joint laplace at r.

bivph_tail	<i>Bivariate phase-type joint tail of the feed forward type</i>
------------	---

Description

Bivariate phase-type joint tail of the feed forward type

Usage

```
bivph_tail(x, alpha, S11, S12, S22)
```

Arguments

x	Matrix of values.
alpha	Vector of initial probabilities.
S11	Sub-intensity matrix.
S12	Matrix.
S22	Sub-intensity matrix.

Value

Joint tail at x .

cdf

New generic for the distribution of matrix distributions

Description

Methods are available for objects of class [ph](#).

Usage

```
cdf(x, ...)
```

Arguments

<code>x</code>	An object of the model class.
<code>...</code>	Further parameters to be passed on.

Value

CDF from the matrix distribution.

cdf, dph-method

Distribution method for discrete phase-type distributions

Description

Distribution method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph'
cdf(x, q, lower.tail = TRUE)
```

Arguments

<code>x</code>	An object of class dph .
<code>q</code>	A vector of locations.
<code>lower.tail</code>	Logical parameter specifying whether lower tail (CDF) or upper tail is computed.

Value

A vector containing the CDF evaluations at the given locations.

Examples

```
obj <- dph(structure = "general")
cdf(obj, c(1, 2, 3))
```

cdf,iph-method	<i>Distribution method for inhomogeneous phase-type distributions</i>
----------------	---

Description

Distribution method for inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'iph'
cdf(x, q, lower.tail = TRUE)
```

Arguments

x	An object of class iph .
q	A vector of locations.
lower.tail	Logical parameter specifying whether lower tail (CDF) or upper tail is computed.

Value

A vector containing the CDF evaluations at the given locations.

Examples

```
obj <- iph(ph(structure = "general"), gfun = "weibull", gfun_pars = 2)
cdf(obj, c(1, 2, 3))
```

cdf,miph-method	<i>Distribution method for multivariate inhomogeneous phase-type distributions</i>
-----------------	--

Description

Distribution method for multivariate inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'miph'
cdf(x, y, lower.tail = TRUE)
```

Arguments

x	An object of class <code>mph</code> .
y	A matrix of observations.
lower.tail	Logical parameter specifying whether lower tail (CDF) or upper tail is computed.

Value

A list containing the locations and corresponding CDF evaluations.

Examples

```
under_mph <- mph(structure = c("general", "general"))
obj <- mph(under_mph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
cdf(obj, c(1, 2))
```

cdf, mph-method

Distribution method for multivariate phase-type distributions

Description

Distribution method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
cdf(x, y, lower.tail = TRUE)
```

Arguments

x	An object of class <code>mph</code> .
y	A matrix of observations.
lower.tail	Logical parameter specifying whether lower tail (CDF) or upper tail is computed.

Value

A list containing the locations and corresponding CDF evaluations.

Examples

```
obj <- mph(structure = c("general", "general"))
cdf(obj, matrix(c(0.5, 1), ncol = 2))
```

cdf,ph-method	<i>Distribution method for phase-type distributions</i>
---------------	---

Description

Distribution method for phase-type distributions

Usage

```
## S4 method for signature 'ph'  
cdf(x, q, lower.tail = TRUE)
```

Arguments

x	An object of class ph .
q	A vector of locations.
lower.tail	Logical parameter specifying whether lower tail (CDF) or upper tail is computed.

Value

A vector containing the CDF evaluations at the given locations.

Examples

```
obj <- ph(structure = "general")  
cdf(obj, c(1, 2, 3))
```

clone_matrix	<i>Clone a matrix</i>
--------------	-----------------------

Description

Clone a matrix

Usage

```
clone_matrix(m)
```

Arguments

m	A matrix.
---	-----------

Value

A clone of the matrix.

clone_vector	<i>Clone a vector</i>
--------------	-----------------------

Description

Clone a vector

Usage

```
clone_vector(v)
```

Arguments

v A vector.

Value

A clone of the vector.

coef,bivdph-method	<i>Coef method for bivdph class</i>
--------------------	-------------------------------------

Description

Coef method for bivdph class

Usage

```
## S4 method for signature 'bivdph'  
coef(object)
```

Arguments

object An object of class [bivdph](#).

Value

Parameters of bivariate discrete phase-type model.

Examples

```
obj <- bivdph(dimensions = c(3, 3))  
coef(obj)
```

coef,bivph-method *Coef method for biviph class*

Description

Coef method for biviph class

Usage

```
## S4 method for signature 'biviph'  
coef(object)
```

Arguments

object An object of class [biviph](#).

Value

Parameters of bivariate inhomogeneous phase-type model.

Examples

```
under_bivph <- bivph(dimensions = c(3, 3))  
obj <- biviph(under_bivph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))  
coef(obj)
```

coef,bivph-method *Coef method for biviph class*

Description

Coef method for biviph class

Usage

```
## S4 method for signature 'biviph'  
coef(object)
```

Arguments

object An object of class [bivph](#).

Value

Parameters of bivariate phase-type model.

Examples

```
obj <- bivph(dimensions = c(3, 3))
coef(obj)
```

coef, dph-method *Coef method for dph Class*

Description

Coef method for dph Class

Usage

```
## S4 method for signature 'dph'
coef(object)
```

Arguments

object An object of class [dph](#).

Value

Parameters of dph model.

Examples

```
obj <- dph(structure = "general", dim = 3)
coef(obj)
```

coef, iph-method *Coef method for iph class*

Description

Coef method for iph class

Usage

```
## S4 method for signature 'iph'
coef(object)
```

Arguments

object An object of class [iph](#).

Value

Parameters of iph model.

Examples

```
obj <- iph(ph(structure = "general", dimension = 2), gfun = "lognormal", gfun_pars = 2)
coef(obj)
```

coef,mdph-method *Coef method for mdph class*

Description

Coef method for mdph class

Usage

```
## S4 method for signature 'mdph'
coef(object)
```

Arguments

object An object of class [mdph](#).

Value

Parameters of multivariate discrete phase-type model.

Examples

```
obj <- mdph(structure = c("general", "general"))
coef(obj)
```

coef,ph-method *Coef method for ph class*

Description

Coef method for ph class

Usage

```
## S4 method for signature 'ph'
coef(object)
```

Arguments

object An object of class [ph](#).

Value

Parameters of ph model.

Examples

```
obj <- ph(structure = "general")
coef(obj)
```

coef , sph-method *Coef method for sph Class*

Description

Coef method for sph Class

Usage

```
## S4 method for signature 'sph'
coef(object)
```

Arguments

object An object of class [sph](#).

Value

Parameters of sph model.

cor , bivdph-method *Cor method for bivdph class*

Description

Cor method for bivdph class

Usage

```
## S4 method for signature 'bivdph'
cor(x)
```

Arguments

x An object of class [bivdph](#).

Value

The correlation matrix of the bivariate discrete phase-type distribution.

Examples

```
obj <- bivdph(dimensions = c(3, 3))
cor(obj)
```

cor, bivph-method *Cor method for bivph class*

Description

Cor method for bivph class

Usage

```
## S4 method for signature 'bivph'
cor(x)
```

Arguments

x An object of class [bivph](#).

Value

The correlation matrix of the bivariate phase-type distribution.

Examples

```
obj <- bivph(dimensions = c(3, 3))
cor(obj)
```

cor, mdph-method *Cor method for multivariate discrete phase-type distributions*

Description

Cor method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'
cor(x)
```

Arguments

x An object of class `mdph`.

Value

The correlation matrix of the multivariate discrete phase-type distribution.

Examples

```
obj <- mdph(structure = c("general", "general"))
cor(obj)
```

cor,mph-method *Cor method for multivariate phase-type distributions*

Description

Cor method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
cor(x)
```

Arguments

x An object of class `mph`.

Value

The correlation matrix of the multivariate phase-type distribution.

Examples

```
obj <- mph(structure = c("general", "general"))
cor(obj)
```

cor, MPHstar-method *Cor method for MPHstar class*

Description

Cor method for MPHstar class

Usage

```
## S4 method for signature 'MPHstar'  
cor(x)
```

Arguments

x An object of class [MPHstar](#).

Value

The correlation matrix of the MPHstar distribution.

Examples

```
obj <- MPHstar(structure = "general")  
cor(obj)
```

cumulate_matrix *Cumulate matrix*

Description

Creates a new matrix with entries the cumulated rows of A.

Usage

```
cumulate_matrix(A)
```

Arguments

A A matrix.

Value

The cumulated matrix.

cumulate_vector	<i>Cumulate vector</i>
-----------------	------------------------

Description

Creates a new vector with entries the cumulated entries of A.

Usage

```
cumulate_vector(A)
```

Arguments

A A vector.

Value

The cumulated vector.

default_step_length	<i>Default size of the steps in the RK</i>
---------------------	--

Description

Computes the default step length for a matrix S to be employed in the RK method.

Usage

```
default_step_length(S)
```

Arguments

S Sub-intensity matrix.

Value

The step length for S.

dens *New generic for the density of matrix distributions*

Description

Methods are available for objects of class `ph`.

Usage

```
dens(x, ...)
```

Arguments

`x` An object of the model class.
`...` Further parameters to be passed on.

Value

Density from the matrix distribution.

dens,bivdph-method *Density method for bivariate discrete phase-type distributions*

Description

Density method for bivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'bivdph'
dens(x, y)
```

Arguments

`x` An object of class `bivdph`.
`y` A matrix of locations.

Value

A vector containing the joint density evaluations at the given locations.

Examples

```
obj <- bivdph(dimensions = c(3, 3))
dens(obj, matrix(c(1, 2), ncol = 2))
```

dens,biviph-method *Density method for bivariate inhomogeneous phase-type distributions*

Description

Density method for bivariate inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'biviph'  
dens(x, y)
```

Arguments

x An object of class [biviph](#).
y A matrix of locations.

Value

A vector containing the joint density evaluations at the given locations.

Examples

```
under_bivph <- bivph(dimensions = c(3, 3))  
obj <- biviph(under_bivph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))  
dens(obj, matrix(c(0.5, 1), ncol = 2))
```

dens,bivph-method *Density method for bivariate phase-type distributions*

Description

Density method for bivariate phase-type distributions

Usage

```
## S4 method for signature 'bivph'  
dens(x, y)
```

Arguments

x An object of class [bivph](#).
y A matrix of locations.

Value

A vector containing the joint density evaluations at the given locations.

Examples

```
obj <- bivph(dimensions = c(3, 3))
dens(obj, matrix(c(0.5, 1), ncol = 2))
```

dens, dph-method *Density method for discrete phase-type distributions*

Description

Density method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph'
dens(x, y)
```

Arguments

x An object of class [dph](#).

y A vector of locations.

Value

A vector containing the density evaluations at the given locations.

Examples

```
obj <- dph(structure = "general")
dens(obj, c(1, 2, 3))
```

dens, iph-method *Density method for inhomogeneous phase-type distributions*

Description

Density method for inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'iph'
dens(x, y)
```

Arguments

x An object of class `iph`.
y A vector of locations.

Value

A vector containing the density evaluations at the given locations.

Examples

```
obj <- iph(ph(structure = "general"), gfun = "weibull", gfun_pars = 2)
dens(obj, c(1, 2, 3))
```

dens,mdph-method *Density method for multivariate discrete phase-type distributions*

Description

Density method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'
dens(x, y)
```

Arguments

x An object of class `mdph`.
y A matrix of locations.

Value

A vector containing the joint density evaluations at the given locations.

Examples

```
obj <- mdph(structure = c("general", "general"))
dens(obj, matrix(c(1, 1), ncol = 2))
```

dens,miph-method	<i>Density method for multivariate inhomogeneous phase-type distributions</i>
------------------	---

Description

Density method for multivariate inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'miph'
dens(x, y, delta = NULL)
```

Arguments

x	An object of class miph .
y	A matrix of observations.
delta	Matrix with right-censoring indicators (1 uncensored, 0 right censored).

Value

A list containing the locations and corresponding density evaluations.

Examples

```
under_mph <- mph(structure = c("general", "general"))
obj <- miph(under_mph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
dens(obj, c(1, 2))
```

dens,mph-method	<i>Density method for multivariate phase-type distributions</i>
-----------------	---

Description

Density method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
dens(x, y, delta = NULL)
```

Arguments

x	An object of class mph .
y	A matrix of observations.
delta	Matrix with right-censoring indicators (1 uncensored, 0 right censored).

Value

A list containing the locations and corresponding density evaluations.

Examples

```
obj <- mph(structure = c("general", "general"))
dens(obj, matrix(c(0.5, 1), ncol = 2))
```

dens,ph-method

Density method for phase-type distributions

Description

Density method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
dens(x, y)
```

Arguments

x An object of class [ph](#).
y A vector of locations.

Value

A vector containing the density evaluations at the given locations.

Examples

```
obj <- ph(structure = "general")
dens(obj, c(1, 2, 3))
```

dph

Constructor function for discrete phase-type distributions

Description

Constructor function for discrete phase-type distributions

Usage

```
dph(alpha = NULL, S = NULL, structure = NULL, dimension = 3)
```

Arguments

alpha	A probability vector.
S	A sub-transition matrix.
structure	A valid dph structure: "general", "coxian", "hyperexponential", "gcoxian", or "gerlang".
dimension	The dimension of the dph structure (if structure is provided).

Value

An object of class `dph`.

Examples

```
dph(structure = "general", dim = 5)
dph(alpha = c(0.5, 0.5), S = matrix(c(0.1, 0.5, 0.5, 0.2), 2, 2))
```

dph-class

Discrete phase-type distributions

Description

Class of objects for discrete phase-type distributions.

Value

Class object.

Slots

`name` Name of the discrete phase-type distribution.

`pars` A list comprising of the parameters.

`fit` A list containing estimation information.

dphcdf	<i>Discrete phase-type cdf</i>
--------	--------------------------------

Description

Computes the cdf (tail) of a discrete phase-type distribution with parameters `alpha` and `S` at `x`.

Usage

```
dphcdf(x, alpha, S, lower_tail = TRUE)
```

Arguments

<code>x</code>	Non-negative value.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>lower_tail</code>	Cdf or tail.

Value

The cdf (tail) at `x`.

dphdensity	<i>Discrete phase-type density</i>
------------	------------------------------------

Description

Computes the density of discrete phase-type distribution with parameters `alpha` and `S` at `x`.

Usage

```
dphdensity(x, alpha, S)
```

Arguments

<code>x</code>	Non-negative value.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-transition matrix.

Value

The density at `x`.

dph_pgf	<i>Pgf of a discrete phase-type distribution</i>
---------	--

Description

Computes the pgf at z of a discrete phase-type distribution with parameters α and S .

Usage

```
dph_pgf(z, alpha, S)
```

Arguments

z	Vector of real values.
α	Vector of initial probabilities.
S	Sub-transition matrix.

Value

Laplace transform at r .

embedded_mc	<i>Embedded Markov chain of a sub-intensity matrix</i>
-------------	--

Description

Returns the transition probabilities of the embedded Markov chain determined the sub-intensity matrix.

Usage

```
embedded_mc(S)
```

Arguments

S	A sub-intensity matrix.
-----	-------------------------

Value

The embedded Markov chain.

