

Package ‘SimCorrMix’

November 30, 2017

Type Package

Title Simulation of Correlated Data of Multiple Variable Types including Continuous and Count Mixture Distributions

Version 0.1.0

Author Allison Cynthia Fialkowski

Maintainer Allison Cynthia Fialkowski <allijazz@uab.edu>

Description Generate continuous (normal, non-normal, or mixture distributions), binary, ordinal, and count (regular or zero-inflated, Poisson or Negative Binomial) variables with a specified correlation matrix, or one continuous variable with a mixture distribution. This package can be used to simulate data sets that mimic real-world clinical or genetic data sets (i.e., plasmodes, as in Vaughan et al., 2009 <DOI:10.1016/j.cstda.2008.02.032>). The methods extend those found in the SimMultiCorrData R package. Standard normal variables with an imposed intermediate correlation matrix are transformed to generate the desired distributions. Continuous variables are simulated using either Fleishman (1978)'s third order <DOI:10.1007/BF02293811> or Headrick (2002)'s fifth order <DOI:10.1016/S0167-9473(02)00072-5> polynomial transformation method (the power method transformation, PMT). Non-mixture distributions require the user to specify mean, variance, skewness, standardized kurtosis, and standardized fifth and sixth cumulants. Mixture distributions require these inputs for the component distributions plus the mixing probabilities. Simulation occurs at the component level for continuous mixture distributions. The target correlation matrix is specified in terms of correlations with components of continuous mixture variables. However, the package provides functions to determine expected correlations with continuous mixture variables given target correlations with the components. Binary and ordinal variables are simulated using a modification of package GenOrd's ordsample function. Count variables are simulated using the inverse CDF method. There are two simulation pathways which calculate intermediate correlations involving count variables differently. Correlation Method 1 adapts Yahav and Shmueli's 2012 method <DOI:10.1002/asmb.901>. Correlation Method 2 adapts Barbiero and Ferrari's 2015 modification of the GenOrd package <DOI:10.1002/asmb.2072>. The optional error loop may be used to improve the accuracy of the final correlation matrix. The package also contains functions to calculate the standardized cumulants of continuous mixture distributions, check parameter inputs, calculate feasible correlation boundaries, and plot simulated variables.

Depends R (>= 3.3.1),
SimMultiCorrData (>= 0.2.1)

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Imports BB, nleqslv, MASS, mvtnorm, psych, Matrix, VGAM, triangle, ggplot2, grid, stats, utils

Encoding UTF-8

LazyData true

Roxygen list(wrap = FALSE)

RoxygenNote 6.0.1

Suggests knitr,
rmarkdown, printr,
testthat

VignetteBuilder knitr

URL <https://github.com/AFialkowski>

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calc_mixmoments	<i>Find Standardized Cumulants of a Continuous Mixture Distribution by Method of Moments</i>
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Description

This function uses the method of moments to calculate the expected mean, standard deviation, skewness, standardized kurtosis, and standardized fifth and sixth cumulants for a continuous mixture variable based on the distributions of its components. The result can be used as input to [find_constants](#) or for comparison to a simulated mixture variable from [contmixvar1](#), [corrvar](#), or [corrvar2](#). See the **Expected Cumulants and Correlations for Continuous Mixture Variables** vignette for equations of the cumulants.

Usage

```
calc_mixmoments(mix_pis = NULL, mix_mus = NULL, mix_sigmas = NULL,
  mix_skews = NULL, mix_skurts = NULL, mix_fifths = NULL,
  mix_sixths = NULL)
```

Arguments

mix_pis	a vector of mixing probabilities that sum to 1 for the component distributions
mix_mus	a vector of means for the component distributions
mix_sigmas	a vector of standard deviations for the component distributions
mix_skews	a vector of skew values for the component distributions
mix_skurts	a vector of standardized kurtoses for the component distributions
mix_fifths	a vector of standardized fifth cumulants for the component distributions; keep NULL if using method = "Fleishman" to generate continuous variables
mix_sixths	a vector of standardized sixth cumulants for the component distributions; keep NULL if using method = "Fleishman" to generate continuous variables

Value

A vector of the mean, standard deviation, skewness, standardized kurtosis, and standardized fifth and sixth cumulants

References

- Davenport JW, Bezder JC, & Hathaway RJ (1988). Parameter Estimation for Finite Mixture Distributions. *Computers & Mathematics with Applications*, 15(10):819-28.
- Headrick TC (2002). Fast Fifth-order Polynomial Transforms for Generating Univariate and Multivariate Non-normal Distributions. *Computational Statistics & Data Analysis*, 40(4):685-711. doi: [10.1016/S01679473\(02\)000725](https://doi.org/10.1016/S01679473(02)000725). ([ScienceDirect](#))
- Headrick TC, Kowalchuk RK (2007). The Power Method Transformation: Its Probability Density Function, Distribution Function, and Its Further Use for Fitting Data. *Journal of Statistical Computation and Simulation*, 77:229-249. doi: [10.1080/10629360600605065](https://doi.org/10.1080/10629360600605065).
- Headrick TC, Sheng Y, & Hodis FA (2007). Numerical Computing and Graphics for the Power Method Transformation Using Mathematica. *Journal of Statistical Software*, 19(3):1-17. doi: [10.18637/jss.v019.i03](https://doi.org/10.18637/jss.v019.i03).

Kendall M & Stuart A (1977). The Advanced Theory of Statistics, 4th Edition. Macmillan, New York.

Schork NJ, Allison DB, & Thiel B (1996). Mixture Distributions in Human Genetics Research. Statistical Methods in Medical Research, 5:155-178. doi: [10.1177/096228029600500204](https://doi.org/10.1177/096228029600500204).

Examples

```
# Two mixture variables: 1st is mixture of Normal(-2, 1) and Normal(2, 1),
# 2nd is mixture of Logistic(0, 1), Chisq(4), and Beta(4, 1.5)
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))
mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
mix_skews <- list(rep(0, 2), c(L[3], C[3], B[3]))
mix_skurts <- list(rep(0, 2), c(L[4], C[4], B[4]))
mix_fifths <- list(rep(0, 2), c(L[5], C[5], B[5]))
mix_sixths <- list(rep(0, 2), c(L[6], C[6], B[6]))
Nstcum <- calc_mixmoments(mix_pis[[1]], mix_mus[[1]], mix_sigmas[[1]],
  mix_skews[[1]], mix_skurts[[1]], mix_fifths[[1]], mix_sixths[[1]])
Nstcum
Mstcum <- calc_mixmoments(mix_pis[[2]], mix_mus[[2]], mix_sigmas[[2]],
  mix_skews[[2]], mix_skurts[[2]], mix_fifths[[2]], mix_sixths[[2]])
Mstcum
```

contmixvar1

*Generation of One Continuous Variable with a Mixture Distribution
Using the Power Method Transformation*

Description

This function simulates one continuous mixture variable. Mixture distributions describe random variables that are drawn from more than one component distribution. For a random variable Y_{mix} from a finite continuous mixture distribution with k components, the probability density function (PDF) can be described by:

$$h_Y(y) = \sum_{i=1}^k \pi_i f_{Y_i}(y), \sum_{i=1}^k \pi_i = 1.$$

The π_i are mixing parameters which determine the weight of each component distribution $f_{Y_i}(y)$ in the overall probability distribution. As long as each component has a valid PDF, the overall distribution $h_Y(y)$ has a valid PDF. The main assumption is statistical independence between the process of randomly selecting the component distribution and the distributions themselves. Each component Y_i is generated using either Fleishman's third-order (method = "Fleishman", doi: [10.1007/BF02293811](https://doi.org/10.1007/BF02293811)) or Headrick's fifth-order (method = "Polynomial", doi: [10.1016/S01679473\(02\)00072-5](https://doi.org/10.1016/S01679473(02)00072-5)) power method transformation (PMT). It works by matching standardized cumulants – the first four (mean, variance, skew, and standardized kurtosis) for Fleishman's method, or the first six (mean, variance, skew, standardized kurtosis, and standardized fifth and sixth cumulants) for Headrick's method. The transformation is expressed as follows:

$$Y = c_0 + c_1 * Z + c_2 * Z^2 + c_3 * Z^3 + c_4 * Z^4 + c_5 * Z^5, Z \sim N(0, 1),$$

where c_4 and c_5 both equal 0 for Fleishman's method. The real constants are calculated by [find_constants](#). These components are then transformed to the desired mixture variable using a random multinomial variable generated based on the mixing probabilities. There are no parameter input checks in order to decrease simulation time. All inputs should be checked prior to simulation with [validpar](#).

Mixture distributions provide a useful way for describing heterogeneity in a population, especially when an outcome is a composite response from multiple sources. The vignette **Variable Types** provides more information about simulation of mixture variables and the required parameters. The vignette **Expected Cumulants and Correlations for Continuous Mixture Variables** gives the equations for the expected cumulants of a mixture variable. In addition, Headrick & Kowalchuk (2007, doi: [10.1080/10629360600605065](https://doi.org/10.1080/10629360600605065)) outlined a general method for comparing a simulated distribution Y to a given theoretical distribution Y^* . These steps can be found in the **Continuous Mixture Distributions** vignette.