EMstep_bivdph	<i>EM for discrete bivariate phase-type</i>
---------------	---

Description

EM for discrete bivariate phase-type

Usage

EMstep_bivdph(alpha, S11, S12, S22, obs, weight)

Arguments

alpha	Initial probabilities.
S11	Sub-transition matrix.
S12	Matrix.
S22	Sub-transition matrix.
obs	The observations.
weight	The weights for the observations.

EMstep_bivdph_MoE	<i>EM for discrete bivariate phase-type MoE</i>
-------------------	---

Description

EM for discrete bivariate phase-type MoE

Usage

EMstep_bivdph_MoE(alpha, S11, S12, S22, obs, weight)

Arguments

alpha	Initial probabilities.
S11	Sub-transition matrix.
S12	Matrix.
S22	Sub-transition matrix.
obs	The observations.
weight	The weights for the observations.

EMstep_bivph	<i>EM for bivariate phase-type distributions using Pade for matrix exponential</i>
--------------	--

Description

EM for bivariate phase-type distributions using Pade for matrix exponential

Usage

EMstep_bivph(alpha, S11, S12, S22, obs, weight)

Arguments

alpha	Initial probabilities.
S11	Sub-intensity.
S12	A matrix.
S22	Sub-intensity.
obs	The observations.
weight	The weights for the observations.

Value

Fitted alpha, S11, S12 and S22 after one iteration.

EMstep_dph	<i>EM for discrete phase-type</i>
------------	-----------------------------------

Description

EM for discrete phase-type

Usage

EMstep_dph(alpha, S, obs, weight)

Arguments

alpha	Initial probabilities.
S	Sub-transition matrix.
obs	The observations.
weight	The weights for the observations.

EMstep_dph_MoE	<i>EM for discrete phase-type MoE</i>
----------------	---------------------------------------

Description

EM for discrete phase-type MoE

Usage

EMstep_dph_MoE(alpha, S, obs, weight)

Arguments

alpha	Initial probabilities.
S	Sub-transition matrix.
obs	The observations.
weight	The weights for the observations.

EMstep_mdph	<i>EM for multivariate discrete phase-type</i>
-------------	--

Description

EM for multivariate discrete phase-type

Usage

EMstep_mdph(alpha, S_list, obs, weight)

Arguments

alpha	Initial probabilities.
S_list	List of marginal sub-transition matrices.
obs	The observations.
weight	The weights for the observations.

EMstep_mdph_MoE	<i>EM for multivariate discrete phase-type MoE</i>
-----------------	--

Description

EM for multivariate discrete phase-type MoE

Usage

```
EMstep_mdph_MoE(alpha, S_list, obs, weight)
```

Arguments

alpha	Initial probabilities.
S_list	List of marginal sub-transition matrices.
obs	The observations.
weight	The weights for the observations.

EMstep_MoE_PADE	<i>EM for PH-MoE</i>
-----------------	----------------------

Description

No recycling of information

Usage

```
EMstep_MoE_PADE(alpha, S, obs, weight, rcens, rcweight)
```

Arguments

alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	The weights for the observations.
rcens	Censored observations.
rcweight	The weights for the censored observations.

EMstep_PADE	<i>EM for phase-type distributions using Pade approximation for matrix exponential</i>
-------------	--

Description

EM for phase-type distributions using Pade approximation for matrix exponential

Usage

EMstep_PADE(h, alpha, S, obs, weight, rcens, rcweight)

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	The weights for the observations.
rcens	Censored observations.
rcweight	The weights for the censored observations.

EMstep_RK	<i>EM step for phase-type using Runge-Kutta</i>
-----------	---

Description

Computes one step of the EM algorithm by using a Runge-Kutta method of fourth order.

Usage

EMstep_RK(h, alpha, S, obs, weight, rcens, rcweight)

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	The weights for the observations.
rcens	Censored observations.
rcweight	The weights for the censored observations.

EMstep_UNI	<i>EM for phase-type using uniformization for matrix exponential</i>
------------	--

Description

EM for phase-type using uniformization for matrix exponential

Usage

EMstep_UNI(h, alpha, S, obs, weight, rcens, rcweight)

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	The weights for the observations.
rcens	Censored observations.
rcweight	The weights for the censored observations.

EM_step_mPH_rc	<i>EM step for the mPH class with right-censoring, for different marginal sub-intensity matrices</i>
----------------	--

Description

EM step for the mPH class with right-censoring, for different marginal sub-intensity matrices

Usage

EM_step_mPH_rc(alpha, S_list, y, delta, h)

Arguments

alpha	Common initial distribution vector.
S_list	List of marginal sub-intensity matrices.
y	Matrix of marginal observations.
delta	Matrix with right-censoring indications (1 uncensored, 0 right-censored).
h	Tolerance of uniformization.

evaluate	<i>New generic for evaluating survival matrix distributions</i>
----------	---

Description

Methods are available for objects of class [sph](#).

Usage

```
evaluate(x, subject, ...)
```

Arguments

x	An object of the model class.
subject	A vector of data.
...	Further parameters to be passed on.

evaluate, sph-method	<i>Evaluation method for sph Class</i>
----------------------	--

Description

Evaluation method for sph Class

Usage

```
## S4 method for signature 'sph'  
evaluate(x, subject)
```

Arguments

x	An object of class sph .
subject	Covariates of a single subject.

Value

A [ph](#) model.

expmat

Matrix exponential

Description

Armadillo matrix exponential implementation.

Usage

```
expmat(A)
```

Arguments

A A matrix.

Value

exp(A).

expm_terms

expm terms of phase-type likelihood using uniformization

Description

expm terms of phase-type likelihood using uniformization

Usage

```
expm_terms(h, S, obs)
```

Arguments

h Positive parameter.
S Sub-intensity matrix.
obs The observations.

find_n	<i>Find n such that $P(N > n) = h$ with N Poisson distributed</i>
--------	---

Description

Find n such that $P(N > n) = h$ with N Poisson distributed

Usage

```
find_n(h, lambda)
```

Arguments

h	Probability.
lambda	Mean of Poisson random variable.

Value

Integer satisfying condition.

find_weight	<i>Find weight of observations</i>
-------------	------------------------------------

Description

Find weight of observations

Usage

```
find_weight(x)
```

Arguments

x	A vector of observations from which we want to know their weights.
---	--

Value

A matrix with unique observations as first column and associated weights for second column.

Fisher	<i>New generic for obtaining the Fisher information of survival matrix distributions</i>
--------	--

Description

Methods are available for objects of class [sph](#).

Usage

```
Fisher(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Fisher,sph-method	<i>Fisher information method for sph class</i>
-------------------	--

Description

Fisher information method for sph class

Usage

```
## S4 method for signature 'sph'
Fisher(x, y, X, w = numeric(0))
```

Arguments

x	An object of class sph .
y	Independent variate.
X	Matrix of covariates.
w	Weights.

Value

A matrix.

fit	<i>New generic for estimating matrix distributions</i>
-----	--

Description

Methods are available for objects of class [ph](#).

Usage

```
fit(x, y, ...)
```

Arguments

x	An object of the model class.
y	A vector of data.
...	Further parameters to be passed on.

Value

An object of the fitted model class.

fit,bivdph-method	<i>Fit method for bivdph Class</i>
-------------------	------------------------------------

Description

Fit method for bivdph Class

Usage

```
## S4 method for signature 'bivdph'
fit(x, y, weight = numeric(0), stepsEM = 1000, every = 10)
```

Arguments

x	An object of class bivdph .
y	A matrix with the data.
weight	Vector of weights.
stepsEM	Number of EM steps to be performed.
every	Number of iterations between likelihood display updates.

Value

An object of class [bivdph](#).

Examples

```
obj <- bivdph(dimensions = c(3, 3))
data <- sim(obj, n = 100)
fit(obj, data, stepsEM = 100, every = 50)
```

fit,bivph-method *Fit method for bivph Class*

Description

Fit method for bivph Class

Usage

```
## S4 method for signature 'bivph'
fit(
  x,
  y,
  weight = numeric(0),
  stepsEM = 1000,
  maxit = 100,
  reltol = 1e-08,
  every = 10
)
```

Arguments

x	An object of class bivph .
y	A matrix with the data.
weight	Vector of weights.
stepsEM	Number of EM steps to be performed.
maxit	Maximum number of iterations when optimizing g functions.
reltol	Relative tolerance when optimizing g functions.
every	Number of iterations between likelihood display updates.

Value

An object of class [bivph](#).

Examples

```
obj <- bivph(dimensions = c(3, 3))
data <- sim(obj, n = 100)
fit(obj, data, stepsEM = 100, every = 50)
```

fit,dph-method	<i>Fit method for dph class</i>
----------------	---------------------------------

Description

Fit method for dph class

Usage

```
## S4 method for signature 'dph'  
fit(x, y, weight = numeric(0), stepsEM = 1000, every = 100)
```

Arguments

x	An object of class dph .
y	Vector or data.
weight	Vector of weights.
stepsEM	Number of EM steps to be performed.
every	Number of iterations between likelihood display updates.

Value

An object of class [dph](#).

Examples

```
obj <- dph(structure = "general", dimension = 2)  
data <- sim(obj, n = 100)  
fit(obj, data, stepsEM = 100, every = 20)
```

fit,mdph-method	<i>Fit method for mdph Class</i>
-----------------	----------------------------------

Description

Fit method for mdph Class

Usage

```
## S4 method for signature 'mdph'  
fit(x, y, weight = numeric(0), stepsEM = 1000, every = 10)
```

Arguments

x	An object of class <code>mdph</code> .
y	A matrix with the data.
weight	Vector of weights.
stepsEM	Number of EM steps to be performed.
every	Number of iterations between likelihood display updates.

Value

An object of class `mdph`.

Examples

```
obj <- mdph(structure = c("general", "general"))
data <- sim(obj, n = 100)
fit(obj, data, stepsEM = 100, every = 50)
```

fit,mph-method

Fit method for mph Class

Description

Fit method for mph Class

Usage

```
## S4 method for signature 'mph'
fit(
  x,
  y,
  delta = numeric(0),
  stepsEM = 1000,
  equal_marginals = FALSE,
  r = 1,
  maxit = 100,
  reltol = 1e-08
)
```

Arguments

x	An object of class <code>mph</code> .
y	Matrix of data.
delta	Matrix with right-censoring indicators (1 uncensored, 0 right censored).
stepsEM	Number of EM steps to be performed.

equal_marginals	Logical. If TRUE, all marginals are fitted to be equal.
r	Sub-sampling parameter, defaults to 1.
maxit	Maximum number of iterations when optimizing g function.
reltol	Relative tolerance when optimizing g function.

Examples

```
obj <- mph(structure = c("general", "coxian"))
data <- sim(obj, 100)
fit(x = obj, y = data, stepsEM = 20)
```

fit,MPHstar-method	<i>Fit method for mph class</i>
--------------------	---------------------------------

Description

Fit method for mph class

Usage

```
## S4 method for signature 'MPHstar'
fit(
  x,
  y,
  weight = numeric(0),
  stepsEM = 1000,
  uni_epsilon = 1e-04,
  zero_tol = 1e-04,
  every = 100,
  plot = F,
  r = 1,
  replace = F
)
```

Arguments

x	An object of class MPHstar .
y	A matrix of marginal data.
weight	A matrix of marginal weights.
stepsEM	The number of EM steps to be performed, defaults to 1000.
uni_epsilon	The epsilon parameter for the uniformization method, defaults to 1e-4.
zero_tol	The smallest value that a reward can take (to avoid numerical instability), defaults to 1e-4.

every	The number of iterations between likelihood display updates. The originating distribution is used, given that there is no explicit density.
plot	Boolean that determines if the plot of the loglikelihood evolution is plotted, defaults to False.
r	The sub-sampling proportion for stochastic EM, defaults to 1.
replace	Boolean that determines if sub-sampling is done with replacement or not, defaults to False.

Value

An object of class [MPHstar](#).

Examples

```
set.seed(123)
obj <- MPHstar(structure = "general")
data <- sim(obj, 100)
fit(obj, data, stepsEM = 20)
```

fit,ph-method

Fit method for ph class

Description

Fit method for ph class

Usage

```
## S4 method for signature 'ph'
fit(
  x,
  y,
  weight = numeric(0),
  rcen = numeric(0),
  rcenweight = numeric(0),
  stepsEM = 1000,
  methods = c("RK", "RK"),
  rkstep = NA,
  uni_epsilon = NA,
  maxit = 100,
  reltol = 1e-08,
  every = 100,
  r = 1
)
```

Arguments

x	An object of class ph .
y	Vector or data.
weight	Vector of weights.
rcen	Vector of right-censored observations.
rcenweight	Vector of weights for right-censored observations.
stepsEM	Number of EM steps to be performed.
methods	Methods to use for matrix exponential calculation: RM, UNI or PADE.
rkstep	Runge-Kutta step size (optional).
uni_epsilon	Epsilon parameter for uniformization method.
maxit	Maximum number of iterations when optimizing g function.
reltol	Relative tolerance when optimizing g function.
every	Number of iterations between likelihood display updates.
r	Sub-sampling proportion for stochastic EM, defaults to 1.

Value

An object of class [ph](#).

Examples

```
obj <- iph(ph(structure = "general", dimension = 2), gfun = "weibull", gfun_pars = 2)
data <- sim(obj, n = 100)
fit(obj, data, stepsEM = 100, every = 20)
```

haz

New generic for the hazard rate of matrix distributions

Description

Methods are available for objects of class [ph](#).

Usage

```
haz(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Value

Hazard rate from the matrix distribution.

haz, ph-method	<i>Hazard rate method for phase-type distributions</i>
----------------	--

Description

Hazard rate method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
haz(x, y)
```

Arguments

x	An object of class <code>ph</code> .
y	A vector of locations.

Value

A vector containing the hazard rate evaluations at the given locations.

Examples

```
obj <- ph(structure = "general")
haz(obj, c(1, 2, 3))
```

inf_norm	<i>L inf norm of a matrix</i>
----------	-------------------------------

Description

Computes the L inf norm of a matrix A, which is defined as: $L_inf(A) = \max(1 \leq i \leq M) \sum(1 \leq j \leq N) \text{abs}(A(i,j))$.

Usage

```
inf_norm(A)
```

Arguments

A	A matrix.
---	-----------

Value

The L inf norm.

initial_state	<i>Initial state of Markov jump process</i>
---------------	---

Description

Given the accumulated values of the initial probabilities alpha and a uniform value u, it returns the initial state of a Markov jump process. This corresponds to the states satisfying $\text{cum_alpha}_{(k-1)} < u < \text{cum_alpha}_{(k)}$.

Usage

```
initial_state(cum_alpha, u)
```

Arguments

cum_alpha	A cummulated vector of initial probabilities.
u	Random value in (0,1).

Value

Initial state of the Markov jump process.

iph	<i>Constructor function for inhomogeneous phase-type distributions</i>
-----	--

Description

Constructor function for inhomogeneous phase-type distributions

Usage

```
iph(  
  ph = NULL,  
  gfun = NULL,  
  gfun_pars = NULL,  
  alpha = NULL,  
  S = NULL,  
  structure = NULL,  
  dimension = 3,  
  scale = 1  
)
```

Arguments

ph	An object of class ph .
gfun	Inhomogeneity transform.
gfun_pars	The parameters of the inhomogeneity function.
alpha	A probability vector.
S	A sub-intensity matrix.
structure	A valid ph structure.
dimension	The dimension of the ph structure (if provided).
scale	Scale.

Value

An object of class [iph](#).

Examples

```
iph(ph(structure = "coxian", dimension = 4), gfun = "pareto", gfun_pars = 3)
```

 iph-class

Inhomogeneous phase-type distributions

Description

Class of objects for inhomogeneous phase-type distributions.

Value

Class object.

Slots

name Name of the phase-type distribution.
 gfun A list comprising of the parameters.
 scale Scale.

laplace	<i>New generic for Laplace transform of matrix distributions</i>
---------	--

Description

Methods are available for objects of class `ph`.

Usage

```
laplace(x, ...)
```

Arguments

<code>x</code>	An object of the model class.
<code>...</code>	Further parameters to be passed on.

Value

Laplace transform of the matrix distribution.

laplace, bivph-method	<i>Laplace method for bivph class</i>
-----------------------	---------------------------------------

Description

Laplace method for bivph class

Usage

```
## S4 method for signature 'bivph'
laplace(x, r)
```

Arguments

<code>x</code>	An object of class <code>mph</code> .
<code>r</code>	A matrix of real values.

Value

A vector containing the corresponding Laplace transform evaluations.

Examples

```
obj <- bivph(dimensions = c(3, 3))
laplace(obj, matrix(c(0.5, 1), ncol = 2))
```

laplace,mp-method *Laplace method for multivariate phase-type distributions*

Description

Laplace method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'  
laplace(x, r)
```

Arguments

x An object of class [mph](#).
r A matrix of real values.

Value

A vector containing the corresponding Laplace transform evaluations.

Examples

```
set.seed(123)  
obj <- mph(structure = c("general", "general"))  
laplace(obj, matrix(c(0.5, 1), ncol = 2))
```

laplace,ph-method *Laplace method for phase-type distributions*

Description

Laplace method for phase-type distributions

Usage

```
## S4 method for signature 'ph'  
laplace(x, r)
```

Arguments

x An object of class [ph](#).
r A vector of real values.

Value

The Laplace transform of the [ph](#) (or underlying [ph](#)) object at the given locations.

Examples

```
set.seed(123)
obj <- ph(structure = "general", dimension = 3)
laplace(obj, 3)
```

linCom	<i>New generic for linear combinations of multivariate matrix distributions</i>
--------	---

Description

Methods are available for objects of multivariate classes.

Usage

```
linCom(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Value

Marginal of the matrix distribution.

linCom, bivph-method	<i>Linear combination method for bivariate phase-type distributions</i>
----------------------	---

Description

Linear combination method for bivariate phase-type distributions

Usage

```
## S4 method for signature 'bivph'
linCom(x, w = c(1, 1))
```

Arguments

x	An object of class bivph .
w	A vector with non-negative entries.

Value

An object of class `ph`.

Examples

```
obj <- bivph(dimensions = c(3, 3))
linCom(obj, c(1, 0))
```

`linCom,MPHstar-method` *Linear combination method for MPHstar class*

Description

Linear combination method for MPHstar class

Usage

```
## S4 method for signature 'MPHstar'
linCom(x, w)
```

Arguments

`x` An object of class `MPHstar`.
`w` A vector with non-negative entries.

Value

An object of class `ph`.

Examples

```
obj <- MPHstar(structure = "general")
linCom(obj, c(1, 0))
```

`linear_combination` *Computes PH parameters of a linear combination of vector from MPHstar*

Description

Computes PH parameters of a linear combination of vector from MPHstar

Usage

```
linear_combination(w, alpha, S, R)
```

Arguments

w	Vector with weights.
alpha	Initial distribution vector.
S	Sub-intensity matrix.
R	Reward matrix.

Value

A list of PH parameters.

logLik,ph-method	<i>Loglikelihood method for ph class</i>
------------------	--

Description

Loglikelihood method for ph class

Usage

```
## S4 method for signature 'ph'  
logLik(object)
```

Arguments

object An object of class [ph](#).

Value

An object of class logLik.

Examples

```
obj <- iph(ph(structure = "general", dimension = 2), gfun = "weibull", gfun_pars = 2)  
data <- sim(obj, n = 100)  
fitted_ph <- fit(obj, data, stepsEM = 10)  
logLik(fitted_ph)
```

logLikelihoodbivDPH *Loglikelihood for bivariate discrete phase-type*

Description

Loglikelihood for bivariate discrete phase-type

Usage

```
logLikelihoodbivDPH(alpha, S11, S12, S22, obs, weight)
```

Arguments

alpha	Initial probabilities.
S11	Sub-transition matrix.
S12	Matrix.
S22	Sub-transition matrix.
obs	The observations.
weight	The weights of the observations.

logLikelihoodbivDPH_MoE

Loglikelihood for bivariate discrete phase-type MoE

Description

Loglikelihood for bivariate discrete phase-type MoE

Usage

```
logLikelihoodbivDPH_MoE(alpha, S11, S12, S22, obs, weight)
```

Arguments

alpha	Initial probabilities.
S11	Sub-transition matrix.
S12	Matrix.
S22	Sub-transition matrix.
obs	The observations.
weight	The weights of the observations.

logLikelihoodbivPH *Loglikelihood for Bivariate PH*

Description

Loglikelihood for Bivariate PH

Usage

```
logLikelihoodbivPH(alpha, S11, S12, S22, obs, weight)
```

Arguments

alpha	Vector of initial probabilities.
S11	Sub-intensity matrix.
S12	Matrix.
S22	Sub-intensity matrix.
obs	The observations.
weight	The weights of the observations.

logLikelihoodDPH *Loglikelihood for discrete phase-type*

Description

Loglikelihood for discrete phase-type

Usage

```
logLikelihoodDPH(alpha, S, obs, weight)
```

Arguments

alpha	Initial probabilities.
S	Sub-transition matrix.
obs	The observations.
weight	The weights of the observations.

logLikelihoodDPH_MoE *Loglikelihood for discrete phase-type MoE*

Description

Loglikelihood for discrete phase-type MoE

Usage

```
logLikelihoodDPH_MoE(alpha, S, obs, weight)
```

Arguments

alpha	Initial probabilities.
S	Sub-transition matrix.
obs	The observations.
weight	The weights of the observations.

logLikelihoodmDPH *Loglikelihood for multivariate discrete phase-type*

Description

Loglikelihood for multivariate discrete phase-type

Usage

```
logLikelihoodmDPH(alpha, S_list, obs, weight)
```

Arguments

alpha	Initial probabilities.
S_list	List of marginal sub-transition matrices.
obs	The observations.
weight	The weights of the observations.

logLikelihoodmDPH_MoE *Loglikelihood for multivariate discrete phase-type MoE*

Description

Loglikelihood for multivariate discrete phase-type MoE

Usage

```
logLikelihoodmDPH_MoE(alpha, S_list, obs, weight)
```

Arguments

alpha	Initial probabilities.
S_list	List of marginal sub-transition matrices.
obs	The observations.
weight	The weights of the observations.

logLikelihoodMgev_PADE

Loglikelihood of matrix-GEV using Pade

Description

Loglikelihood for a sample

Usage

```
logLikelihoodMgev_PADE(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

logLikelihoodMgev_RK *Loglikelihood of matrix-GEV using Runge-Kutta*

Description

Loglikelihood for a sample.

Usage

logLikelihoodMgev_RK(h, alpha, S, beta, obs, weight, rcens, rcweight)

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

logLikelihoodMgev_UNI *Loglikelihood of matrix-GEV using uniformization*

Description

Loglikelihood for a sample.

Usage

logLikelihoodMgev_UNI(h, alpha, S, beta, obs, weight, rcens, rcweight)

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	censored observations.
rcweight	Weights of the censored observations.

 logLikelihoodMgompertz_PADE

Loglikelihood of matrix-Gompertz using Pade

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMgompertz_PADE(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

 logLikelihoodMgompertz_PADEs

Loglikelihood of PI with matrix-Gompertz using Pade

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMgompertz_PADEs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity.
beta	Inhomogeneity parameter.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodMgompertz_RK

Loglikelihood of matrix-Gompertz using Runge-Kutta

Description

Loglikelihood for a sample.

Usage

logLikelihoodMgompertz_RK(h, alpha, S, beta, obs, weight, rcens, rcweight)

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

`logLikelihoodMgompertz_RKs`*Loglikelihood of PI with matrix-Gompertz using Runge-Kutta*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMgompertz_RKs(  
  h,  
  alpha,  
  S,  
  beta,  
  obs,  
  weight,  
  rcens,  
  rcweight,  
  scale1,  
  scale2  
)
```

Arguments

<code>h</code>	Step-length.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>beta</code>	Parameter of transformation.
<code>obs</code>	The observations.
<code>weight</code>	Weights of the observations.
<code>rcens</code>	Censored observations.
<code>rcweight</code>	Weights of the censored observations.
<code>scale1</code>	Scale for observations.
<code>scale2</code>	Scale for censored observations.

logLikelihoodMgompertz_UNI

Loglikelihood of matrix-Gompertz using uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMgompertz_UNI(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	censored observations.
rcweight	Weights of the censored observations.

logLikelihoodMgompertz_UNIs

Loglikelihood of PI with matrix-Gompertz using Uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMgompertz_UNIs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodMloglogistic_PADE

Loglikelihood of matrix-loglogistic using Pade

Description

Loglikelihood for a sample.

Usage

logLikelihoodMloglogistic_PADE(h, alpha, S, beta, obs, weight, rcens, rcweight)

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

`logLikelihoodMloglogistic_PADEs`*Loglikelihood of PI with matrix-loglogistic using Pade*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMloglogistic_PADEs(  
  h,  
  alpha,  
  S,  
  beta,  
  obs,  
  weight,  
  rcens,  
  rcweight,  
  scale1,  
  scale2  
)
```

Arguments

<code>h</code>	Nuisance parameter.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>beta</code>	Inhomogeneity parameter.
<code>obs</code>	The observations.
<code>weight</code>	Weights of the observations.
<code>rcens</code>	Censored observations.
<code>rcweight</code>	Weights of the censored observations.
<code>scale1</code>	Scale for observations.
<code>scale2</code>	Scale for censored observations.

```
logLikelihoodMloglogistic_RK
```

Loglikelihood of matrix-loglogistic using Runge-Kutta

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMloglogistic_RK(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameters of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

```
logLikelihoodMloglogistic_RKs
```

Loglikelihood of PI with matrix-loglogistic using Runge-Kutta

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMloglogistic_RKs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameters of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodMloglogistic_UNI

Loglikelihood of matrix-loglogistic using uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMloglogistic_UNI(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	censored observations.
rcweight	Weights of the censored observations.

`logLikelihoodMloglogistic_UNIs`*Loglikelihood of PI with matrix-loglogistic using uniformization*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMloglogistic_UNIs(  
  h,  
  alpha,  
  S,  
  beta,  
  obs,  
  weight,  
  rcens,  
  rcweight,  
  scale1,  
  scale2  
)
```

Arguments

<code>h</code>	Positive parameter.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>beta</code>	Parameter of transformation.
<code>obs</code>	The observations.
<code>weight</code>	Weights of the observations.
<code>rcens</code>	Censored observations.
<code>rcweight</code>	Weights of the censored observations.
<code>scale1</code>	Scale for observations.
<code>scale2</code>	Scale for censored observations.

logLikelihoodMlognormal_PADE

Loglikelihood of matrix-lognormal using Pade

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMlognormal_PADE(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

logLikelihoodMlognormal_PADEs

Loglikelihood of PI with matrix-lognormal using Pade

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMlognormal_PADEs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

 logLikelihoodMlognormal_RK

Loglikelihood of matrix-lognormal using Runge-Kutta

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMlognormal_RK(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

`logLikelihoodMlognormal_RKs`*Loglikelihood of PI matrix-lognormal using Runge-Kutta*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMlognormal_RKs(  
  h,  
  alpha,  
  S,  
  beta,  
  obs,  
  weight,  
  rcens,  
  rcweight,  
  scale1,  
  scale2  
)
```

Arguments

<code>h</code>	Step-length.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>beta</code>	Parameter of transformation.
<code>obs</code>	The observations.
<code>weight</code>	Weights of the observations.
<code>rcens</code>	Censored observations.
<code>rcweight</code>	Weights of the censored observations.
<code>scale1</code>	Scale for observations.
<code>scale2</code>	Scale for censored observations.

 logLikelihoodMlognormal_UNI

Loglikelihood of matrix-lognormal using uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMlognormal_UNI(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	censored observations.
rcweight	Weights of the censored observations.

 logLikelihoodMlognormal_UNIs

Loglikelihood of PI with matrix-lognormal using uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMlognormal_UNIs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodMpareto_PADE

Loglikelihood of matrix-Pareto using Pade

Description

Loglikelihood for a sample.

Usage

logLikelihoodMpareto_PADE(h, alpha, S, beta, obs, weight, rcens, rcweight)

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

`logLikelihoodMpareto_PADEs`*Loglikelihood of PI with matrix-Pareto using Pade*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMpareto_PADEs(  
  h,  
  alpha,  
  S,  
  beta,  
  obs,  
  weight,  
  rcens,  
  rcweight,  
  scale1,  
  scale2  
)
```

Arguments

<code>h</code>	Nuisance parameter.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>beta</code>	Inhomogeneity parameter.
<code>obs</code>	The observations.
<code>weight</code>	Weights of the observations.
<code>rcens</code>	Censored observations.
<code>rcweight</code>	Weights of the censored observations.
<code>scale1</code>	Scale for observations.
<code>scale2</code>	Scale for censored observations.

logLikelihoodMpareto_RK

Loglikelihood of matrix-Pareto using Runge-Kutta

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMpareto_RK(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

logLikelihoodMpareto_RKs

Loglikelihood of PI with matrix-Pareto using Runge-Kutta

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMpareto_RKs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodMpareto_UNI

Loglikelihood of matrix-Pareto using uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMpareto_UNI(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	censored observations.
rcweight	Weights of the censored observations.

`logLikelihoodMpareto_UNIs`*Loglikelihood of PI with matrix-Pareto using uniformization*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMpareto_UNIs(  
  h,  
  alpha,  
  S,  
  beta,  
  obs,  
  weight,  
  rcens,  
  rcweight,  
  scale1,  
  scale2  
)
```

Arguments

<code>h</code>	Positive parameter.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>beta</code>	Parameter of transformation.
<code>obs</code>	The observations.
<code>weight</code>	Weights of the observations.
<code>rcens</code>	Censored observations.
<code>rcweight</code>	Weights of the censored observations.
<code>scale1</code>	Scale for observations.
<code>scale2</code>	Scale for censored observations.

 logLikelihoodMweibull_PADE

Loglikelihood of matrix-Weibull using Pade

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMweibull_PADE(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

 logLikelihoodMweibull_PADEs

Loglikelihood of PI with matrix-Weibull using Pade

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMweibull_PADEs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Inhomogeneity parameter.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodMweibull_RK

Loglikelihood of matrix-Weibull using Runge-Kutta

Description

Loglikelihood for a sample.