Usage

```
contmixvar1(n = 10000, method = c("Fleishman", "Polynomial"), means = 0,
  vars = 1, mix_pis = NULL, mix_mus = NULL, mix_sigmas = NULL,
  mix_skews = NULL, mix_skurts = NULL, mix_fifths = NULL,
  mix_sixths = NULL, mix_Six = list(), seed = 1234, cstart = list())
```

Arguments

n	the sample size (i.e. the length of the simulated variable; default = 10000)
method	the method used to generate the component variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
means	mean for the mixture variable (default = 0)
vars	variance for the mixture variable (default = 1)
mix_pis	a vector of mixing probabilities that sum to 1 for the component distributions
mix_mus	a vector of means for the component distributions
mix_sigmas	a vector of standard deviations for the component distributions
mix_skews	a vector of skew values for the component distributions
mix_skurts	a vector of standardized kurtoses for the component distributions
mix_fifths	a vector of standardized fifth cumulants for the component distributions; keep NULL if using method = "Fleishman" to generate continuous variables
mix_sixths	a vector of standardized sixth cumulants for the component distributions; keep NULL if using method = "Fleishman" to generate continuous variables
mix_Six	a list of vectors of sixth cumulant correction values for the component distributions of Y_{mix} ; use NULL if no correction is desired for a given component; if no correction is desired for any component keep as <code>mix_Six = list()</code> (not necessary for method = "Fleishman")
seed	the seed value for random number generation (default = 1234)

cstart a list of length equal to the total number of mixture components containing initial values for root-solving algorithm used in [find_constants](#). If user specified, each list element must be input as a matrix. For method = "Fleishman", each should have 3 columns for c_1, c_2, c_3 ; for method = "Polynomial", each should have 5 columns for c_1, c_2, c_3, c_4, c_5 . If no starting values are specified for a given component, that list element should be NULL.

Value

A list with the following components:

constants a data.frame of the constants

Y_comp a data.frame of the components of the mixture variable

cont_sum a data.frame summarizing Y_comp

target_sum a data.frame summarizing the target distributions of Y_comp

Y_mix a data.frame of the generated mixture variable

mix_sum a data.frame summarizing Y_mix

target_mix a data.frame summarizing the target distribution of Y_mix

sixth_correction the sixth cumulant correction values for Y_comp

valid.pdf "TRUE" if constants generate a valid PDF, else "FALSE"

Constants_Time the time in minutes required to calculate the constants

Simulation_Time the total simulation time in minutes

Choice of Fleishman's third-order or Headrick's fifth-order method

Using the fifth-order approximation allows additional control over the fifth and sixth moments of the generated distribution, improving accuracy. In addition, the range of feasible standardized kurtosis values, given skew and standardized fifth (γ_3) and sixth (γ_4) cumulants, is larger than with Fleishman's method (see [calc_lower_skurt](#)). For example, the Fleishman method can not be used to generate a non-normal distribution with a ratio of $\gamma_3^2/\gamma_4 > 9/14$ (see Headrick & Kowalchuk, 2007). This eliminates the Chi-squared family of distributions, which has a constant ratio of $\gamma_3^2/\gamma_4 = 2/3$. The fifth-order method also generates more distributions with valid PDF's. However, if the fifth and sixth cumulants are unknown or do not exist, the Fleishman approximation should be used.

Overview of Simulation Process

- 1) A check is performed to see if any distributions are repeated within the parameter inputs, i.e. if the mixture variable contains 2 components with the same standardized cumulants. These are noted so that the constants are only calculated once.
- 2) The constants are calculated for each component variable using [find_constants](#). If no solutions are found that generate a valid power method PDF, the function will return constants that produce an invalid PDF (or a stop error if no solutions can be found). Possible solutions include: 1) changing the seed, or 2) using a mix_Six list with vectors of sixth cumulant correction values (if method = "Polynomial"). Errors regarding constant calculation are the most probable cause of function failure.
- 3) A matrix X_cont of dim $n \times \text{length}(\text{mix_pis})$ of standard normal variables is generated and singular-value decomposition is done to remove any correlation. The constants are applied to X_cont to create the component variables Y with the desired distributions.

4) A random multinomial variable $M = \text{rmultinom}(n, \text{size} = 1, \text{prob} = \text{mix_pis})$ is generated using `rmultinom`. The continuous mixture variable Y_{mix} is created from the component variables Y based on this multinomial variable. That is, if $M[i, k_i] = 1$, then $Y_{\text{mix}}[i] = Y[i, k_i]$. A location-scale transformation is done on Y_{mix} to give it mean means and variance vars.

5) Summary statistics are calculated.

Reasons for Function Errors

1) The most likely cause for function errors is that no solutions to `fleish` or `poly` converged when using `find_constants`. If this happens, the simulation will stop. It may help to first use `find_constants` for each component variable to determine if a sixth cumulant correction value is needed. The solutions can be used as starting values (see `cstart` below). If the standardized cumulants are obtained from `calc_theory`, the user may need to use rounded values as inputs (i.e. `skews = round(skews, 8)`). For example, in order to ensure that skew is exactly 0 for symmetric distributions.

2) The kurtosis may be outside the region of possible values. There is an associated lower boundary for kurtosis associated with a given skew (for Fleishman's method) or skew and fifth and sixth cumulants (for Headrick's method). Use `calc_lower_skurt` to determine the boundary for a given set of cumulants.

References

- Davenport, JW, JC Bezder, and RJ Hathaway. 1988. "Parameter Estimation for Finite Mixture Distributions." *Computers & Mathematics with Applications* 15 (10): 819-28.
- Fleishman AI (1978). A Method for Simulating Non-normal Distributions. *Psychometrika*, 43, 521-532. doi: [10.1007/BF02293811](https://doi.org/10.1007/BF02293811).
- Headrick TC (2002). Fast Fifth-order Polynomial Transforms for Generating Univariate and Multivariate Non-normal Distributions. *Computational Statistics & Data Analysis*, 40(4):685-711. doi: [10.1016/S01679473\(02\)000725](https://doi.org/10.1016/S01679473(02)000725).
- Headrick TC (2004). On Polynomial Transformations for Simulating Multivariate Nonnormal Distributions. *Journal of Modern Applied Statistical Methods*, 3(1), 65-71. doi: [10.22237/jmasm/1083370080](https://doi.org/10.22237/jmasm/1083370080).
- Headrick TC, Kowalchuk RK (2007). The Power Method Transformation: Its Probability Density Function, Distribution Function, and Its Further Use for Fitting Data. *Journal of Statistical Computation and Simulation*, 77, 229-249. doi: [10.1080/10629360600605065](https://doi.org/10.1080/10629360600605065).
- Headrick TC, Sawilowsky SS (1999). Simulating Correlated Non-normal Distributions: Extending the Fleishman Power Method. *Psychometrika*, 64, 25-35. doi: [10.1007/BF02294317](https://doi.org/10.1007/BF02294317).
- Headrick TC, Sheng Y, & Hodis FA (2007). Numerical Computing and Graphics for the Power Method Transformation Using Mathematica. *Journal of Statistical Software*, 19(3), 1 - 17. doi: [10.18637/jss.v019.i03](https://doi.org/10.18637/jss.v019.i03).
- Pearson, RK. 2011. "Exploring Data in Engineering, the Sciences, and Medicine." In. New York: Oxford University Press.

See Also

[find_constants](#), [validpar](#)

Examples

```
## Not run:
# Mixture of Beta(6, 3), Beta(4, 1.5), and Beta(10, 20)
Stcum1 <- calc_theory("Beta", c(6, 3))
Stcum2 <- calc_theory("Beta", c(4, 1.5))
Stcum3 <- calc_theory("Beta", c(10, 20))
mix_pis <- c(0.5, 0.2, 0.3)
mix_mus <- c(Stcum1[1], Stcum2[1], Stcum3[1])
mix_sigmas <- c(Stcum1[2], Stcum2[2], Stcum3[2])
mix_skews <- c(Stcum1[3], Stcum2[3], Stcum3[3])
mix_skurts <- c(Stcum1[4], Stcum2[4], Stcum3[4])
mix_fifths <- c(Stcum1[5], Stcum2[5], Stcum3[5])
mix_sixths <- c(Stcum1[6], Stcum2[6], Stcum3[6])
mix_Six <- list(seq(0.01, 10, 0.01), c(0.01, 0.02, 0.03),
  seq(0.01, 10, 0.01))
Bstcum <- calc_mixmoments(mix_pis, mix_mus, mix_sigmas, mix_skews,
  mix_skurts, mix_fifths, mix_sixths)
Bmix <- contmixvar1(n = 10000, "Polynomial", Bstcum[1], Bstcum[2]^2,
  mix_pis, mix_mus, mix_sigmas, mix_skews, mix_skurts, mix_fifths,
  mix_sixths, mix_Six)
Bmix$target_mix
Bmix$mix_sum

## End(Not run)
```

corrvar

Generation of Correlated Ordinal, Continuous (mixture and non-mixture), and/or Count (Poisson and Negative Binomial, regular and zero-inflated) Variables: Correlation Method 1

Description

This function simulates k_cat ordinal ($r \geq 2$ categories), k_cont continuous non-mixture, k_mix continuous mixture, k_pois Poisson (regular and zero-inflated), and/or k_nb Negative Binomial (regular and zero-inflated) variables with a specified correlation matrix ρ . The variables are generated from multivariate normal variables with intermediate correlation matrix Σ , calculated by [intercorr](#), and then transformed. The intermediate correlations involving count variables are determined using **correlation method 1**. The *ordering* of the variables in ρ must be 1st ordinal, 2nd continuous non-mixture, 3rd components of the continuous mixture, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, and 7th zero-inflated NB. Note that it is possible for k_cat , k_cont , k_mix , k_pois , and/or k_nb to be 0. The target correlations are specified with respect to the components of the continuous mixture variables. There are no parameter input checks in order to decrease simulation time. All inputs should be checked prior to simulation with [validpar](#).

All continuous variables are simulated using either Fleishman's third-order (method = "Fleishman", doi: [10.1007/BF02293811](#)) or Headrick's fifth-order (method = "Polynomial", doi: [10.1016/S0167-9473\(02\)000725](#)) power method transformation. It works by matching standardized cumulants – the first four (mean, variance, skew, and standardized kurtosis) for Fleishman's method, or the first six (mean, variance, skew, standardized kurtosis, and standardized fifth and sixth cumulants) for Headrick's method. The transformation is expressed as follows:

$$Y = c_0 + c_1 * Z + c_2 * Z^2 + c_3 * Z^3 + c_4 * Z^4 + c_5 * Z^5, Z \sim N(0, 1),$$

where c_4 and c_5 both equal 0 for Fleishman's method. The real constants are calculated by [find_constants](#). Continuous mixture variables are generated componentwise and then transformed to the desired mixture variables. Ordinal variables ($r \geq 2$ categories) are generated by discretizing the standard normal variables at quantiles. These quantiles are determined by evaluating the inverse standard normal cdf at the cumulative probabilities defined by each variable's marginal distribution. Count variables are generated using the inverse cdf method. The CDF of a standard normal variable has a uniform distribution. The appropriate quantile function $(F_Y)^{-1}$ is applied to this uniform variable with the designated parameters to generate the count variable: $Y = (F_Y)^{-1}(\Phi(Z))$. The Negative Binomial variable represents the number of failures which occur in a sequence of Bernoulli trials before the target number of successes is achieved. Zero-inflated Poisson or NB variables are obtained by setting the probability of a structural zero to be greater than 0. The optional error loop attempts to correct the final pairwise correlations to be within a user-specified precision value (epsilon) of the target correlations.

The vignette **Variable Types** discusses how each of the different variables are generated and describes the required parameters.

The vignette **Overall Workflow for Generation of Correlated Data** provides a detailed example discussing the step-by-step simulation process and comparing correlation methods 1 and 2.

Usage

```
corrvar(n = 10000, k_cat = 0, k_cont = 0, k_mix = 0, k_pois = 0,
  k_nb = 0, method = c("Fleishman", "Polynomial"), means = NULL,
  vars = NULL, skews = NULL, skurts = NULL, fifths = NULL,
  sixths = NULL, Six = list(), mix_pis = list(), mix_mus = list(),
  mix_sigmas = list(), mix_skews = list(), mix_skurts = list(),
  mix_fifths = list(), mix_sixths = list(), mix_Six = list(),
  marginal = list(), support = list(), lam = NULL, p_zip = 0,
  size = NULL, prob = NULL, mu = NULL, p_zinb = 0, rho = NULL,
  seed = 1234, errorloop = FALSE, epsilon = 0.001, maxit = 1000,
  use.nearPD = TRUE, nrand = 1e+05, Sigma = NULL, cstart = list())
```

Arguments

n	the sample size (i.e. the length of each simulated variable; default = 10000)
k_cat	the number of ordinal ($r \geq 2$ categories) variables (default = 0)
k_cont	the number of continuous non-mixture variables (default = 0)
k_mix	the number of continuous mixture variables (default = 0)
k_pois	the number of regular Poisson and zero-inflated Poisson variables (default = 0)
k_nb	the number of regular Negative Binomial and zero-inflated Negative Binomial variables (default = 0)
method	the method used to generate the k_cont non-mixture and k_mix mixture continuous variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
means	a vector of means for the k_cont non-mixture and k_mix mixture continuous variables (i.e. <code>rep(0, (k_cont + k_mix))</code>)
vars	a vector of variances for the k_cont non-mixture and k_mix mixture continuous variables (i.e. <code>rep(1, (k_cont + k_mix))</code>)
skews	a vector of skewness values for the k_cont non-mixture continuous variables
skurts	a vector of standardized kurtoses (kurtosis - 3, so that normal variables have a value of 0) for the k_cont non-mixture continuous variables

fifths	a vector of standardized fifth cumulants for the k_cont non-mixture continuous variables (not necessary for method = "Fleishman")
sixths	a vector of standardized sixth cumulants for the k_cont non-mixture continuous variables (not necessary for method = "Fleishman")
Six	a list of vectors of sixth cumulant correction values for the k_cont non-mixture continuous variables if no valid PDF constants are found, ex: Six = list(seq(0.01, 2, 0.01), seq(1, 10, 0.5)); if no correction is desired for Y_{cont_i} , set the i-th list component equal to NULL; if no correction is desired for any of the Y_{cont} keep as Six = list() (not necessary for method = "Fleishman")
mix_pis	a list of length k_mix with i-th component a vector of mixing probabilities that sum to 1 for component distributions of Y_{mix_i}
mix_mus	a list of length k_mix with i-th component a vector of means for component distributions of Y_{mix_i}
mix_sigmas	a list of length k_mix with i-th component a vector of standard deviations for component distributions of Y_{mix_i}
mix_skews	a list of length k_mix with i-th component a vector of skew values for component distributions of Y_{mix_i}
mix_skurts	a list of length k_mix with i-th component a vector of standardized kurtoses for component distributions of Y_{mix_i}
mix_fifths	a list of length k_mix with i-th component a vector of standardized fifth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")
mix_sixths	a list of length k_mix with i-th component a vector of standardized sixth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")
mix_Six	a list of length k_mix with i-th component a list of vectors of sixth cumulant correction values for component distributions of Y_{mix_i} ; use NULL if no correction is desired for a given component or mixture variable; if no correction is desired for any of the Y_{mix} keep as mix_Six = list() (not necessary for method = "Fleishman")
marginal	a list of length equal to k_cat; the i-th element is a vector of the cumulative probabilities defining the marginal distribution of the i-th variable; if the variable can take r values, the vector will contain r - 1 probabilities (the r-th is assumed to be 1); for binary variables, these should be input the same as for ordinal variables with more than 2 categories (i.e. the user-specified probability is the probability of the 1st category, which has the smaller support value)
support	a list of length equal to k_cat; the i-th element is a vector containing the r ordered support values; if not provided (i.e. support = list()), the default is for the i-th element to be the vector 1, ..., r
lam	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if p_zip = 0, Y_{pois} has a regular Poisson distribution; if p_zip is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if

	$p_zip = -(\exp(lam) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if $\text{length}(p_zip) < \text{length}(lam)$, the missing values are set to 0 (and ordered 1st)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
prob	a vector of success probability parameters for the NB variables; order the same as in size
mu	a vector of mean parameters for the NB variables (*Note: either prob or mu should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if $p_zinb = 0$, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if $p_zinb = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if $\text{length}(p_zinb) < \text{length}(size)$, the missing values are set to 0 (and ordered 1st)
rho	the target correlation matrix which must be ordered <i>1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixtures, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, 7th zero-inflated NB</i> ; note that rho is specified in terms of the components of Y_{mix}
seed	the seed value for random number generation (default = 1234)
errorloop	if TRUE, uses corr_error to attempt to correct final pairwise correlations to be within epsilon of target pairwise correlations (default = FALSE)
epsilon	the maximum acceptable error between the final and target pairwise correlations (default = 0.001) in the calculation of ordinal intermediate correlations with ord_norm or in the error loop
maxit	the maximum number of iterations to use (default = 1000) in the calculation of ordinal intermediate correlations with ord_norm or in the error loop
use.nearPD	TRUE to convert rho to the nearest positive definite matrix with <code>Matrix::nearPD</code> if necessary
nrand	the number of random numbers to generate in calculating intermediate correlations with intercorr (default = 10000)
Sigma	an intermediate correlation matrix to use if the user wants to provide one, else it is calculated within by intercorr
cstart	a list of length equal to k_cont + the total number of mixture components containing initial values for root-solving algorithm used in find_constants . If user specified, each list element must be input as a matrix. For method = "Fleishman", each should have 3 columns for c_1, c_2, c_3 ; for method = "Polynomial", each should have 5 columns for c_1, c_2, c_3, c_4, c_5 . If no starting values are specified for a given component, that list element should be NULL.