Usage

logLikelihoodMweibull_RK(h, alpha, S, beta, obs, weight, rcens, rcweight)

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

`logLikelihoodMweibull_RKs`*Loglikelihood of PI with matrix-Weibull using Runge-Kutta*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMweibull_RKs(  
  h,  
  alpha,  
  S,  
  beta,  
  obs,  
  weight,  
  rcens,  
  rcweight,  
  scale1,  
  scale2  
)
```

Arguments

<code>h</code>	Step-length.
<code>alpha</code>	Initial probabilities.
<code>S</code>	Sub-intensity matrix.
<code>beta</code>	Parameter of transformation.
<code>obs</code>	The observations.
<code>weight</code>	Weights of the observations.
<code>rcens</code>	Censored observations.
<code>rcweight</code>	Weights of the censored observations.
<code>scale1</code>	Scale for observations.
<code>scale2</code>	Scale for censored observations.

logLikelihoodMweibull_UNI

Loglikelihood of matrix-Weibull using uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMweibull_UNI(h, alpha, S, beta, obs, weight, rcens, rcweight)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	censored observations.
rcweight	Weights of the censored observations.

logLikelihoodMweibull_UNIs

Loglikelihood of PI with matrix-Weibull using uniformization

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodMweibull_UNIs(
  h,
  alpha,
  S,
  beta,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of transformation.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodPH_MoE *Loglikelihood for PH-MoE*

Description

Loglikelihood for PH-MoE

Usage

```
logLikelihoodPH_MoE(alpha1, alpha2, S, obs, weight, rcens, rcweight)
```

Arguments

alpha1	Initial probabilities for non-censored data.
alpha2	Initial probabilities for censored data.
S	Sub-intensity matrix.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

logLikelihoodPH_PADE *Loglikelihood of phase-type using Pade approximation*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodPH_PADE(h, alpha, S, obs, weight, rcens, rcweight)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.

logLikelihoodPH_PADEs *Loglikelihood of PI with phase-type using Pade*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodPH_PADEs(
  h,
  alpha,
  S,
  obs,
  weight,
  rcens,
  rcweight,
  scale1,
  scale2
)
```

Arguments

h	Nuisance parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	The weights of the observations.
rcens	Censored observations.
rcweight	The weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodPH_RK *Loglikelihood of phase-type using Runge-Kutta*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodPH_RK(h, alpha, S, obs, weight, rcens, rcweight)
```

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

logLikelihoodPH_RKs *Loglikelihood of PI with phase-type using Runge-Kutta*

Description

Loglikelihood for a sample.

Usage

logLikelihoodPH_RKs(h, alpha, S, obs, weight, rcens, rcweight, scale1, scale2)

Arguments

h	Step-length.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

logLikelihoodPH_UNI *Loglikelihood of phase-type using uniformization*

Description

Loglikelihood for a sample.

Usage

logLikelihoodPH_UNI(h, alpha, S, obs, weight, rcens, rcweight)

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.

logLikelihoodPH_UNIs *Loglikelihood of PI with phase-type using uniformization*

Description

Loglikelihood for a sample.

Usage

```
logLikelihoodPH_UNIs(h, alpha, S, obs, weight, rcens, rcweight, scale1, scale2)
```

Arguments

h	Positive parameter.
alpha	Initial probabilities.
S	Sub-intensity matrix.
obs	The observations.
weight	Weights of the observations.
rcens	Censored observations.
rcweight	Weights of the censored observations.
scale1	Scale for observations.
scale2	Scale for censored observations.

LRT *New generic for likelihood ratio test between two matrix distribution models*

Description

Methods are available for objects of class [ph](#).

Usage

```
LRT(x, y, ...)
```

Arguments

x, y	Objects of the model class.
...	Further parameters to be passed on.

Value

A likelihood ratio test result.

LRT, ph, ph-method	<i>LRT method for ph class</i>
--------------------	--------------------------------

Description

LRT method for ph class

Usage

```
## S4 method for signature 'ph,ph'
LRT(x, y)
```

Arguments

x, y Objects of class [ph](#).

Value

LRT between the models.

marginal	<i>New generic for the marginals of multivariate matrix distributions</i>
----------	---

Description

Methods are available for objects of multivariate classes.

Usage

```
marginal(x, ...)
```

Arguments

x An object of the model class.
 ... Further parameters to be passed on.

Value

Marginal of the matrix distribution.

marginal,bivdph-method

Marginal method for bivdph class

Description

Marginal method for bivdph class

Usage

```
## S4 method for signature 'bivdph'  
marginal(x, mar = 1)
```

Arguments

x An object of class [bivdph](#).
mar Indicator of which marginal.

Value

An object of the of class [dph](#).

Examples

```
obj <- bivdph(dimensions = c(3, 3))  
marginal(obj, 1)
```

marginal,biviph-method

Marginal method for biviph class

Description

Marginal method for biviph class

Usage

```
## S4 method for signature 'biviph'  
marginal(x, mar = 1)
```

Arguments

x An object of class [biviph](#).
mar Indicator of which marginal.

Value

An object of the of class [iph](#).

Examples

```
under_bivph <- bivph(dimensions = c(3, 3))
obj <- bivph(under_bivph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
marginal(obj, 1)
```

marginal,bivph-method *Marginal method for bivph class*

Description

Marginal method for bivph class

Usage

```
## S4 method for signature 'bivph'
marginal(x, mar = 1)
```

Arguments

x	An object of class bivph .
mar	Indicator of which marginal.

Value

An object of the of class [ph](#).

Examples

```
obj <- bivph(dimensions = c(3, 3))
marginal(obj, 1)
```

marginal,mdph-method *Marginal method for mdph class*

Description

Marginal method for mdph class

Usage

```
## S4 method for signature 'mdph'  
marginal(x, mar = 1)
```

Arguments

x An object of class [mdph](#).
mar Indicator of which marginal.

Value

An object of the of class [dph](#).

Examples

```
obj <- mdph(structure = c("general", "general"))  
marginal(obj, 1)
```

marginal,miph-method *Marginal method for multivariate inhomogeneous phase-type distributions*

Description

Marginal method for multivariate inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'miph'  
marginal(x, mar = 1)
```

Arguments

x An object of class [miph](#).
mar Indicator of which marginal.

Value

An object of the of class [iph](#).

Examples

```
under_mph <- mph(structure = c("general", "general"))
obj <- mph(under_mph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
marginal(obj, 1)
```

marginal,mph-method *Marginal method for multivariate phase-type distributions*

Description

Marginal method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
marginal(x, mar = 1)
```

Arguments

x	An object of class <code>mph</code> .
mar	Indicator of which marginal.

Value

An object of the of class `ph`.

Examples

```
obj <- mph(structure = c("general", "general"))
marginal(obj, 1)
```

marginal,MPHstar-method *Marginal method for MPHstar class*

Description

Marginal method for MPHstar class

Usage

```
## S4 method for signature 'MPHstar'
marginal(x, mar = 1)
```

Arguments

x An object of class `MPHstar`.
mar Indicator of which marginal.

Value

An object of the of class `ph`.

Examples

```
obj <- MPHstar(structure = "general")  
marginal(obj, 1)
```

marginal_expectation *Marginal conditional expectations*

Description

Marginal conditional expectations

Usage

```
marginal_expectation(rew, pos, N, alpha, S, obs, weight)
```

Arguments

rew Column of the reward matrix corresponding to its marginal.
pos Vector that indicates which state is associated to a positive reward.
N Uniformization parameter.
alpha Marginal initial distribution vector.
S Marginal sub-intensity matrix.
obs Marginal observations.
weight Marginal weights.

Value

A vector with the expected time spent in each state by the marginal, conditional on the observations.

matrix_exponential *Matrix exponential*

Description

MATLAB's built-in algorithm for matrix exponential - Pade approximation.

Usage

matrix_exponential(A)

Arguments

A A matrix.

Value

exp(A).

matrix_inverse *Inverse of a matrix*

Description

Inverse of a matrix

Usage

matrix_inverse(A)

Arguments

A A matrix.

Value

Inverse of A.

matrix_power	<i>Computes A^n</i>
--------------	----------------------------------

Description

Computes A^n

Usage

```
matrix_power(n, A)
```

Arguments

n	An integer.
A	A matrix.

Value

A^n .

matrix_product	<i>Product of two matrices</i>
----------------	--------------------------------

Description

Product of two matrices

Usage

```
matrix_product(A1, A2)
```

Arguments

A1	A matrix.
A2	A matrix.

Value

Computes $A1 * A2$.

matrix_vanloan	<i>Creates the matrix (A1, B1 ; 0, A2)</i>
----------------	--

Description

Creates the matrix (A1, B1 ; 0, A2)

Usage

```
matrix_vanloan(A1, A2, B1)
```

Arguments

A1	Matrix.
A2	Matrix.
B1	Matrix.

Value

Computes (A1, B1 ; 0, A2).

maximum	<i>New generic for maximum of two matrix distributions</i>
---------	--

Description

Methods are available for objects of class [ph](#).

Usage

```
maximum(x1, x2, ...)
```

Arguments

x1	An object of the model class.
x2	An object of the model class.
...	Further parameters to be passed on.

Value

An object of the model class.

Value

An object of class `iph`.

Examples

```
iph1 <- iph(ph(structure = "general", dimension = 3), gfun = "weibull", gfun_pars = 2)
iph2 <- iph(ph(structure = "gcoxian", dimension = 5), gfun = "weibull", gfun_pars = 2)
iph_min <- maximum(iph1, iph2)
iph_min
```

maximum,ph,ph-method *Maximum method for phase-type distributions*

Description

Maximum method for phase-type distributions

Usage

```
## S4 method for signature 'ph,ph'
maximum(x1, x2)
```

Arguments

x1 An object of class `ph`.
x2 An object of class `ph`.

Value

An object of class `ph`.

Examples

```
ph1 <- ph(structure = "general", dimension = 3)
ph2 <- ph(structure = "gcoxian", dimension = 5)
ph_max <- maximum(ph1, ph2)
ph_max
```

max_diagonal	<i>Maximum diagonal element of a matrix</i>
--------------	---

Description

Maximum diagonal element of a matrix

Usage

```
max_diagonal(A)
```

Arguments

A Matrix.

Value

The maximum value in the diagonal.

mdph	<i>Constructor function for multivariate discrete phase-type distributions</i>
------	--

Description

Constructor function for multivariate discrete phase-type distributions

Usage

```
mdph(alpha = NULL, S = NULL, structure = NULL, dimension = 3, variables = NULL)
```

Arguments

alpha A probability vector.
 S A list of sub-transition matrices.
 structure A vector of valid ph structures.
 dimension The dimension of the dph structure (if provided).
 variables The dimension of the multivariate discrete phase-type.

Value

An object of class [mdph](#).

Examples

```
mdph(structure = c("general", "general"), dimension = 5)
```

mdph-class	<i>Multivariate discrete phase-type distributions</i>
------------	---

Description

Class of objects for multivariate discrete phase-type distributions.

Value

Class object.

Slots

`name` Name of the discrete phase-type distribution.

`pars` A list comprising of the parameters.

`fit` A list containing estimation information.

mdphdensity	<i>Multivariate discrete phase-type density</i>
-------------	---

Description

Computes the density of multivariate discrete phase-type distribution with parameters α and S at x .

Usage

```
mdphdensity(x, alpha, S_list)
```

Arguments

`x` Matrix of positive integer values.

`alpha` Initial probabilities.

`S_list` List of marginal sub-transition matrices.

Value

The density at x .

mean,bivdph-method *Mean method for bivdph class*

Description

Mean method for bivdph class

Usage

```
## S4 method for signature 'bivdph'  
mean(x)
```

Arguments

x An object of class [bivdph](#).

Value

The mean of the bivariate discrete phase-type distribution.

Examples

```
obj <- bivdph(dimensions = c(3, 3))  
mean(obj)
```

mean,bivph-method *Mean Method for bivph class*

Description

Mean Method for bivph class

Usage

```
## S4 method for signature 'bivph'  
mean(x)
```

Arguments

x An object of class [bivph](#).

Value

The mean of the bivariate phase-type distribution.

Examples

```
obj <- bivph(dimensions = c(3, 3))  
mean(obj)
```

mean, dph-method	<i>Mean method for discrete phase-type distributions</i>
------------------	--

Description

Mean method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph'  
mean(x)
```

Arguments

x An object of class [dph](#).

Value

The raw first moment of the [dph](#) object.

Examples

```
set.seed(123)  
obj <- dph(structure = "general", dimension = 3)  
mean(obj)
```

mean, mdph-method	<i>Mean method for multivariate discrete phase-type distributions</i>
-------------------	---

Description

Mean method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'  
mean(x)
```

Arguments

x An object of class [mdph](#).

Value

The mean of the multivariate discrete phase-type distribution.

Examples

```
obj <- mdph(structure = c("general", "general"))
mean(obj)
```

mean, mph-method	<i>Mean method for multivariate phase-type distributions</i>
------------------	--

Description

Mean method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
mean(x)
```

Arguments

x An object of class [mph](#).

Value

The mean of the multivariate phase-type distribution.

Examples

```
obj <- mph(structure = c("general", "general"))
mean(obj)
```

mean, MPHstar-method	<i>Mean method for MPHstar class</i>
----------------------	--------------------------------------

Description

Mean method for MPHstar class

Usage

```
## S4 method for signature 'MPHstar'
mean(x)
```

Arguments

x An object of class [MPHstar](#).

Value

The mean of MPHstar distribution.

Examples

```
obj <- MPHstar(structure = "general")
mean(obj)
```

mean, ph-method	<i>Mean method for phase-type distributions</i>
-----------------	---

Description

Mean method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
mean(x)
```

Arguments

x An object of class `ph`.

Value

The raw first moment of the `ph` (or underlying `ph`) object.

Examples

```
set.seed(123)
obj <- ph(structure = "general", dimension = 3)
mean(obj)
```

merge_matrices	<i>Merges the matrices S11, S12 and S22 into a sub-intensity matrix</i>
----------------	---

Description

Merges the matrices S11, S12 and S22 into a sub-intensity matrix

Usage

```
merge_matrices(S11, S12, S22)
```

Arguments

S11	A sub-intensity matrix.
S12	A matrix.
S22	A sub-intensity matrix.

Value

A sub-intensity matrix.

mgevcd	<i>Matrix-GEV cdf</i>
--------	-----------------------

Description

Computes the cdf (tail) of a matrix-GEV distribution with parameters alpha, S and beta at x.

Usage

```
mgevcd(x, alpha, S, beta, lower_tail = TRUE)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Transformation parameters.
lower_tail	Cdf or tail.