Value

A list whose components vary based on the type of simulated variables.

If **ordinal variables** are produced:

Y_cat the ordinal variables,

ord_sum a list, where the i-th element contains a data.frame with target and simulated cumulative probabilities for ordinal variable Y_i

If **continuous variables** are produced:

constants a data.frame of the constants,

Y_cont the continuous non-mixture variables,

Y_comp the components of the continuous mixture variables,

Y_mix the continuous mixture variables,

cont_sum a data.frame summarizing Y_cont and Y_comp,

mix_sum a data.frame summarizing Y_mix,

target_sum a data.frame with the target distributions for Y_cont and Y_comp,

target_mix a data.frame with the target distributions for Y_mix,

sixth_correction a list of sixth cumulant correction values,

valid.pdf a vector where the i-th element is "TRUE" if the constants for the i-th continuous variable generate a valid PDF, else "FALSE"

If **Poisson variables** are produced:

Y_pois the regular and zero-inflated Poisson variables,

pois_sum a data.frame summarizing Y_pois

If **Negative Binomial variables** are produced:

Y_nb the regular and zero-inflated Negative Binomial variables,

nb_sum a data.frame summarizing Y_nb

Additionally, the following elements:

rho the target correlation matrix used in the simulation (which will differ from the user-supplied rho if it was converted to the nearest positive-definite matrix)

rho_calc the final correlation matrix for Y_cat, Y_cont, Y_comp, Y_pois, and Y_nb

rho_mix the final correlation matrix for Y_cat, Y_cont, Y_mix, Y_pois, and Y_nb

Sigma1 the intermediate correlation before the error loop,

Sigma2 the intermediate correlation matrix after the error loop,

Constants_Time the time in minutes required to calculate the constants,

Intercorrelation_Time the time in minutes required to calculate the intermediate correlation matrix,

Error_Loop_Time the time in minutes required to use the error loop,

Simulation_Time the total simulation time in minutes,

niter a matrix of the number of iterations used for each variable in the error loop,

maxerr the maximum final correlation error (from the target rho).

Overview of Correlation Method 1

The intermediate correlations used in method 1 are more simulation based than those in method 2, which means that accuracy increases with sample size and the number of repetitions. In addition, specifying the seed allows for reproducibility. In addition, method 1 differs from method 2 in the following ways:

1) The intermediate correlation for **count variables** is based on the method of Yahav & Shmueli (2012, doi: [10.1002/asmb.901](https://doi.org/10.1002/asmb.901)), which uses a simulation based, logarithmic transformation of the target correlation. This method becomes less accurate as the variable mean gets closer to zero.

2) The **ordinal - count variable** correlations are based on an extension of the method of Amatya & Demirtas (2015, doi: [10.1080/00949655.2014.953534](https://doi.org/10.1080/00949655.2014.953534)), in which the correlation correction factor is the product of the upper Frechet-Hoeffding bound on the correlation between the count variable and the normal variable used to generate it and a simulated upper bound on the correlation between an ordinal variable and the normal variable used to generate it (see Demirtas & Hedeker, 2011, doi: [10.1198/tast.2011.10090](https://doi.org/10.1198/tast.2011.10090)).

3) The **continuous - count variable** correlations are based on an extension of the methods of Amatya & Demirtas (2015) and Demirtas et al. (2012, doi: [10.1002/sim.5362](https://doi.org/10.1002/sim.5362)), in which the correlation correction factor is the product of the upper Frechet-Hoeffding bound on the correlation between the count variable and the normal variable used to generate it and the power method correlation between the continuous variable and the normal variable used to generate it (see Headrick & Kowalchuk, 2007, doi: [10.1080/10629360600605065](https://doi.org/10.1080/10629360600605065)). The intermediate correlations are the ratio of the target correlations to the correction factor.

Please see the **Comparison of Correlation Methods 1 and 2** vignette for more information and a step-by-step overview of the simulation process.

Choice of Fleishman's third-order or Headrick's fifth-order method

Using the fifth-order approximation allows additional control over the fifth and sixth moments of the generated distribution, improving accuracy. In addition, the range of feasible standardized kurtosis values, given skew and standardized fifth (γ_3) and sixth (γ_4) cumulants, is larger than with Fleishman's method (see [calc_lower_skurt](#)). For example, the Fleishman method can not be used to generate a non-normal distribution with a ratio of $\gamma_3^2/\gamma_4 > 9/14$ (see Headrick & Kowalchuk, 2007). This eliminates the Chi-squared family of distributions, which has a constant ratio of $\gamma_3^2/\gamma_4 = 2/3$. The fifth-order method also generates more distributions with valid PDF's. However, if the fifth and sixth cumulants are unknown or do not exist, the Fleishman approximation should be used.

Reasons for Function Errors

1) The most likely cause for function errors is that no solutions to [fleish](#) or [poly](#) converged when using [find_constants](#). If this happens, the simulation will stop. It may help to first use [find_constants](#) for each continuous variable to determine if a sixth cumulant correction value is needed. The solutions can be used as starting values (see [cstart](#) below). If the standardized cumulants are obtained from [calc_theory](#), the user may need to use rounded values as inputs (i.e. `skews = round(skews, 8)`). For example, in order to ensure that skew is exactly 0 for symmetric distributions.

2) The kurtosis may be outside the region of possible values. There is an associated lower boundary for kurtosis associated with a given skew (for Fleishman's method) or skew and fifth and sixth cumulants (for Headrick's method). Use [calc_lower_skurt](#) to determine the boundary for a given set of cumulants.

3) The feasibility of the final correlation matrix `rho`, given the distribution parameters, should be checked first using [validcorr](#). This function either checks if a given `rho` is plausible or returns the lower and upper final correlation limits. It should be noted that even if a target correlation matrix is within the "plausible range," it still may not be possible to achieve the desired matrix. This happens most frequently when generating ordinal variables or using negative correlations. The error loop frequently fixes these problems.

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See Also

[find_constants](#), [validpar](#), [validcorr](#), [intercorr](#), [corr_error](#)

Examples

```
## Not run:

# 2 continuous mixture, 1 binary, 1 zero-inflated Poisson, and
# 1 zero-inflated NB variable
n <- 10000
seed <- 1234

# Mixture variables: Normal mixture with 2 components;
# mixture of Logistic(0, 1), Chisq(4), Beta(4, 1.5)
# Find cumulants of components of 2nd mixture variable
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))

skews <- skurts <- fifths <- sixths <- NULL
Six <- list()
mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
mix_skews <- list(rep(0, 2), c(L[3], C[3], B[3]))
mix_skurts <- list(rep(0, 2), c(L[4], C[4], B[4]))
mix_fifths <- list(rep(0, 2), c(L[5], C[5], B[5]))
mix_sixths <- list(rep(0, 2), c(L[6], C[6], B[6]))
mix_Six <- list(list(NULL, NULL), list(1.75, NULL, 0.03))
Nstcum <- calc_mixmoments(mix_pis[[1]], mix_mus[[1]], mix_sigmas[[1]],
  mix_skews[[1]], mix_skurts[[1]], mix_fifths[[1]], mix_sixths[[1]])
Mstcum <- calc_mixmoments(mix_pis[[2]], mix_mus[[2]], mix_sigmas[[2]],
  mix_skews[[2]], mix_skurts[[2]], mix_fifths[[2]], mix_sixths[[2]])
means <- c(Nstcum[1], Mstcum[1])
vars <- c(Nstcum[2]^2, Mstcum[2]^2)

marginal <- list(0.3)
support <- list(c(0, 1))
lam <- 0.5
p_zip <- 0.1
size <- 2
prob <- 0.75
p_zinb <- 0.2
```

```

k_cat <- k_pois <- k_nb <- 1
k_cont <- 0
k_mix <- 2
Rey <- matrix(0.39, 8, 8)
diag(Rey) <- 1
rownames(Rey) <- colnames(Rey) <- c("O1", "M1_1", "M1_2", "M2_1", "M2_2",
  "M2_3", "P1", "NB1")

# set correlation between components of the same mixture variable to 0
Rey["M1_1", "M1_2"] <- Rey["M1_2", "M1_1"] <- 0
Rey["M2_1", "M2_2"] <- Rey["M2_2", "M2_1"] <- Rey["M2_1", "M2_3"] <- 0
Rey["M2_3", "M2_1"] <- Rey["M2_2", "M2_3"] <- Rey["M2_3", "M2_2"] <- 0

# check parameter inputs
validpar(k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal, support,
  lam, p_zip, size, prob, mu = NULL, p_zinb, rho = Rey)

# check to make sure Rey is within the feasible correlation boundaries
validcorr(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal,
  lam, p_zip, size, prob, mu = NULL, p_zinb, Rey, seed)

# simulate without the error loop
Sim1 <- corrvar(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal, support,
  lam, p_zip, size, prob, mu = NULL, p_zinb, Rey, seed, epsilon = 0.01)

Sim1_error <- abs(Rey - Sim1$rho_calc)
summary(as.numeric(Sim1_error))

# simulate with the error loop
Sim1_EL <- corrvar(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial",
  means, vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus,
  mix_sigmas, mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six,
  marginal, support, lam, p_zip, size, prob, mu = NULL, p_zinb, Rey,
  seed, errorloop = TRUE, epsilon = 0.01)

EL1_error <- abs(Rey - Sim1_EL$rho_calc)
summary(as.numeric(EL1_error))

## End(Not run)

```


Description

This function simulates `k_cat` ordinal ($r \geq 2$ categories), `k_cont` continuous non-mixture, `k_mix` continuous mixture, `k_pois` Poisson (regular and zero-inflated), and/or `k_nb` Negative Binomial (regular and zero-inflated) variables with a specified correlation matrix `rho`. The variables are generated from multivariate normal variables with intermediate correlation matrix `Sigma`, calculated by [intercorr2](#), and then transformed. The intermediate correlations involving count variables are determined using **correlation method 2**. The *ordering* of the variables in `rho` must be 1st ordinal, 2nd continuous non-mixture, 3rd components of the continuous mixture, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, and 7th zero-inflated NB. Note that it is possible for `k_cat`, `k_cont`, `k_mix`, `k_pois`, and/or `k_nb` to be 0. The target correlations are specified with respect to the components of the continuous mixture variables. There are no parameter input checks in order to decrease simulation time. All inputs should be checked prior to simulation with [validpar](#).

All continuous variables are simulated using either Fleishman's third-order (`method = "Fleishman"`, doi: [10.1007/BF02293811](#)) or Headrick's fifth-order (`method = "Polynomial"`, doi: [10.1016/S0167-9473\(02\)000725](#)) power method transformation. It works by matching standardized cumulants – the first four (mean, variance, skew, and standardized kurtosis) for Fleishman's method, or the first six (mean, variance, skew, standardized kurtosis, and standardized fifth and sixth cumulants) for Headrick's method. The transformation is expressed as follows:

$$Y = c_0 + c_1 * Z + c_2 * Z^2 + c_3 * Z^3 + c_4 * Z^4 + c_5 * Z^5, Z \sim N(0, 1),$$

where c_4 and c_5 both equal 0 for Fleishman's method. The real constants are calculated by [find_constants](#). Continuous mixture variables are generated componentwise and then transformed to the desired mixture variables. Ordinal variables ($r \geq 2$ categories) are generated by discretizing the standard normal variables at quantiles. These quantiles are determined by evaluating the inverse standard normal cdf at the cumulative probabilities defined by each variable's marginal distribution. Count variables are generated using the inverse cdf method. The CDF of a standard normal variable has a uniform distribution. The appropriate quantile function $(F_Y)^{-1}$ is applied to this uniform variable with the designated parameters to generate the count variable: $Y = (F_Y)^{-1}(\Phi(Z))$. The Negative Binomial variable represents the number of failures which occur in a sequence of Bernoulli trials before the target number of successes is achieved. Zero-inflated Poisson or NB variables are obtained by setting the probability of a structural zero to be greater than 0. The optional error loop attempts to correct the final pairwise correlations to be within a user-specified precision value (`epsilon`) of the target correlations.

The vignette **Variable Types** discusses how each of the different variables are generated and describes the required parameters.

The vignette **Overall Workflow for Generation of Correlated Data** provides a detailed example discussing the step-by-step simulation process and comparing correlation methods 1 and 2.

Usage

```
corrvar2(n = 10000, k_cat = 0, k_cont = 0, k_mix = 0, k_pois = 0,
  k_nb = 0, method = c("Fleishman", "Polynomial"), means = NULL,
  vars = NULL, skews = NULL, skurts = NULL, fifths = NULL,
  sixths = NULL, Six = list(), mix_pis = list(), mix_mus = list(),
  mix_sigmas = list(), mix_skews = list(), mix_skurts = list(),
  mix_fifths = list(), mix_sixths = list(), mix_Six = list(),
  marginal = list(), support = list(), lam = NULL, p_zip = 0,
  size = NULL, prob = NULL, mu = NULL, p_zinb = 0, pois_eps = 1e-04,
  nb_eps = 1e-04, rho = NULL, seed = 1234, errorloop = FALSE,
  epsilon = 0.001, maxit = 1000, use.nearPD = TRUE, Sigma = NULL,
  cstart = list())
```

Arguments

n	the sample size (i.e. the length of each simulated variable; default = 10000)
k_cat	the number of ordinal ($r \geq 2$ categories) variables (default = 0)
k_cont	the number of continuous non-mixture variables (default = 0)
k_mix	the number of continuous mixture variables (default = 0)
k_pois	the number of regular Poisson and zero-inflated Poisson variables (default = 0)
k_nb	the number of regular Negative Binomial and zero-inflated Negative Binomial variables (default = 0)
method	the method used to generate the k_cont non-mixture and k_mix mixture continuous variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
means	a vector of means for the k_cont non-mixture and k_mix mixture continuous variables (i.e. $\text{rep}(0, (k_cont + k_mix))$)
vars	a vector of variances for the k_cont non-mixture and k_mix mixture continuous variables (i.e. $\text{rep}(1, (k_cont + k_mix))$)
skews	a vector of skewness values for the k_cont non-mixture continuous variables
skurts	a vector of standardized kurtoses (kurtosis - 3, so that normal variables have a value of 0) for the k_cont non-mixture continuous variables
fifths	a vector of standardized fifth cumulants for the k_cont non-mixture continuous variables (not necessary for method = "Fleishman")
sixths	a vector of standardized sixth cumulants for the k_cont non-mixture continuous variables (not necessary for method = "Fleishman")
Six	a list of vectors of sixth cumulant correction values for the k_cont non-mixture continuous variables if no valid PDF constants are found, ex: <code>Six = list(seq(0.01, 2, 0.01), seq(1, 10, 0.5))</code> ; if no correction is desired for Y_{cont_i} , set the i-th list component equal to NULL; if no correction is desired for any of the Y_{cont} keep as <code>Six = list()</code> (not necessary for method = "Fleishman")
mix_pis	a list of length k_mix with i-th component a vector of mixing probabilities that sum to 1 for component distributions of Y_{mix_i}
mix_mus	a list of length k_mix with i-th component a vector of means for component distributions of Y_{mix_i}
mix_sigmas	a list of length k_mix with i-th component a vector of standard deviations for component distributions of Y_{mix_i}
mix_skews	a list of length k_mix with i-th component a vector of skew values for component distributions of Y_{mix_i}
mix_skurts	a list of length k_mix with i-th component a vector of standardized kurtoses for component distributions of Y_{mix_i}
mix_fifths	a list of length k_mix with i-th component a vector of standardized fifth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")
mix_sixths	a list of length k_mix with i-th component a vector of standardized sixth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")

mix_Six	a list of length k_mix with i-th component a list of vectors of sixth cumulant correction values for component distributions of Y_{mix_i} ; use NULL if no correction is desired for a given component or mixture variable; if no correction is desired for any of the Y_{mix} keep as mix_Six = list() (not necessary for method = "Fleishman")
marginal	a list of length equal to k_cat; the i-th element is a vector of the cumulative probabilities defining the marginal distribution of the i-th variable; if the variable can take r values, the vector will contain r - 1 probabilities (the r-th is assumed to be 1); for binary variables, these should be input the same as for ordinal variables with more than 2 categories (i.e. the user-specified probability is the probability of the 1st category, which has the smaller support value)
support	a list of length equal to k_cat; the i-th element is a vector containing the r ordered support values; if not provided (i.e. support = list()), the default is for the i-th element to be the vector 1, ..., r
lam	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if p_zip = 0, Y_{pois} has a regular Poisson distribution; if p_zip is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if p_zip = $-(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if length(p_zip) < length(lam), the missing values are set to 0 (and ordered 1st)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
prob	a vector of success probability parameters for the NB variables; order the same as in size
mu	a vector of mean parameters for the NB variables (*Note: either prob or mu should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if p_zinb = 0, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if p_zinb = $-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if length(p_zinb) < length(size), the missing values are set to 0 (and ordered 1st)
pois_eps	a vector of length k_pois containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable
nb_eps	a vector of length k_nb containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable
rho	the target correlation matrix which must be ordered <i>1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixtures, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, 7th zero-inflated NB</i> ; note that rho is specified in terms of the components of Y_{mix}
seed	the seed value for random number generation (default = 1234)

errorloop	if TRUE, uses <code>corr_error</code> to attempt to correct final pairwise correlations to be within epsilon of target pairwise correlations (default = FALSE)
epsilon	the maximum acceptable error between the final and target pairwise correlations (default = 0.001) in the calculation of ordinal intermediate correlations with <code>ord_norm</code> or in the error loop
maxit	the maximum number of iterations to use (default = 1000) in the calculation of ordinal intermediate correlations with <code>ord_norm</code> or in the error loop
use.nearPD	TRUE to convert rho to the nearest positive definite matrix with <code>Matrix::nearPD</code> if necessary
Sigma	an intermediate correlation matrix to use if the user wants to provide one, else it is calculated within by <code>intercorr2</code>
cstart	a list of length equal to <code>k_cont</code> + the total number of mixture components containing initial values for root-solving algorithm used in <code>find_constants</code> . If user specified, each list element must be input as a matrix. For method = "Fleishman", each should have 3 columns for c_1, c_2, c_3 ; for method = "Polynomial", each should have 5 columns for c_1, c_2, c_3, c_4, c_5 . If no starting values are specified for a given component, that list element should be NULL.