Value

The cdf (tail) at x.

 mgevden

Matrix-GEV density

Description

Computes the density of a matrix-GEV distribution with parameters alpha, S and beta at x. Does not allow for atoms in zero.

Usage

```
mgevden(x, alpha, S, beta)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Transformation parameters.

Value

The density at x.

 mgf

New generic for mgf of matrix distributions

Description

Methods are available for objects of class [ph](#).

Usage

```
mgf(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Value

Mgf of the matrix distribution.

mgf,bivph-method *Mgf method for bivph class*

Description

Mgf method for bivph class

Usage

```
## S4 method for signature 'bivph'  
mgf(x, r)
```

Arguments

x An object of class [mph](#).
r A matrix of real values.

Value

A vector containing the corresponding mgf evaluations.

Examples

```
set.seed(123)  
obj <- bivph(dimensions = c(3, 3))  
mgf(obj, matrix(c(0.5, 0.1), ncol = 2))
```

mgf,mph-method *Mgf method for multivariate phase-type distributions*

Description

Mgf method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'  
mgf(x, r)
```

Arguments

x An object of class [mph](#).
r A matrix of real values.

Value

A vector containing the corresponding mgf evaluations.

Examples

```
set.seed(124)
obj <- mph(structure = c("general", "general"))
mgf(obj, matrix(c(0.5, 0.3), ncol = 2))
```

mgf,ph-method

Mgf method for phase-type distributions

Description

Mgf method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
mgf(x, r)
```

Arguments

x An object of class `ph`.

r A vector of real values.

Value

The mgf of the `ph` (or underlying `ph`) object at the given locations.

Examples

```
set.seed(123)
obj <- ph(structure = "general", dimension = 3)
mgf(obj, 0.4)
```

mgompertzcdf	<i>Matrix-Gompertz cdf</i>
--------------	----------------------------

Description

Computes the cdf (tail) of a matrix-Gompertz distribution with parameters alpha, S and beta at x.

Usage

```
mgompertzcdf(x, alpha, S, beta, lower_tail = TRUE)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Shape parameter.
lower_tail	Cdf or tail.

Value

The cdf (tail) at x.

mgompertzden	<i>Matrix-Gompertz density</i>
--------------	--------------------------------

Description

Computes the density of a matrix-Gompertz distribution with parameters alpha, S and beta at x.

Usage

```
mgompertzden(x, alpha, S, beta)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Shape parameter.

Value

The density at x.

 minimum

New generic for minimum of two matrix distributions

Description

Methods are available for objects of class [ph](#).

Usage

```
minimum(x1, x2, ...)
```

Arguments

x1	An object of the model class.
x2	An object of the model class.
...	Further parameters to be passed on.

Value

An object of the model class.

 minimum,dph,dph-method

Minimum method for discrete phase-type distributions

Description

Minimum method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph,dph'
minimum(x1, x2)
```

Arguments

x1	An object of class dph .
x2	An object of class dph .

Value

An object of class [dph](#).

Examples

```
dph1 <- dph(structure = "general", dimension = 3)
dph2 <- dph(structure = "general", dimension = 5)
dph_min <- minimum(dph1, dph2)
dph_min
```

minimum,iph,iph-method

Minimum method for inhomogeneous phase-type distributions

Description

Minimum method for inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'iph,iph'
minimum(x1, x2)
```

Arguments

x1 An object of class `iph`.
x2 An object of class `iph`.

Value

An object of class `iph`.

Examples

```
iph1 <- iph(ph(structure = "general", dimension = 3), gfun = "weibull", gfun_pars = 2)
iph2 <- iph(ph(structure = "gcoxian", dimension = 5), gfun = "weibull", gfun_pars = 2)
iph_min <- minimum(iph1, iph2)
iph_min
```

minimum,ph,ph-method *Minimum method for phase-type distributions*

Description

Minimum method for phase-type distributions

Usage

```
## S4 method for signature 'ph,ph'
minimum(x1, x2)
```

Arguments

x1 An object of class [ph](#).
 x2 An object of class [ph](#).

Value

An object of class [ph](#).

Examples

```
ph1 <- ph(structure = "general", dimension = 3)
ph2 <- ph(structure = "gcoxian", dimension = 5)
ph_min <- minimum(ph1, ph2)
ph_min
```

miph	<i>Constructor function for multivariate inhomogeneous phase-type distributions</i>
------	---

Description

Constructor function for multivariate inhomogeneous phase-type distributions

Usage

```
miph(
  mph = NULL,
  gfun = NULL,
  gfun_pars = NULL,
  alpha = NULL,
  S = NULL,
  structure = NULL,
  dimension = 3,
  variables = NULL,
  scale = 1
)
```

Arguments

mph An object of class [mph](#).
 gfun Vector of inhomogeneity transforms.
 gfun_pars List of parameters for the inhomogeneity functions.
 alpha A probability vector.
 S A list of sub-intensity matrices.
 structure A vector of valid [ph](#) structures.

dimension	The dimension of the ph structure (if provided).
variables	Number of marginals.
scale	Scale.

Value

An object of class [iph](#).

Examples

```
under_mph <- mph(structure = c("gcoxian", "general"), dimension = 4)
miph(under_mph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
```

miph-class	<i>Multivariate inhomogeneous phase-type distributions</i>
------------	--

Description

Class of objects for multivariate inhomogeneous phase-type distributions.

Value

Class object.

Slots

name	Name of the phase type distribution.
gfun	A list comprising of the parameters.
scale	Scale.

mixture	<i>New generic for mixture of two matrix distributions</i>
---------	--

Description

Methods are available for objects of classes [ph](#) and [dph](#).

Usage

```
mixture(x1, x2, ...)
```

Arguments

x1	An object of the model class.
x2	An object of the model class.
...	Further parameters to be passed on.

Value

An object of the model class.

mixture,dph,dph-method

Mixture method for phase-type distributions

Description

Mixture method for phase-type distributions

Usage

```
## S4 method for signature 'dph,dph'
mixture(x1, x2, prob)
```

Arguments

x1	An object of class dph .
x2	An object of class dph .
prob	Probability for first object.

Value

An object of class [dph](#).

Examples

```
dph1 <- dph(structure = "general", dimension = 3)
dph2 <- dph(structure = "general", dimension = 5)
dph_mix <- mixture(dph1, dph2, 0.5)
dph_mix
```

mixture,ph,ph-method

Mixture method for phase-type distributions

Description

Mixture method for phase-type distributions

Usage

```
## S4 method for signature 'ph,ph'
mixture(x1, x2, prob)
```

Arguments

x1	An object of class <code>ph</code> .
x2	An object of class <code>ph</code> .
prob	Probability for first object.

Value

An object of class `ph`.

Examples

```
ph1 <- ph(structure = "general", dimension = 3)
ph2 <- ph(structure = "gcoxian", dimension = 5)
ph_mix <- mixture(ph1, ph2, 0.5)
ph_mix
```

mloglogisticcdf	<i>Matrix-loglogistic cdf</i>
-----------------	-------------------------------

Description

Computes the cdf (tail) of a matrix-loglogistic distribution with parameters α , S and β at x .

Usage

```
mloglogisticcdf(x, alpha, S, beta, lower_tail = TRUE)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Transformation parameters.
lower_tail	Cdf or tail.

Value

The cdf (tail) at x .

mloglogisticden	<i>Matrix-loglogistic density</i>
-----------------	-----------------------------------

Description

Computes the density of a matrix-loglogistic distribution with parameters alpha, S and beta at x.

Usage

```
mloglogisticden(x, alpha, S, beta)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Transformation parameters.

Value

The density at x.

mlognormalcdf	<i>Matrix-lognormal cdf</i>
---------------	-----------------------------

Description

Computes the cdf (tail) of a matrix-lognormal distribution with parameters alpha, S and beta at x.

Usage

```
mlognormalcdf(x, alpha, S, beta, lower_tail = TRUE)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Shape parameter.
lower_tail	Cdf or tail.

Value

The cdf (tail) at x.

mlognormalden	<i>Matrix-lognormal density</i>
---------------	---------------------------------

Description

Computes the density of a matrix-lognormal distribution with parameters alpha, S and beta at x.

Usage

```
mlognormalden(x, alpha, S, beta)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Shape parameter.

Value

The density at x.

MoE	<i>New generic for mixture-of-experts regression with matrix distributions</i>
-----	--

Description

Methods are available for objects of class [ph](#)

Usage

```
MoE(x, y, ...)
```

Arguments

x	An object of the model class.
y	A vector of data.
...	Further parameters to be passed on.

Value

An object of the fitted model class.

MoE,bivdph-method *MoE method for bivdph Class*

Description

MoE method for bivdph Class

Usage

```
## S4 method for signature 'bivdph'
MoE(
  x,
  formula,
  y,
  data,
  alpha_vecs = NULL,
  weight = numeric(0),
  stepsEM = 1000,
  every = 10,
  rand_init = TRUE
)
```

Arguments

x	An object of class bivdph .
formula	A regression formula.
y	A matrix of observations.
data	A data frame of covariates.
alpha_vecs	Matrix of initial probabilities.
weight	Vector of weights.
stepsEM	Number of EM steps to be performed.
every	Number of iterations between likelihood display updates.
rand_init	Random initiation in the R-step.

Value

An object of class [sph](#).

Examples

```
x <- bivdph(dimensions = c(3, 3))
n <- 100
responses <- cbind(rpois(n, 3) + 1, rbinom(n, 5, 0.5))
covariates <- data.frame(age = sample(18:65, n, replace = TRUE) / 100, income = runif(n, 0, 0.99))
f <- responses ~ age + income
MoE(x = x, formula = f, y = responses, data = covariates, stepsEM = 20)
```

MoE, dph-method	<i>MoE method for dph Class</i>
-----------------	---------------------------------

Description

MoE method for dph Class

Usage

```
## S4 method for signature 'dph'
MoE(
  x,
  formula,
  data,
  alpha_vecs = NULL,
  weight = numeric(0),
  stepsEM = 1000,
  every = 10,
  rand_init = TRUE,
  maxWts = 1000
)
```

Arguments

x	An object of class dph .
formula	A regression formula.
data	A data frame.
alpha_vecs	Matrix of initial probabilities.
weight	Vector of weights.
stepsEM	Number of EM steps to be performed.
every	Number of iterations between likelihood display updates.
rand_init	Random initiation in the R-step.
maxWts	Maximal number of weights in the nnet function.

Value

An object of class [sph](#).

Examples

```
x <- dph(structure = "general")
n <- 100
responses <- rpois(n, 3) + 1
covariate <- data.frame(age = sample(18:65, n, replace = TRUE) / 100, income = runif(n, 0, 0.99))
f <- responses ~ age + income # regression formula
MoE(x = x, formula = f, y = responses, data = covariate, stepsEM = 20)
```

MoE,mdph-method

MoE method for mdph Class

Description

MoE method for mdph Class

Usage

```
## S4 method for signature 'mdph'  
MoE(  
  x,  
  formula,  
  y,  
  data,  
  alpha_vecs = NULL,  
  weight = numeric(0),  
  stepsEM = 1000,  
  every = 10,  
  rand_init = TRUE,  
  maxWts = 1000  
)
```

Arguments

x	An object of class mdph .
formula	A regression formula.
y	A matrix of observations.
data	A data frame of covariates.
alpha_vecs	Matrix of initial probabilities.
weight	Vector of weights.
stepsEM	Number of EM steps to be performed.
every	Number of iterations between likelihood display updates.
rand_init	Random initiation in the R-step.
maxWts	Maximal number of weights in the nnet function.

Value

An object of class [sph](#).

Examples

```
x <- mdph(structure = c("general", "general"))
n <- 100
responses <- cbind(rpois(n, 3) + 1, rbinom(n, 5, 0.5))
covariates <- data.frame(age = sample(18:65, n, replace = TRUE) / 100, income = runif(n, 0, 0.99))
f <- responses ~ age + income
MoE(x = x, formula = f, y = responses, data = covariates, stepsEM = 20)
```

MoE,mph-method

*Fit method for mph/miph class, using mixture-of-experts regression***Description**

Fit method for mph/miph class, using mixture-of-experts regression

Usage

```
## S4 method for signature 'mph'
MoE(
  x,
  formula,
  y,
  data,
  alpha_mat = NULL,
  delta = numeric(0),
  stepsEM = 1000,
  r = 1,
  maxit = 100,
  reltol = 1e-08,
  rand_init = T
)
```

Arguments

x	An object of class mph .
formula	a regression formula.
y	A matrix of observations.
data	A data frame of covariates (they need to be scaled for the regression).
alpha_mat	Matrix with initial distribution vectors for each row of observations.
delta	Matrix with right-censoring indicators (1 uncensored, 0 right censored).
stepsEM	Number of EM steps to be performed.
r	Sub-sampling parameter, defaults to 1 (not supported for this method).
maxit	Maximum number of iterations when optimizing the g function (inhomogeneous likelihood).
reltol	Relative tolerance when optimizing g function.
rand_init	Random initiation in the R-step of the EM algorithm.

Examples

```

under_mph <- mph(structure = c("general", "general"), dimension = 3)
x <- miph(under_mph, gfun = c("weibull", "weibull"), gfun_pars = list(c(2), c(3)))
n <- 100
responses <- cbind(rexp(n), rweibull(n, 2, 3))
covariates <- data.frame(age = sample(18:65, n, replace = TRUE) / 100, income = runif(n, 0, 0.99))
f <- responses ~ age + income
MoE(x = x, formula = f, y = responses, data = covariates, stepsEM = 20)

```

MoE,ph-method

*MoE method for ph Class***Description**

MoE method for ph Class

Usage

```

## S4 method for signature 'ph'
MoE(
  x,
  formula,
  data,
  inhom = NULL,
  alpha_vecs = NULL,
  weight = numeric(0),
  delta = numeric(0),
  stepsEM = 1000,
  optim_method = "BFGS",
  maxit = 50,
  reltol = 1e-08,
  every = 10,
  rand_init = TRUE
)

```

Arguments

x	An object of class ph .
formula	A regression formula.
data	A data frame.
inhom	A list with the inhomogeneity functions.
alpha_vecs	Matrix of initial probabilities.s
weight	Vector of weights.
delta	Right-censoring indicator.
stepsEM	Number of EM steps to be performed.

optim_method	Method to use in gradient optimization.
maxit	Maximum number of iterations when optimizing g function.
reltol	Relative tolerance when optimizing g function.
every	Number of iterations between likelihood display updates.
rand_init	Random initiation in the R-step.

Value

An object of class [sph](#).

Examples

```
x <- iph(ph(structure = "general"), gfun = "weibull")
n <- 100
responses <- rweibull(n, 2, 3)
covariate <- data.frame(age = sample(18:65, n, replace = TRUE) / 100, income = runif(n, 0, 0.99))
f <- responses ~ age + income # regression formula
MoE(x = x, formula = f, y = responses, data = covariate, stepsEM = 20)
```

moment	<i>New generic for moments of matrix distributions</i>
--------	--

Description

Methods are available for objects of class [ph](#).