Value

A list whose components vary based on the type of simulated variables.

If **ordinal variables** are produced:

`Y_cat` the ordinal variables,

`ord_sum` a list, where the i-th element contains a data.frame with target and simulated cumulative probabilities for ordinal variable `Y_i`

If **continuous variables** are produced:

`constants` a data.frame of the constants,

`Y_cont` the continuous non-mixture variables,

`Y_comp` the components of the continuous mixture variables,

`Y_mix` the continuous mixture variables,

`cont_sum` a data.frame summarizing `Y_cont` and `Y_comp`,

`mix_sum` a data.frame summarizing `Y_mix`,

`target_sum` a data.frame with the target distributions for `Y_cont` and `Y_comp`,

`target_mix` a data.frame with the target distributions for `Y_mix`,

`sixth_correction` a list of sixth cumulant correction values,

`valid.pdf` a vector where the i-th element is "TRUE" if the constants for the i-th continuous variable generate a valid PDF, else "FALSE"

If **Poisson variables** are produced:

`Y_pois` the regular and zero-inflated Poisson variables,

`pois_sum` a data.frame summarizing `Y_pois`

If **Negative Binomial variables** are produced:

`Y_nb` the regular and zero-inflated Negative Binomial variables,

`nb_sum` a data.frame summarizing `Y_nb`

Additionally, the following elements:

rho the target correlation matrix used in the simulation (which will differ from the user-supplied rho if it was converted to the nearest positive-definite matrix)

rho_calc the final correlation matrix for Y_cat, Y_cont, Y_comp, Y_pois, and Y_nb

rho_mix the final correlation matrix for Y_cat, Y_cont, Y_mix, Y_pois, and Y_nb

Sigma1 the intermediate correlation before the error loop,

Sigma2 the intermediate correlation matrix after the error loop,

Constants_Time the time in minutes required to calculate the constants,

Intercorrelation_Time the time in minutes required to calculate the intermediate correlation matrix,

Error_Loop_Time the time in minutes required to use the error loop,

Simulation_Time the total simulation time in minutes,

niter a matrix of the number of iterations used for each variable in the error loop,

maxerr the maximum final correlation error (from the target rho).

Overview of Method 2

The intermediate correlations used in method 2 are less simulation based than those in method 1, and no seed is needed. Their calculations involve greater utilization of correction loops which make iterative adjustments until a maximum error has been reached (if possible). In addition, method 2 differs from method 1 in the following ways:

1) The intermediate correlations involving **count variables** are based on the methods of Barbiero & Ferrari (2012, doi: [10.1080/00273171.2012.692630](https://doi.org/10.1080/00273171.2012.692630), 2015, doi: [10.1002/asmb.2072](https://doi.org/10.1002/asmb.2072)). The Poisson or Negative Binomial support is made finite by removing a small user-specified value (i.e. 1e-06) from the total cumulative probability. This truncation factor may differ for each count variable. The count variables are subsequently treated as ordinal and intermediate correlations are calculated using the correction loop of [ord_norm](#).

2) The **continuous - count variable** correlations are based on an extension of the method of Demirtas et al. (2012, doi: [10.1002/sim.5362](https://doi.org/10.1002/sim.5362)), and the count variables are treated as ordinal. The correction factor is the product of the power method correlation between the continuous variable and the normal variable used to generate it (see Headrick & Kowalchuk, 2007, doi: [10.1080/10629360600605065](https://doi.org/10.1080/10629360600605065)) and the point-polyserial correlation between the ordinalized count variable and the normal variable used to generate it (see Olsson et al., 1982, doi: [10.1007/BF02294164](https://doi.org/10.1007/BF02294164)). The intermediate correlations are the ratio of the target correlations to the correction factor.

Please see the **Comparison of Correlation Methods 1 and 2** vignette for more information and a step-by-step overview of the simulation process.

Choice of Fleishman's third-order or Headrick's fifth-order method

Using the fifth-order approximation allows additional control over the fifth and sixth moments of the generated distribution, improving accuracy. In addition, the range of feasible standardized kurtosis values, given skew and standardized fifth (γ_3) and sixth (γ_4) cumulants, is larger than with Fleishman's method (see [calc_lower_skurt](#)). For example, the Fleishman method can not be used to generate a non-normal distribution with a ratio of $\gamma_3^2/\gamma_4 > 9/14$ (see Headrick & Kowalchuk, 2007). This eliminates the Chi-squared family of distributions, which has a constant ratio of $\gamma_3^2/\gamma_4 = 2/3$. The fifth-order method also generates more distributions with valid PDF's. However, if the fifth and sixth cumulants are unknown or do not exist, the Fleishman approximation should be used.

Reasons for Function Errors

- 1) The most likely cause for function errors is that no solutions to `fleish` or `poly` converged when using `find_constants`. If this happens, the simulation will stop. It may help to first use `find_constants` for each continuous variable to determine if a sixth cumulant correction value is needed. The solutions can be used as starting values (see `cstart` below). If the standardized cumulants are obtained from `calc_theory`, the user may need to use rounded values as inputs (i.e. `skews = round(skews, 8)`). For example, in order to ensure that skew is exactly 0 for symmetric distributions.
- 2) The kurtosis may be outside the region of possible values. There is an associated lower boundary for kurtosis associated with a given skew (for Fleishman's method) or skew and fifth and sixth cumulants (for Headrick's method). Use `calc_lower_skurt` to determine the boundary for a given set of cumulants.
- 3) The feasibility of the final correlation matrix `rho`, given the distribution parameters, should be checked first using `validcorr2`. This function either checks if a given `rho` is plausible or returns the lower and upper final correlation limits. It should be noted that even if a target correlation matrix is within the "plausible range," it still may not be possible to achieve the desired matrix. This happens most frequently when generating ordinal variables or using negative correlations. The error loop frequently fixes these problems.

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See Also

[find_constants](#), [validpar](#), [validcorr2](#), [intercorr2](#), [corr_error](#)

Examples

```
## Not run:

# 2 continuous mixture, 1 binary, 1 zero-inflated Poisson, and
# 1 zero-inflated NB variable
n <- 10000
seed <- 1234

# Mixture variables: Normal mixture with 2 components;
# mixture of Logistic(0, 1), Chisq(4), Beta(4, 1.5)
# Find cumulants of components of 2nd mixture variable
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))

skews <- skurts <- fifths <- sixths <- NULL
Six <- list()
```

```

mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
mix_skews <- list(rep(0, 2), c(L[3], C[3], B[3]))
mix_skurts <- list(rep(0, 2), c(L[4], C[4], B[4]))
mix_fifths <- list(rep(0, 2), c(L[5], C[5], B[5]))
mix_sixths <- list(rep(0, 2), c(L[6], C[6], B[6]))
mix_Six <- list(list(NULL, NULL), list(1.75, NULL, 0.03))
Nstcum <- calc_mixmoments(mix_pis[[1]], mix_mus[[1]], mix_sigmas[[1]],
  mix_skews[[1]], mix_skurts[[1]], mix_fifths[[1]], mix_sixths[[1]])
Mstcum <- calc_mixmoments(mix_pis[[2]], mix_mus[[2]], mix_sigmas[[2]],
  mix_skews[[2]], mix_skurts[[2]], mix_fifths[[2]], mix_sixths[[2]])
means <- c(Nstcum[1], Mstcum[1])
vars <- c(Nstcum[2]^2, Mstcum[2]^2)

marginal <- list(0.3)
support <- list(c(0, 1))
lam <- 0.5
p_zip <- 0.1
pois_eps <- 0.0001
size <- 2
prob <- 0.75
p_zinb <- 0.2
nb_eps <- 0.0001

k_cat <- k_pois <- k_nb <- 1
k_cont <- 0
k_mix <- 2
Rey <- matrix(0.39, 8, 8)
diag(Rey) <- 1
rownames(Rey) <- colnames(Rey) <- c("01", "M1_1", "M1_2", "M2_1", "M2_2",
  "M2_3", "P1", "NB1")

# set correlation between components of the same mixture variable to 0
Rey["M1_1", "M1_2"] <- Rey["M1_2", "M1_1"] <- 0
Rey["M2_1", "M2_2"] <- Rey["M2_2", "M2_1"] <- Rey["M2_1", "M2_3"] <- 0
Rey["M2_3", "M2_1"] <- Rey["M2_2", "M2_3"] <- Rey["M2_3", "M2_2"] <- 0

# check parameter inputs
validpar(k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal, support,
  lam, p_zip, size, prob, mu = NULL, p_zinb, pois_eps, nb_eps, Rey)

# check to make sure Rey is within the feasible correlation boundaries
validcorr2(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal,
  lam, p_zip, size, prob, mu = NULL, p_zinb, pois_eps, nb_eps, Rey, seed)

# simulate without the error loop
Sim2 <- corrvar2(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal, support,
  lam, p_zip, size, prob, mu = NULL, p_zinb, pois_eps, nb_eps, Rey, seed,
  epsilon = 0.01)