Usage

```
moment(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Value

Moment of the matrix distribution.

moment,bivdph-method *Moment method for bivdph class*

Description

Moment method for bivdph class

Usage

```
## S4 method for signature 'bivdph'  
moment(x, k = c(1, 1))
```

Arguments

x An object of class [bivdph](#).
k A vector with the location.

Value

An real value.

Examples

```
obj <- bivdph(dimensions = c(3, 3))  
moment(obj, c(1, 1))
```

moment,bivph-method *Moment method for bivph class*

Description

Moment method for bivph class

Usage

```
## S4 method for signature 'bivph'  
moment(x, k = c(1, 1))
```

Arguments

x An object of class [bivph](#).
k A vector with the location.

Value

An real value.

Examples

```
obj <- bivph(dimensions = c(3, 3))
moment(obj, c(1, 1))
```

moment,dph-method	<i>Moment method for discrete phase-type distributions</i>
-------------------	--

Description

Moment method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph'
moment(x, k = 1)
```

Arguments

x	An object of class dph .
k	A positive integer (moment order).

Value

The fractional moment of the [dph](#) object.

Examples

```
set.seed(123)
obj <- dph(structure = "general", dimension = 3)
moment(obj, 2)
```

moment,mdph-method	<i>Moment method for multivariate discrete phase-type distributions</i>
--------------------	---

Description

Moment method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'
moment(x, k)
```

Arguments

x	An object of class mdph .
k	A vector of positive integer values.

Value

The corresponding joint factorial moment evaluation.

Examples

```
obj <- mdph(structure = c("general", "general"))
moment(obj, c(2, 1))
```

moment, mph-method *Moment method for multivariate phase-type distributions*

Description

Moment method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
moment(x, k)
```

Arguments

x An object of class `mph`.
k A vector of non-negative integer values.

Value

The corresponding joint moment evaluation.

Examples

```
obj <- mph(structure = c("general", "general"))
moment(obj, c(2, 1))
```

moment, ph-method *Moment method for phase-type distributions*

Description

Moment method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
moment(x, k = 1)
```

Arguments

- x An object of class `ph`.
- k A positive integer (moment order).

Value

The raw moment of the `ph` (or underlying `ph`) object.

Examples

```
set.seed(123)
obj <- ph(structure = "general", dimension = 3)
moment(obj, 2)
```

mparetocdf	<i>Matrix-Pareto cdf</i>
------------	--------------------------

Description

Computes the cdf (tail) of a matrix-Pareto distribution with parameters α , S and β at x .

Usage

```
mparetocdf(x, alpha, S, beta, lower_tail = TRUE)
```

Arguments

- x Non-negative value.
- alpha Initial probabilities.
- S Sub-intensity matrix.
- beta Scale parameter.
- lower_tail Cdf or tail.

Value

The cdf (tail) at x .

mparetoden	<i>Matrix-Pareto density</i>
------------	------------------------------

Description

Computes the density of a matrix-Pareto distribution with parameters alpha, S and beta at x.

Usage

```
mparetoden(x, alpha, S, beta)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Scale parameter.

Value

The density at x.

mph	<i>Constructor function for multivariate phase-type distributions</i>
-----	---

Description

Constructor function for multivariate phase-type distributions

Usage

```
mph(alpha = NULL, S = NULL, structure = NULL, dimension = 3, variables = NULL)
```

Arguments

alpha	A probability vector.
S	A list of sub-intensity matrices.
structure	A vector of valid ph structures.
dimension	The dimension of the ph structure (if provided).
variables	The dimension of the multivariate phase-type.

Value

An object of class [mph](#).

Examples

```
mph(structure = c("gcoxian", "general"), dimension = 5)
```

mph-class	<i>Multivariate phase-type distributions</i>
-----------	--

Description

Class of objects for multivariate phase-type distributions.

Value

Class object.

Slots

name Name of the phase type distribution.
 pars A list comprising of the parameters.
 fit A list containing estimation information.

MPHstar	<i>Constructor function for multivariate phase-type distributions (MPH* class)</i>
---------	--

Description

Constructor function for multivariate phase-type distributions (MPH* class)

Usage

```
MPHstar(  
  alpha = NULL,  
  S = NULL,  
  structure = NULL,  
  dimension = 3,  
  R = NULL,  
  variables = 2  
)
```

Arguments

alpha	A probability vector.
S	A sub-intensity matrix.
structure	A valid ph structure.
dimension	The dimension of the ph structure (if provided).
R	A compatible (non-negative) reward matrix.
variables	The number of desired marginals.

Value

An object of class `MPHstar`.

Examples

```
MPHstar(structure = "general", dimension = 4, variables = 3)
```

MPHstar-class	<i>Multivariate phase-type distributions obtained by transformation via rewards</i>
---------------	---

Description

Class of objects for multivariate phase type distributions.

Slots

name Name of the phase type distribution.
 pars A list comprising of the parameters.

MPHstar_data_aggregation	<i>Prepare data for the MPHstar_EMstep_UNI</i>
--------------------------	--

Description

Prepare data for the MPHstar_EMstep_UNI

Usage

```
MPHstar_data_aggregation(y, w = numeric(0))
```

Arguments

y A matrix with marginal observations, each column corresponds to a marginal.
 w A matrix of weights, each column corresponds to a marginal.

Value

For summed and marginal observations we have a list with matrices of unique observations and their associated weights, separated by uncensored and right-censored data.

MPHstar_EMstep_UNI *EM step using Uniformization for MPHstar class*

Description

EM step using Uniformization for MPHstar class

Usage

MPHstar_EMstep_UNI(h, Rtol, alpha, S, R, mph_obs)

Arguments

h	positive parameter for precision of uniformization method.
Rtol	The smallest value that a reward can take.
alpha	Vector of initial probabilities of the originating distribution.
S	The sub-intensity matrix of the originating distribution.
R	The reward matrix.
mph_obs	The list of summed, marginal observations with associated weights.

mweibullcdf *Matrix-Weibull cdf*

Description

Computes the cdf (tail) of a matrix-Weibull distribution with parameters alpha, S and beta at x.

Usage

mweibullcdf(x, alpha, S, beta, lower_tail = TRUE)

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Shape parameter.
lower_tail	Cdf or tail.

Value

The cdf (tail) at x.

mweibullden	<i>Matrix-Weibull density</i>
-------------	-------------------------------

Description

Computes the density of a matrix-Weibull distribution with parameters alpha, S and beta at x.

Usage

```
mweibullden(x, alpha, S, beta)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Shape parameter.

Value

The density at x.

m_exp_sum	<i>Computes $\exp(Sx)$ via series representation</i>
-----------	---

Description

Computes $\exp(Sx)$ via series representation

Usage

```
m_exp_sum(x, n, pow_vector, a)
```

Arguments

x	A number.
n	An integer.
pow_vector	A vector.
a	A number.

new_state	<i>New state in a Markov jump process</i>
-----------	---

Description

Given a transition matrix Q , a uniform value u , and a previous state k , it returns the new state of a Markov jump process.

Usage

```
new_state(prev_state, cum_embedded_mc, u)
```

Arguments

prev_state	Previous state of the Markov jump process.
cum_embedded_mc	Transition matrix.
u	Random value in (0,1).

Value

Next state of the Markov jump process.

Nfold	<i>New generic for N-fold convolution of two matrix distributions</i>
-------	---

Description

Methods are available for objects of classes [ph](#) and [dph](#).

Usage

```
Nfold(x1, x2, ...)
```

Arguments

x1	An object of the class dph .
x2	An object of the model class.
...	Further parameters to be passed on.

Value

An object of the model class.

Nfold, dph-method	<i>Nfold method for phase-type distributions</i>
-------------------	--

Description

Nfold method for phase-type distributions

Usage

```
## S4 method for signature 'dph'  
Nfold(x1, x2)
```

Arguments

x1	An object of class ph .
x2	An object of class dph .

Value

An object of class [ph](#).

Examples

```
dph1 <- dph(structure = "general", dimension = 3)  
dph2 <- dph(structure = "general", dimension = 2)  
ph0 <- ph(structure = "general", dimension = 2)  
Nfold(dph1, ph0)  
Nfold(dph1, dph2)
```

n_pos	<i>Find how many states have positive reward</i>
-------	--

Description

Find how many states have positive reward

Usage

```
n_pos(R)
```

Arguments

R	reward vector
---	---------------

Value

The number of states with positive rewards

pgf *New generic for pgf of matrix distributions*

Description

Methods are available for objects of class [dph](#).

Usage

```
pgf(x, ...)
```

Arguments

x An object of the model class.
 ... Further parameters to be passed on.

Value

Pgf of the matrix distribution.

pgf, bivdph-method *Pgf method for bivariate discrete phase-type distributions*

Description

Pgf method for bivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'bivdph'  
pgf(x, z)
```

Arguments

x An object of class [bivdph](#).
 z A vector of real values.

Value

The joint pdf of the [dph](#) object at the given location.

Examples

```
obj <- bivdph(dimensions = c(3, 3))  
pgf(obj, c(0.5, 0.2))
```

pgf, dph-method *Pgf Method for discrete phase-type distributions*

Description

Pgf Method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph'
pgf(x, z)
```

Arguments

x An object of class [dph](#).
z A vector of real values.

Value

The probability generating of the [dph](#) object at the given locations.

Examples

```
set.seed(123)
obj <- dph(structure = "general", dimension = 3)
pgf(obj, 0.5)
```

pgf, mdph-method *Pgf method for multivariate discrete phase-type distributions*

Description

Pgf method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'
pgf(x, z)
```

Arguments

x An object of class [mdph](#).
z A matrix of real values.

Value

A vector containing the corresponding pgf evaluations.

Examples

```
obj <- mdph(structure = c("general", "general"))
pgf(obj, matrix(c(0.5, 1), ncol = 2))
```

ph	<i>Constructor function for phase-type distributions</i>
----	--

Description

Constructor function for phase-type distributions

Usage

```
ph(alpha = NULL, S = NULL, structure = NULL, dimension = 3)
```

Arguments

alpha	A probability vector.
S	A sub-intensity matrix.
structure	A valid ph structure: "general", "coxian", "hyperexponential", "gcoxian", or "gerlang".
dimension	The dimension of the ph structure (if structure is provided).

Value

An object of class [ph](#).

Examples

```
ph(structure = "gcoxian", dimension = 5)
ph(alpha = c(.5, .5), S = matrix(c(-1, .5, .5, -1), 2, 2))
```

ph-class	<i>Phase-type distributions</i>
----------	---------------------------------

Description

Class of objects for phase-type distributions.

Value

Class object.

Slots

name Name of the phase-type distribution.
 pars A list comprising of the parameters.
 fit A list containing estimation information.

phcdf	<i>Phase-type cdf</i>
-------	-----------------------

Description

Computes the cdf (tail) of a phase-type distribution with parameters alpha and S at x.

Usage

```
phcdf(x, alpha, S, lower_tail = TRUE)
```

Arguments

x	Non-negative value.
alpha	Initial probabilities.
S	Sub-intensity matrix.
lower_tail	Cdf or tail.

Value

The cdf (tail) at x.

phdensity	<i>Phase-type density</i>
-----------	---------------------------

Description

Computes the density of a phase-type distribution with parameters α and S at x .

Usage

```
phdensity(x, alpha, S)
```

Arguments

x	Non-negative value.
α	Initial probabilities.
S	Sub-intensity matrix.

Value

The density at x .

ph_laplace	<i>Laplace transform of a phase-type distribution</i>
------------	---

Description

Computes the Laplace transform at r of a phase-type distribution with parameters α and S .

Usage

```
ph_laplace(r, alpha, S)
```

Arguments

r	Vector of real values.
α	Vector of initial probabilities.
S	Sub-intensity matrix.

Value

Laplace transform at r .

plus_states	<i>Find which states have positive reward</i>
-------------	---

Description

Find which states have positive reward

Usage

```
plus_states(R)
```

Arguments

R reward vector

Value

A vector with the states (number) that are associated with positive rewards

pow2_matrix	<i>Computes $A^{(2^n)}$</i>
-------------	--

Description

Computes $A^{(2^n)}$

Usage

```
pow2_matrix(n, A)
```

Arguments

n An integer.
A A matrix.

Value

$A^{(2^n)}$.

quan	<i>New generic for the quantile of matrix distributions</i>
------	---

Description

Methods are available for objects of class [ph](#).

Usage

```
quan(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Value

Quantile from the matrix distribution.

quan, ph-method	<i>Quantile method for phase-type distributions</i>
-----------------	---

Description

Quantile method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
quan(x, p)
```

Arguments

x	An object of class ph .
p	A vector of probabilities.

Value

A vector containing the quantile evaluations at the given locations.

Examples

```
obj <- ph(structure = "general")
quan(obj, c(0.5, 0.9, 0.99))
```

random_reward	<i>Random reward matrix</i>
---------------	-----------------------------

Description

Generates a random reward matrix for a multivariate phase-type distribution with p states and d marginals.

Usage

```
random_reward(p, d)
```

Arguments

p	Number of transient states in the sub-intensity matrix.
d	Number of marginals.

Value

A random reward matrix.

random_structure	<i>Random structure of a phase-type</i>
------------------	---

Description

Generates random parameters α and S of a phase-type distribution of dimension p with chosen structure.

Usage

```
random_structure(p, structure = "general", scale_factor = 1)
```

Arguments

p	Dimension of the phase-type.
structure	Type of structure: "general", "hyperexponential", "gerlang", "coxian" or "gcoxian".
scale_factor	A factor that multiplies the sub-intensity matrix.

Value

Random parameters α and S of a phase-type.

random_structure_bivph

Random structure of a bivariate phase-type

Description

Generates random parameters α , S_{11} , S_{12} , and S_{22} of a bivariate phase-type distribution of dimension $p = p_1 + p_2$.

Usage

```
random_structure_bivph(p1, p2, scale_factor = 1)
```

Arguments

p1	Dimension of the first block.
p2	Dimension of the second block.
scale_factor	A factor that multiplies the sub-intensity matrix.

Value

Random parameters α , S_{11} , S_{12} , and S_{22} of a bivariate phase-type.

rdphasetype

Simulate discrete phase-type

Description

Generates a sample of size n from a discrete phase-type distribution with parameters α and S .

Usage

```
rdphasetype(n, alpha, S)
```

Arguments

n	Sample size.
alpha	Vector of initial probabilities.
S	Sub-transition matrix.

Value

Simulated sample.

reg	<i>New generic for regression with matrix distributions</i>
-----	---

Description

Methods are available for objects of class `ph`.

Usage

```
reg(x, y, ...)
```

Arguments

<code>x</code>	An object of the model class.
<code>y</code>	A vector of data.
<code>...</code>	Further parameters to be passed on.