```



```

Sim2_error <- abs(Rey - Sim2$rho_calc)
summary(as.numeric(Sim2_error))

# simulate with the error loop
Sim2_EL <- corrvar2(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial",
  means, vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus,
  mix_sigmas, mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six,
  marginal, support, lam, p_zip, size, prob, mu = NULL, p_zinb, pois_eps,
  nb_eps, Rey, seed, errorloop = TRUE, epsilon = 0.01)

EL2_error <- abs(Rey - Sim2_EL$rho_calc)
summary(as.numeric(EL2_error))

## End(Not run)

```

corr_error

Error Loop to Correct Final Correlation of Simulated Variables

Description

This function attempts to correct the final pairwise correlations of simulated variables to be within epsilon of the target correlations. It updates the intermediate normal correlation iteratively in a loop until either the maximum error is less than epsilon or the number of iterations exceeds `maxit`. This function would not ordinarily be called directly by the user. The function is a modification of Barbiero & Ferrari's `ordcont` function in [GenOrd-package](#). The `ordcont` function has been modified in the following ways:

- 1) It works for continuous, ordinal ($r \geq 2$ categories), and count (regular or zero-inflated, Poisson or Negative Binomial) variables.
- 2) The initial correlation check has been removed because this intermediate correlation Sigma from `corrvar` or `corrvar2` has already been checked for positive-definiteness and used to generate variables.
- 3) Eigenvalue decomposition is done on Sigma to impose the correct intermediate correlations on the normal variables. If Sigma is not positive-definite, the negative eigen values are replaced with 0.
- 4) The final positive-definite check has been removed.
- 5) The intermediate correlation update function was changed to accommodate more situations.
- 6) Allowing specifications for the sample size and the seed for reproducibility.

The vignette **Error Loop Algorithm** describes the algorithm used in the error loop.

Usage

```

corr_error(n = 10000, k_cat = 0, k_cont = 0, k_pois = 0, k_nb = 0,
  method = c("Fleishman", "Polynomial"), means = NULL, vars = NULL,
  constants = NULL, marginal = list(), support = list(), lam = NULL,
  p_zip = 0, size = NULL, mu = NULL, p_zinb = 0, seed = 1234,
  epsilon = 0.001, maxit = 1000, rho0 = NULL, Sigma = NULL,
  rho_calc = NULL)

```

Arguments

n	the sample size
k_cat	the number of ordinal ($r \geq 2$ categories) variables
k_cont	the number of continuous variables (these may be regular continuous variables or components of continuous mixture variables)
k_pois	the number of Poisson (regular or zero-inflated) variables
k_nb	the number of Negative Binomial (regular or zero-inflated) variables
method	the method used to generate the continuous variables. "Fleishman" uses a third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
means	a vector of means for the continuous variables
vars	a vector of variances for the continuous variables
constants	a matrix with k_cont rows, each a vector of constants c0, c1, c2, c3 (if method = "Fleishman") or c0, c1, c2, c3, c4, c5 (if method = "Polynomial"), like that returned by find_constants
marginal	a list of length equal k_cat; the i-th element is a vector of the cumulative probabilities defining the marginal distribution of the i-th variable; if the variable can take r values, the vector will contain r - 1 probabilities (the r-th is assumed to be 1)
support	a list of length equal k_cat; the i-th element is a vector of containing the r ordered support values; if not provided, the default is for the i-th element to be the vector 1, ..., r
lam	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
mu	a vector of mean parameters for the Negative Binomial variables; order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin)
seed	the seed value for random number generation
epsilon	the maximum acceptable error between the final and target pairwise correlation; smaller epsilons take more time
maxit	the maximum number of iterations to use to find the intermediate correlation; the correction loop stops when either the iteration number passes maxit or epsilon is reached
rho0	the target correlation matrix
Sigma	the intermediate correlation matrix previously used in corrvar or corrvar2
rho_calc	the final correlation matrix calculated in corrvar or corrvar2 before execution of corr_error

Value

A list with the following components:

Sigma the intermediate MVN correlation matrix resulting from the error loop

rho_calc the calculated final correlation matrix generated from Sigma

Y_cat the ordinal variables

Y the continuous (mean 0, variance 1) variables

Y_cont the continuous variables with desired mean and variance

Y_pois the Poisson variables

Y_nb the Negative Binomial variables

niter a matrix containing the number of iterations required for each variable pair

References

Please see references for SimCorrMix.

See Also

[corrvar](#), [corrvar2](#)

intercorr

Calculate Intermediate MVN Correlation for Ordinal, Continuous, Poisson, or Negative Binomial Variables: Correlation Method 1

Description

This function calculates a $k \times k$ intermediate matrix of correlations, where $k = k_{\text{cat}} + k_{\text{cont}} + k_{\text{pois}} + k_{\text{nb}}$, to be used in simulating variables with [corrvar](#). The k_{cont} includes regular continuous variables and components of continuous mixture variables. The ordering of the variables must be ordinal, continuous non-mixture, components of continuous mixture variables, regular Poisson, zero-inflated Poisson, regular Negative Binomial (NB), and zero-inflated NB (note that it is possible for k_{cat} , k_{cont} , k_{pois} , and/or k_{nb} to be 0). There are no parameter input checks in order to decrease simulation time. All inputs should be checked prior to simulation with [validpar](#). There is a message given if the calculated intermediate correlation matrix Sigma is not positive-definite because it may not be possible to find a MVN correlation matrix that will produce the desired marginal distributions. This function is called by the simulation function [corrvar](#), and would only be used separately if the user wants to first find the intermediate correlation matrix. This matrix Sigma can be used as an input to [corrvar](#).

Please see the **Comparison of Correlation Methods 1 and 2** vignette for information about calculations by variable pair type and the differences between this function and [intercorr2](#).

Usage

```
intercorr(k_cat = 0, k_cont = 0, k_pois = 0, k_nb = 0,
  method = c("Fleishman", "Polynomial"), constants = NULL,
  marginal = list(), support = list(), lam = NULL, p_zip = 0,
  size = NULL, prob = NULL, mu = NULL, p_zinb = 0, rho = NULL,
  seed = 1234, epsilon = 0.001, maxit = 1000, nrand = 1e+05)
```

Arguments

k_cat	the number of ordinal ($r \geq 2$ categories) variables (default = 0)
k_cont	the number of continuous non-mixture variables and components of continuous mixture variables (default = 0)
k_pois	the number of regular and zero-inflated Poisson variables (default = 0)
k_nb	the number of regular and zero-inflated Negative Binomial variables (default = 0)
method	the method used to generate the k_cont continuous variables. "Fleishman" uses a third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
constants	a matrix with k_cont rows, each a vector of constants c0, c1, c2, c3 (if method = "Fleishman") or c0, c1, c2, c3, c4, c5 (if method = "Polynomial") like that returned by find_constants
marginal	a list of length equal to k_cat; the i-th element is a vector of the cumulative probabilities defining the marginal distribution of the i-th variable; if the variable can take r values, the vector will contain r - 1 probabilities (the r-th is assumed to be 1; default = list())
support	a list of length equal to k_cat; the i-th element is a vector of containing the r ordered support values; if not provided (i.e. support = list()), the default is for the i-th element to be the vector 1, ..., r
lam	a vector of lambda (mean > 0) constants for the regular and zero-inflated Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if p_zip = 0, Y_{pois} has a regular Poisson distribution; if p_zip is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if $p_zip = -(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if $\text{length}(p_zip) < \text{length}(\text{lam})$, the missing values are set to 0 (and ordered 1st)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
prob	a vector of success probability parameters for the NB variables; order the same as in size
mu	a vector of mean parameters for the NB variables (*Note: either prob or mu should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if p_zinb = 0, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if $p_zinb = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if $\text{length}(p_zinb) < \text{length}(\text{size})$, the missing values are set to 0 (and ordered 1st)
rho	the target correlation matrix which must be ordered <i>1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixtures, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, 7th zero-inflated NB</i> ; note that rho is specified in terms of the components of Y_{mix}

seed	the seed value for random number generation (default = 1234)
epsilon	the maximum acceptable error between the pairwise correlations (default = 0.001) in the calculation of ordinal intermediate correlations with ord_norm
maxit	the maximum number of iterations to use (default = 1000) in the calculation of ordinal intermediate correlations with ord_norm
nrand	the number of random numbers to generate in calculating intermediate correlations (default = 10000)

Value

the intermediate MVN correlation matrix

References

Please see [corrvar](#) for references.