Value

An object of the fitted model class.

reg,ph-method	<i>Regression method for ph Class</i>
---------------	---------------------------------------

Description

Regression method for ph Class

Usage

```
## S4 method for signature 'ph'
reg(
  x,
  y,
  weight = numeric(),
  rcen = numeric(),
  rcenweight = numeric(),
  X = numeric(),
  B0 = numeric(),
  stepsEM = 1000,
  methods = c("RK", "UNI"),
  rkstep = NA,
  uni_epsilon = NA,
  optim_method = "BFGS",
  maxit = 50,
```

```

    reltol = 1e-08,
    every = 10
  )

```

Arguments

x	An object of class ph .
y	Vector or data.
weight	Vector of weights.
rcen	Vector of right-censored observations.
rcenweight	Vector of weights for right-censored observations.
X	Model matrix (no intercept needed).
B0	Initial regression coefficients (optional).
stepsEM	Number of EM steps to be performed.
methods	Methods to use for matrix exponential calculation: RM, UNI, or PADE.
rkstep	Runge-Kutta step size (optional).
uni_epsilon	Epsilon parameter for uniformization method.
optim_method	Method to use in gradient optimization.
maxit	Maximum number of iterations when optimizing g function.
reltol	Relative tolerance when optimizing g function.
every	Number of iterations between likelihood display updates.

Value

An object of class [sph](#).

Examples

```

set.seed(1)
obj <- iph(ph(structure = "general", dimension = 2), gfun = "weibull", gfun_pars = 2)
data <- sim(obj, n = 100)
X <- runif(100)
reg(x = obj, y = data, X = X, stepsEM = 10)

```

revers_data_trans	<i>Applies the inverse of the GEV transformation but giving back the resulting vector in reverse order</i>
-------------------	--

Description

Used for EM step in RK.

Usage

```
revers_data_trans(obs, weights, beta)
```

Arguments

obs	The observations.
weights	Weights of the observations.
beta	Parameters of the GEV.

rew_sanity_check	<i>Transform a reward matrix with very small rewards to avoid numerical problems</i>
------------------	--

Description

Transform a reward matrix with very small rewards to avoid numerical problems

Usage

```
rew_sanity_check(R, tol)
```

Arguments

R	Reward matrix
tol	Lower bound considered for a reward

Value

A reward matrix that does not cause issues with uniformization

riph	<i>Random inhomogeneous phase-type</i>
------	--

Description

Generates a sample of size n from an inhomogeneous phase-type distribution with parameters α , S and β .

Usage

```
riph(n, dist_type, alpha, S, beta)
```

Arguments

n	Sample size.
dist_type	Type of IPH.
alpha	Initial probabilities.
S	Sub-intensity matrix.
beta	Parameter of the transformation.

Value

The simulated sample.

rmatrixgev

Random matrix GEV

Description

Generates a sample of size n from an inhomogeneous phase-type distribution with parameters α , S and β .

Usage

```
rmatrixgev(n, alpha, S, mu, sigma, xi = 0)
```

Arguments

n	Sample size.
alpha	Initial probabilities.
S	Sub-intensity matrix.
mu	Location parameter.
sigma	Scale parameter.
xi	Shape parameter: Default 0 which corresponds to the Gumbel case.

Value

The simulated sample.

rMDPHstar	<i>Simulate MDPH*</i>
-----------	-----------------------

Description

Generates a sample of size n from a MDPH* distribution with parameters α , S , and R .

Usage

```
rMDPHstar(n, alpha, S, R)
```

Arguments

n	Sample size.
α	Vector of initial probabilities.
S	Sub-transition matrix.
R	Reward matrix.

Value

Simulated sample.

rMIPHstar	<i>Simulate a MIPH* random vector</i>
-----------	---------------------------------------

Description

Generates a sample of size n from a MIPH* distribution with parameters α , S and R .

Usage

```
rMIPHstar(n, alpha, S, R, gfun, gfun_par)
```

Arguments

n	Sample size.
α	Initial probabilities.
S	Sub-intensity matrix.
R	Reward matrix.
$gfun$	Vector with transformations names.
$gfun_par$	List with transformations parameters.

Value

The simulated sample.

rMPHstar	<i>Simulate a MPH* random vector</i>
----------	--------------------------------------

Description

Generates a sample of size n from a MPH* distribution with parameters α , S and R .

Usage

```
rMPHstar(n, alpha, S, R)
```

Arguments

n	Sample size.
α	Initial probabilities.
S	Sub-intensity matrix.
R	Reward matrix.

Value

The simulated sample.

rphasetype	<i>Simulate phase-type</i>
------------	----------------------------

Description

Generates a sample of size n from a phase-type distribution with parameters α and S .

Usage

```
rphasetype(n, alpha, S)
```

Arguments

n	Sample size.
α	Vector of initial probabilities.
S	Sub-intensity matrix.

Value

Simulated sample.

runge_kutta	<i>Runge-Kutta for the calculation of the a and b vectors and the c matrix in a EM step</i>
-------------	---

Description

Performs the Runge-Kutta method of fourth order.

Usage

```
runge_kutta(avector, bvector, cmatrix, dt, h, S, s)
```

Arguments

avector	The a vector.
bvector	The b vector.
cmatrix	The c matrix.
dt	The increment.
h	Step-length.
S	Sub-intensity matrix.
s	Exit rates.

show,bivdph-method	<i>Show method for bivariate discrete phase-type distributions</i>
--------------------	--

Description

Show method for bivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'bivdph'
show(object)
```

Arguments

object	An object of class bivdph .
--------	---

show,biviph-method	<i>Show method for bivariate inhomogeneous phase-type distributions</i>
--------------------	---

Description

Show method for bivariate inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'biviph'  
show(object)
```

Arguments

object An object of class [biviph](#).

show,bivph-method	<i>Show method for bivariate phase-type distributions</i>
-------------------	---

Description

Show method for bivariate phase-type distributions

Usage

```
## S4 method for signature 'bivph'  
show(object)
```

Arguments

object An object of class [bivph](#).

show,dph-method	<i>Show method for discrete phase-type distributions</i>
-----------------	--

Description

Show method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph'  
show(object)
```

Arguments

object An object of class [dph](#).

show, iph-method	<i>Show method for inhomogeneous phase-type distributions</i>
------------------	---

Description

Show method for inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'iph'  
show(object)
```

Arguments

object An object of class [iph](#).

show, mdph-method	<i>Show method for multivariate discrete phase-type distributions</i>
-------------------	---

Description

Show method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'  
show(object)
```

Arguments

object An object of class [mdph](#).

show,miph-method	<i>Show method for multivariate inhomogeneous phase-type distributions</i>
------------------	--

Description

Show method for multivariate inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'miph'  
show(object)
```

Arguments

object An object of class [miph](#).

show,mph-method	<i>Show method for multivariate phase-type distributions</i>
-----------------	--

Description

Show method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'  
show(object)
```

Arguments

object An object of class [mph](#).

show, MPHstar-method *Show method for multivariate phase-type distributions*

Description

Show method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'MPHstar'
show(object)
```

Arguments

object An object of class [MPHstar](#).

show, ph-method *Show method for phase-type distributions*

Description

Show method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
show(object)
```

Arguments

object An object of class [ph](#).

show, sph-method *Show method for survival phase-type objects*

Description

Show method for survival phase-type objects

Usage

```
## S4 method for signature 'sph'
show(object)
```

Arguments

object An object of class [sph](#).

sim	<i>New generic for simulating matrix distributions</i>
-----	--

Description

Methods are available for objects of class [ph](#).

Usage

```
sim(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Value

A realization from the matrix distribution.

sim, bivdph-method	<i>Simulation method for bivariate discrete phase-type distributions</i>
--------------------	--

Description

Simulation method for bivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'bivdph'
sim(x, n = 1000)
```

Arguments

x	An object of class bivdph .
n	An integer of length of realization.

Value

A realization of independent and identically distributed bivariate discrete phase-type vector.

Examples

```
obj <- bivdph(dimensions = c(3, 3))
sim(obj, n = 100)
```

sim,bivph-method	<i>Simulation method for bivariate inhomogeneous phase-type distributions</i>
------------------	---

Description

Simulation method for bivariate inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'biviph'
sim(x, n = 1000)
```

Arguments

x	An object of class biviph .
n	An integer of length of realization.

Value

A realization of independent and identically distributed bivariate inhomogeneous phase-type vector.

Examples

```
under_bivph <- bivph(dimensions = c(3, 3))
obj <- bivph(under_bivph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
sim(obj, n = 100)
```

sim,bivph-method	<i>Simulation method for bivariate phase-type distributions</i>
------------------	---

Description

Simulation method for bivariate phase-type distributions

Usage

```
## S4 method for signature 'biviph'
sim(x, n = 1000)
```

Arguments

x	An object of class biviph .
n	An integer of length of realization.

Value

A realization of independent and identically distributed bivariate phase-type vector.

Examples

```
obj <- bivph(dimensions = c(3, 3))
sim(obj, n = 100)
```

sim,dph-method

Simulation method for phase-type distributions

Description

Simulation method for phase-type distributions

Usage

```
## S4 method for signature 'dph'
sim(x, n = 1000)
```

Arguments

x An object of class [dph](#).
n An integer of length of realization.

Value

A realization of independent and identically distributed discrete phase-type variables.

Examples

```
obj <- dph(structure = "general")
sim(obj, n = 100)
```

sim,iph-method

Simulation method for inhomogeneous phase-type distributions

Description

Simulation method for inhomogeneous phase-type distributions

Usage

```
## S4 method for signature 'iph'
sim(x, n = 1000)
```

Arguments

x An object of class `iph`.
n An integer of length of realization.

Value

A realization of independent and identically distributed inhomogeneous phase-type variables.

Examples

```
obj <- iph(ph(structure = "general"), gfun = "lognormal", gfun_pars = 2)
sim(obj, n = 100)
```

sim,mdph-method

Simulation method for multivariate discrete phase-type distributions

Description

Simulation method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'
sim(x, n = 1000, equal_marginals = 0)
```

Arguments

x An object of class `mdph`.
n Length of realization.
equal_marginals Non-negative integer. If positive, it specifies the number of marginals to simulate from, all from the first matrix.

Value

A realization of a multivariate discrete phase-type distribution.

Examples

```
obj <- mdph(structure = c("general", "general"))
sim(obj, 100)
```

sim,miph-method	<i>Simulation method for inhomogeneous multivariate phase-type distributions</i>
-----------------	--

Description

Simulation method for inhomogeneous multivariate phase-type distributions

Usage

```
## S4 method for signature 'miph'
sim(x, n = 1000)
```

Arguments

x	An object of class miph .
n	An integer of length of realization.

Value

A realization of independent and identically distributed inhomogeneous multivariate phase-type variables. If x is a MoE miph an array of dimension c(n,d,m) is returned, with d the number of marginals and m the number of initial distribution vectors.

Examples

```
under_mph <- mph(structure = c("general", "general"))
obj <- miph(under_mph, gfun = c("weibull", "pareto"), gfun_pars = list(c(2), c(3)))
sim(obj, 100)
```

sim,mph-method	<i>Simulation method for multivariate phase-type distributions</i>
----------------	--

Description

Simulation method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
sim(x, n = 1000, equal_marginals = 0)
```

Arguments

x An object of class `mph`.

n Length of realization.

equal_marginals Non-negative integer. If positive, it specifies the number of marginals to simulate from, all from the first matrix.

Value

A realization of a multivariate phase-type distribution.

Examples

```
obj <- mph(structure = c("general", "general"))
sim(obj, 100)
```

sim,MPHstar-method *Simulation method for multivariate phase-type distributions*

Description

Simulation method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'MPHstar'
sim(x, n = 1000)
```

Arguments

x An object of class `MPHstar`.

n Desired sample size for each marginal.

Value

A matrix of sample data for each marginal.

Examples

```
obj <- MPHstar(structure = "general")
sim(obj, 100)
```

sim,ph-method	<i>Simulation method for phase-type distributions</i>
---------------	---

Description

Simulation method for phase-type distributions

Usage

```
## S4 method for signature 'ph'  
sim(x, n = 1000)
```

Arguments

x	An object of class ph .
n	An integer of length of realization.

Value

A realization of independent and identically distributed phase-type variables.

Examples

```
obj <- ph(structure = "general")  
sim(obj, n = 100)
```

sph	<i>Constructor function for survival phase-type objects</i>
-----	---

Description

Constructor function for survival phase-type objects

Usage

```
sph(x = NULL, coefs = list(B = numeric(0), C = numeric(0)), type = "reg")
```

Arguments

x	An object of class ph .
coefs	Coefficients of the survival regression object.
type	Type of survival object.

Value

An object of class [sph](#).

sph-class	<i>Survival analysis for phase-type distributions</i>
-----------	---

Description

Class of objects for inhomogeneous phase-type distributions

Value

Class object

Slots

coefs Coefficients of the survival regression object.

type Type of survival object.

sum_dph	<i>Computes the initial distribution and sub-intensity of the sum of two discrete phase-type distributed random variables</i>
---------	---

Description

Computes the initial distribution and sub-intensity of the sum of two discrete phase-type distributed random variables

Usage

```
sum_dph(alpha1, S1, alpha2, S2)
```

Arguments

alpha1	Initial distribution.
S1	Sub-transition matrix.
alpha2	Initial distribution.
S2	Sub-transition matrix.

sum_ph	<i>Computes the initial distribution and sub-intensity of the sum of two phase-type distributed random variables.</i>
--------	---

Description

Computes the initial distribution and sub-intensity of the sum of two phase-type distributed random variables.

Usage

```
sum_ph(alpha1, S1, alpha2, S2)
```

Arguments

alpha1	Initial distribution.
S1	Sub-intensity matrix.
alpha2	Initial distribution.
S2	Sub-intensity matrix.

TVR	<i>New generic for transformation via rewards of a matrix distribution</i>
-----	--

Description

Methods are available for objects of class [ph](#)

Usage

```
TVR(x, ...)
```

Arguments

x	An object of the model class.
...	Further parameters to be passed on.

Value

An object of the model class.

TVR, dph-method

TVR Method for dph Class

Description

TVR Method for dph Class

Usage

```
## S4 method for signature 'dph'  
TVR(x, rew)
```

Arguments

x An object of class [dph](#).
rew A vector of rewards.

Value

An object of the of class [dph](#).

Examples

```
obj <- dph(structure = "general")  
TVR(obj, c(1, 0, 1))
```

TVR, ph-method

TVR method for ph class

Description

TVR method for ph class

Usage

```
## S4 method for signature 'ph'  
TVR(x, rew)
```

Arguments

x An object of class [ph](#).
rew A vector of rewards.

Value

An object of the of class [ph](#).

Examples

```
obj <- ph(structure = "general")
TVR(obj, c(1, 2, 3))
```

tvr_dph	<i>Performs TVR for discrete phase-type distributions</i>
---------	---

Description

Performs TVR for discrete phase-type distributions

Usage

```
tvr_dph(alpha, S, R)
```

Arguments

alpha	Initial distribution vector.
S	Sub-intensity matrix.
R	Reward vector.

Value

A list of PH parameters.

tvr_ph	<i>Performs TVR for phase-type distributions</i>
--------	--

Description

Performs TVR for phase-type distributions

Usage

```
tvr_ph(alpha, S, R)
```

Arguments

alpha	Initial distribution vector.
S	Sub-intensity matrix.
R	Reward vector.

Value

A list of phase-type parameters.

var,bivdph-method *Var method for bivdph class*

Description

Var method for bivdph class

Usage

```
## S4 method for signature 'bivdph'  
var(x)
```

Arguments

x An object of class [bivdph](#).

Value

The covariance matrix of the bivariate discrete phase-type distribution.

Examples

```
obj <- bivdph(dimensions = c(3, 3))  
var(obj)
```

var,bivph-method *Var method for bivph class*

Description

Var method for bivph class

Usage

```
## S4 method for signature 'bivph'  
var(x)
```

Arguments

x An object of class [bivph](#).

Value

The covariance matrix of the bivariate phase-type distribution.

Examples

```
obj <- bivph(dimensions = c(3, 3))  
var(obj)
```

var , dph-method	<i>Var method for discrete phase-type distributions</i>
------------------	---

Description

Var method for discrete phase-type distributions

Usage

```
## S4 method for signature 'dph'  
var(x)
```

Arguments

x An object of class [dph](#).

Value

The variance of the [dph](#) object.

Examples

```
set.seed(123)  
obj <- dph(structure = "general", dimension = 3)  
var(obj)
```

var , mdph-method	<i>Var method for multivariate discrete phase-type distributions</i>
-------------------	--

Description

Var method for multivariate discrete phase-type distributions

Usage

```
## S4 method for signature 'mdph'  
var(x)
```

Arguments

x An object of class [mdph](#).

Value

The covariance matrix of the multivariate discrete phase-type distribution.

Examples

```
obj <- mdph(structure = c("general", "general"))
var(obj)
```

var ,mph-method *Var method for multivariate phase-type distributions*

Description

Var method for multivariate phase-type distributions

Usage

```
## S4 method for signature 'mph'
var(x)
```

Arguments

x An object of class [mph](#).

Value

The covariance matrix of the multivariate phase-type distribution.

Examples

```
obj <- mph(structure = c("general", "general"))
var(obj)
```

var,MPHstar-method *Var method for MPHstar class*

Description

Var method for MPHstar class

Usage

```
## S4 method for signature 'MPHstar'
var(x)
```

Arguments

x An object of class [MPHstar](#).

Value

The covariance matrix of the MPHstar distribution.

Examples

```
obj <- MPHstar(structure = "general")
var(obj)
```

var, ph-method	<i>Var method for phase-type distributions</i>
----------------	--

Description

Var method for phase-type distributions

Usage

```
## S4 method for signature 'ph'
var(x)
```

Arguments

x An object of class `ph`.

Value

The variance of the `ph` (or underlying `ph`) object.

Examples

```
set.seed(123)
obj <- ph(structure = "general", dimension = 3)
var(obj)
```

vector_of_matrices	<i>Computes the elements $S^n / n!$ until the a given size</i>
--------------------	---

Description

Computes the elements $S^n / n!$ until the a given size

Usage

```
vector_of_matrices(vect, S, a, vect_size)
```

Arguments

vect	A vector.
S	Sub-intensity matrix.
a	A number.
vect_size	Size of vector.

vector_of_matrices_2 *Computes the elements $S^n / n!$ until given value of n*

Description

Computes the elements $S^n / n!$ until given value of n

Usage

vector_of_matrices_2(vect, S, vect_size)

Arguments

vect	A vector.
S	Sub-intensity matrix.
vect_size	Size of vector.

vector_of_powers *Computes elements A^n until the given size*

Description

Computes elements A^n until the given size

Usage

vector_of_powers(A, vect_size)

Arguments

A	A matrix.
vect_size	Size of vector.

Index

- * **matrixdist**
 - matrixdist-package, 8
- +, dph, dph-method, 9
- +, ph, ph-method, 10

- a_rungekutta, 10

- bivdph, [11](#), [11](#), [21](#), [25](#), [30](#), [49](#), [97](#), [109](#), [126](#),
[132](#), [143](#), [158](#), [163](#), [174](#)
- bivdph-class, 11
- bivdph_density, 12
- bivdph_tail, 12
- biviph, [13](#), [14](#), [22](#), [31](#), [97](#), [159](#), [164](#)
- biviph-class, 14
- biviph, [13](#), [14](#), [15](#), [22](#), [26](#), [31](#), [50](#), [61](#), [98](#), [109](#),
[132](#), [159](#), [164](#), [174](#)
- biviph-class, 15
- biviph_density, 15
- biviph_laplace, 16
- biviph_tail, 16

- cdf, [17](#)
- cdf, dph-method, [17](#)
- cdf, iph-method, [18](#)
- cdf, miph-method, [18](#)
- cdf, mph-method, [19](#)
- cdf, ph-method, [20](#)
- clone_matrix, [20](#)
- clone_vector, [21](#)
- coef, bivdph-method, [21](#)
- coef, biviph-method, [22](#)
- coef, biviph-method, [22](#)
- coef, dph-method, [23](#)
- coef, iph-method, [23](#)
- coef, mdph-method, [24](#)
- coef, ph-method, [24](#)
- coef, sph-method, [25](#)
- cor, bivdph-method, [25](#)
- cor, biviph-method, [26](#)
- cor, mdph-method, [26](#)

- cor, mph-method, [27](#)
- cor, MPHstar-method, [28](#)
- cumulate_matrix, [28](#)
- cumulate_vector, [29](#)

- default_step_length, [29](#)
- dens, [30](#)
- dens, bivdph-method, [30](#)
- dens, biviph-method, [31](#)
- dens, biviph-method, [31](#)
- dens, dph-method, [32](#)
- dens, iph-method, [32](#)
- dens, mdph-method, [33](#)
- dens, miph-method, [34](#)
- dens, mph-method, [34](#)
- dens, ph-method, [35](#)
- dph, [9](#), [17](#), [23](#), [32](#), [35](#), [36](#), [51](#), [97](#), [99](#), [105](#), [110](#),
[118](#), [121](#), [122](#), [127](#), [133](#), [141–144](#),
[159](#), [165](#), [172](#), [175](#)
- dph-class, [36](#)
- dph_pgf, [38](#)
- dphcdf, [37](#)
- dphdensity, [37](#)

- EM_step_mPH_rc, [44](#)
- embedded_mc, [38](#)
- EMstep_bivdph, [39](#)
- EMstep_bivdph_MoE, [39](#)
- EMstep_biviph, [40](#)
- EMstep_dph, [40](#)
- EMstep_dph_MoE, [41](#)
- EMstep_mdph, [41](#)
- EMstep_mdph_MoE, [42](#)
- EMstep_MoE_PADE, [42](#)
- EMstep_PADE, [43](#)
- EMstep_RK, [43](#)
- EMstep_UNI, [44](#)
- evaluate, [45](#)
- evaluate, sph-method, [45](#)
- expm_terms, [46](#)

- expmat, 46
- find_n, 47
- find_weight, 47
- Fisher, 48
- Fisher, sph-method, 48
- fit, 49
- fit, bivdph-method, 49
- fit, bivph-method, 50
- fit, dph-method, 51
- fit, mdph-method, 51
- fit, mph-method, 52
- fit, MPHstar-method, 53
- fit, ph-method, 54
- haz, 55
- haz, ph-method, 56
- inf_norm, 56
- initial_state, 57
- iph, 18, 23, 33, 57, 58, 98, 99, 105, 106, 119, 121, 160, 166
- iph-class, 58
- laplace, 59
- laplace, bivph-method, 59
- laplace, mph-method, 60
- laplace, ph-method, 60
- linCom, 61
- linCom, bivph-method, 61
- linCom, MPHstar-method, 62
- linear_combination, 62
- logLik, ph-method, 63
- logLikelihoodbivDPH, 64
- logLikelihoodbivDPH_MoE, 64
- logLikelihoodbivPH, 65
- logLikelihoodDPH, 65
- logLikelihoodDPH_MoE, 66
- logLikelihoodmDPH, 66
- logLikelihoodmDPH_MoE, 67
- logLikelihoodMgev_PADE, 67
- logLikelihoodMgev_RK, 68
- logLikelihoodMgev_UNI, 68
- logLikelihoodMgompertz_PADE, 69
- logLikelihoodMgompertz_PADEs, 69
- logLikelihoodMgompertz_RK, 70
- logLikelihoodMgompertz_RKs, 71
- logLikelihoodMgompertz_UNI, 72
- logLikelihoodMgompertz_UNIs, 72
- logLikelihoodMloglogistic_PADE, 73
- logLikelihoodMloglogistic_PADEs, 74
- logLikelihoodMloglogistic_RK, 75
- logLikelihoodMloglogistic_RKs, 75
- logLikelihoodMloglogistic_UNI, 76
- logLikelihoodMloglogistic_UNIs, 77
- logLikelihoodMlognormal_PADE, 78
- logLikelihoodMlognormal_PADEs, 78
- logLikelihoodMlognormal_RK, 79
- logLikelihoodMlognormal_RKs, 80
- logLikelihoodMlognormal_UNI, 81
- logLikelihoodMlognormal_UNIs, 81
- logLikelihoodMpareto_PADE, 82
- logLikelihoodMpareto_PADEs, 83
- logLikelihoodMpareto_RK, 84
- logLikelihoodMpareto_RKs, 84
- logLikelihoodMpareto_UNI, 85
- logLikelihoodMpareto_UNIs, 86
- logLikelihoodMweibull_PADE, 87
- logLikelihoodMweibull_PADEs, 87
- logLikelihoodMweibull_RK, 88
- logLikelihoodMweibull_RKs, 89
- logLikelihoodMweibull_UNI, 90
- logLikelihoodMweibull_UNIs, 90
- logLikelihoodPH_MoE, 91
- logLikelihoodPH_PADE, 92
- logLikelihoodPH_PADEs, 92
- logLikelihoodPH_RK, 93
- logLikelihoodPH_RKs, 94
- logLikelihoodPH_UNI, 94
- logLikelihoodPH_UNIs, 95
- LRT, 95
- LRT, ph, ph-method, 96
- m_exp_sum, 140
- marginal, 96
- marginal, bivdph-method, 97
- marginal, biviph-method, 97
- marginal, bivph-method, 98
- marginal, mdph-method, 99
- marginal, miph-method, 99
- marginal, mph-method, 100
- marginal, MPHstar-method, 100
- marginal_expectation, 101
- matrix_exponential, 102
- matrix_inverse, 102
- matrix_power, 103
- matrix_product, 103
- matrix_vanloan, 104

- matrixdist (matrixdist-package), 8
- matrixdist-package, 8
- max_diagonal, 107
- maximum, 104
- maximum, dph, dph-method, 105
- maximum, iph, iph-method, 105
- maximum, ph, ph-method, 106
- mdph, 24, 27, 33, 52, 99, 107, 107, 110, 128, 133, 144, 160, 166, 175
- mdph-class, 108
- mdphdensity, 108
- mean, bivdph-method, 109
- mean, bivph-method, 109
- mean, dph-method, 110
- mean, mdph-method, 110
- mean, mph-method, 111
- mean, MPHstar-method, 111
- mean, ph-method, 112
- merge_matrices, 112
- mgevcdcf, 113
- mgevden, 114
- mgf, 114
- mgf, bivph-method, 115
- mgf, mph-method, 115
- mgf, ph-method, 116
- mgompertzcdf, 117
- mgompertzden, 117
- minimum, 118
- minimum, dph, dph-method, 118
- minimum, iph, iph-method, 119
- minimum, ph, ph-method, 119
- miph, 19, 34, 99, 120, 161, 167
- miph-class, 121
- mixture, 121
- mixture, dph, dph-method, 122
- mixture, ph, ph-method, 122
- mloglogisticcdf, 123
- mloglogisticden, 124
- mlognormalcdf, 124
- mlognormalden, 125
- MoE, 125
- MoE, bivdph-method, 126
- MoE, dph-method, 127
- MoE, mdph-method, 128
- MoE, mph-method, 129
- MoE, ph-method, 130
- moment, 131
- moment, bivdph-method, 132
- moment, bivph-method, 132
- moment, dph-method, 133
- moment, mdph-method, 133
- moment, mph-method, 134
- moment, ph-method, 134
- mparetocdf, 135
- mparetoden, 136
- mph, 19, 27, 34, 52, 59, 60, 100, 111, 115, 120, 129, 134, 136, 136, 161, 168, 176
- mph-class, 137
- MPHstar, 28, 53, 54, 62, 101, 111, 137, 138, 162, 168, 176
- MPHstar-class, 138
- MPHstar_data_aggregation, 138
- MPHstar_EMstep_UNI, 139
- mweibullcdf, 139
- mweibullden, 140
- n_pos, 142
- new_state, 141
- Nfold, 141
- Nfold, dph-method, 142
- pgf, 143
- pgf, bivdph-method, 143
- pgf, dph-method, 144
- pgf, mdph-method, 144
- ph, 10, 17, 20, 25, 30, 35, 45, 49, 55, 56, 58–63, 95, 96, 98, 100, 101, 104, 106, 112, 114, 116, 118, 120, 121, 123, 125, 130, 131, 135, 141, 142, 145, 145, 149, 152, 153, 162, 163, 169, 171, 172, 177
- ph-class, 146
- ph_laplace, 147
- phcdf, 146
- phdensity, 147
- plus_states, 148
- pow2_matrix, 148
- quan, 149
- quan, ph-method, 149
- random_reward, 150
- random_structure, 150
- random_structure_bivph, 151
- rdphasetype, 151
- reg, 152
- reg, ph-method, 152

- revers_data_trans, [153](#)
- rew_sanity_check, [154](#)
- riph, [154](#)
- rmatrixgev, [155](#)
- rMDPHstar, [156](#)
- rMIPHstar, [156](#)
- rMPHstar, [157](#)
- rphasetype, [157](#)
- runge_kutta, [158](#)

- show, bivdph-method, [158](#)
- show, biviph-method, [159](#)
- show, bivph-method, [159](#)
- show, dph-method, [159](#)
- show, iph-method, [160](#)
- show, mdph-method, [160](#)
- show, miph-method, [161](#)
- show, mph-method, [161](#)
- show, MPHstar-method, [162](#)
- show, ph-method, [162](#)
- show, sph-method, [162](#)
- sim, [163](#)
- sim, bivdph-method, [163](#)
- sim, biviph-method, [164](#)
- sim, bivph-method, [164](#)
- sim, dph-method, [165](#)
- sim, iph-method, [165](#)
- sim, mdph-method, [166](#)
- sim, miph-method, [167](#)
- sim, mph-method, [167](#)
- sim, MPHstar-method, [168](#)
- sim, ph-method, [169](#)
- sph, [25](#), [45](#), [48](#), [126–128](#), [131](#), [153](#), [162](#), [169](#),
[169](#)
- sph-class, [170](#)
- sum_dph, [170](#)
- sum_ph, [171](#)

- TVR, [171](#)
- TVR, dph-method, [172](#)
- TVR, ph-method, [172](#)
- tvr_dph, [173](#)
- tvr_ph, [173](#)

- var, bivdph-method, [174](#)
- var, bivph-method, [174](#)
- var, dph-method, [175](#)
- var, mdph-method, [175](#)
- var, mph-method, [176](#)

- var, MPHstar-method, [176](#)
- var, ph-method, [177](#)
- vector_of_matrices, [177](#)
- vector_of_matrices_2, [178](#)
- vector_of_powers, [178](#)