See Also

[corrvar](#)

Examples

```
## Not run:

# 1 continuous mixture, 1 binary, 1 zero-inflated Poisson, and
# 1 zero-inflated NB variable
seed <- 1234

# Mixture of N(-2, 1) and N(2, 1)
constants <- rbind(c(0, 1, 0, 0, 0, 0), c(0, 1, 0, 0, 0, 0))

marginal <- list(0.3)
support <- list(c(0, 1))
lam <- 0.5
p_zip <- 0.1
size <- 2
prob <- 0.75
p_zinb <- 0.2

k_cat <- k_pois <- k_nb <- 1
k_cont <- 2
Rey <- matrix(0.35, 5, 5)
diag(Rey) <- 1
rownames(Rey) <- colnames(Rey) <- c("01", "M1_1", "M1_2", "P1", "NB1")

# set correlation between components of the same mixture variable to 0
Rey["M1_1", "M1_2"] <- Rey["M1_2", "M1_1"] <- 0

Sigma1 <- intercorr(k_cat, k_cont, k_pois, k_nb, "Polynomial", constants,
  marginal, support, lam, p_zip, size, prob, mu = NULL, p_zinb, Rey, seed)
Sigma1

## End(Not run)
```

intercorr2

Calculate Intermediate MVN Correlation for Ordinal, Continuous, Poisson, or Negative Binomial Variables: Correlation Method 2

Description

This function calculates a $k \times k$ intermediate matrix of correlations, where $k = k_{\text{cat}} + k_{\text{cont}} + k_{\text{pois}} + k_{\text{nb}}$, to be used in simulating variables with [corrvar2](#). The k_{cont} includes regular continuous variables and components of continuous mixture variables. The ordering of the variables must be ordinal, continuous non-mixture, components of continuous mixture variables, regular Poisson, zero-inflated Poisson, regular Negative Binomial (NB), and zero-inflated NB (note that it is possible for k_{cat} , k_{cont} , k_{pois} , and/or k_{nb} to be 0). There are no parameter input checks in order to decrease simulation time. All inputs should be checked prior to simulation with [validpar](#). There is a message given if the calculated intermediate correlation matrix Sigma is not positive-definite because it may not be possible to find a MVN correlation matrix that will produce the desired marginal distributions. This function is called by the simulation function [corrvar2](#), and would only be used separately if the user wants to first find the intermediate correlation matrix. This matrix Sigma can be used as an input to [corrvar2](#).

Please see the **Comparison of Correlation Methods 1 and 2** vignette for information about calculations by variable pair type and the differences between this function and [intercorr](#).

Usage

```
intercorr2(k_cat = 0, k_cont = 0, k_pois = 0, k_nb = 0,
  method = c("Fleishman", "Polynomial"), constants = NULL,
  marginal = list(), support = list(), lam = NULL, p_zip = 0,
  size = NULL, prob = NULL, mu = NULL, p_zinb = 0, pois_eps = 1e-04,
  nb_eps = 1e-04, rho = NULL, epsilon = 0.001, maxit = 1000)
```

Arguments

k_cat	the number of ordinal ($r \geq 2$ categories) variables (default = 0)
k_cont	the number of continuous non-mixture variables and components of continuous mixture variables (default = 0)
k_pois	the number of regular and zero-inflated Poisson variables (default = 0)
k_nb	the number of regular and zero-inflated Negative Binomial variables (default = 0)
method	the method used to generate the k_{cont} continuous variables. "Fleishman" uses a third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
constants	a matrix with k_{cont} rows, each a vector of constants c_0, c_1, c_2, c_3 (if method = "Fleishman") or $c_0, c_1, c_2, c_3, c_4, c_5$ (if method = "Polynomial") like that returned by find_constants
marginal	a list of length equal to k_{cat} ; the i -th element is a vector of the cumulative probabilities defining the marginal distribution of the i -th variable; if the variable can take r values, the vector will contain $r - 1$ probabilities (the r -th is assumed to be 1; default = list())

support	a list of length equal to k_cat; the i-th element is a vector of containing the r ordered support values; if not provided (i.e. support = list()), the default is for the i-th element to be the vector 1, ..., r
lam	a vector of lambda (mean > 0) constants for the regular and zero-inflated Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if p_zip = 0, Y_{pois} has a regular Poisson distribution; if p_zip is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if $p_zip = -(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if $\text{length}(p_zip) < \text{length}(\text{lam})$, the missing values are set to 0 (and ordered 1st)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
prob	a vector of success probability parameters for the NB variables; order the same as in size
mu	a vector of mean parameters for the NB variables (*Note: either prob or mu should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if p_zinb = 0, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if $p_zinb = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if $\text{length}(p_zinb) < \text{length}(\text{size})$, the missing values are set to 0 (and ordered 1st)
pois_eps	a vector of length k_pois containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable
nb_eps	a vector of length k_nb containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable
rho	the target correlation matrix which must be ordered <i>1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixtures, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, 7th zero-inflated NB</i> ; note that rho is specified in terms of the components of Y_{mix}
epsilon	the maximum acceptable error between the pairwise correlations (default = 0.001) in the calculation of ordinal intermediate correlations with ord_norm
maxit	the maximum number of iterations to use (default = 1000) in the calculation of ordinal intermediate correlations with ord_norm
nrand	the number of random numbers to generate in calculating the bound (default = 10000)

Value

the intermediate MVN correlation matrix

References

Please see [corrvar2](#) for references.

See Also[corrvar2](#)**Examples**

```
## Not run:

# 1 continuous mixture, 1 binary, 1 zero-inflated Poisson, and
# 1 zero-inflated NB variable
# The defaults of pois_eps <- nb_eps <- 0.0001 are used.

# Mixture of N(-2, 1) and N(2, 1)
constants <- rbind(c(0, 1, 0, 0, 0, 0), c(0, 1, 0, 0, 0, 0))

marginal <- list(0.3)
support <- list(c(0, 1))
lam <- 0.5
p_zip <- 0.1
size <- 2
prob <- 0.75
p_zinb <- 0.2

k_cat <- k_pois <- k_nb <- 1
k_cont <- 2
Rey <- matrix(0.35, 5, 5)
diag(Rey) <- 1
rownames(Rey) <- colnames(Rey) <- c("O1", "M1_1", "M1_2", "P1", "NB1")

# set correlation between components of the same mixture variable to 0
Rey["M1_1", "M1_2"] <- Rey["M1_2", "M1_1"] <- 0

Sigma2 <- intercorr2(k_cat, k_cont, k_pois, k_nb, "Polynomial", constants,
  marginal, support, lam, p_zip, size, prob, mu = NULL, p_zinb, rho = Rey)
Sigma2

## End(Not run)
```

intercorr_cat_nb

Calculate Intermediate MVN Correlation for Ordinal - Negative Binomial Variables: Correlation Method 1

Description

This function calculates the $k_{\text{cat}} \times k_{\text{nb}}$ intermediate matrix of correlations for the k_{cat} ordinal ($r \geq 2$ categories) and k_{nb} Negative Binomial variables required to produce the target correlations in $\rho_{\text{cat_nb}}$. It extends the method of Amatya & Demirtas (2015, doi: [10.1080/00949655.2014.953534](#)) to ordinal - Negative Binomial pairs and allows for regular or zero-inflated NB variables. Here, the intermediate correlation between $Z1$ and $Z2$ (where $Z1$ is the standard normal variable discretized to produce an ordinal variable $Y1$, and $Z2$ is the standard normal variable used to generate a Negative Binomial variable via the inverse CDF method) is calculated by dividing the target correlation by a correction factor. The correction factor is the product of the upper Frechet-Hoeffding bound on the correlation between a Negative Binomial variable and the normal variable used to generate it and a simulated GSC upper bound on the correlation between an ordinal

variable and the normal variable used to generate it (see Demirtas & Hedeker, 2011, doi: [10.1198/tast.2011.10090](https://doi.org/10.1198/tast.2011.10090)). The function is used in [intercorr](#) and [corrvar](#). This function would not ordinarily be called by the user.

Usage

```
intercorr_cat_nb(rho_cat_nb = NULL, marginal = list(), size = NULL,
  mu = NULL, p_zinb = 0, nrand = 1e+05, seed = 1234)
```

Arguments

<code>rho_cat_nb</code>	a $k_{\text{cat}} \times k_{\text{nb}}$ matrix of target correlations among ordinal and Negative Binomial variables; the NB variables should be ordered 1st regular, 2nd zero-inflated
<code>marginal</code>	a list of length equal to k_{cat} ; the i -th element is a vector of the cumulative probabilities defining the marginal distribution of the i -th variable; if the variable can take r values, the vector will contain $r - 1$ probabilities (the r -th is assumed to be 1)
<code>size</code>	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
<code>mu</code>	a vector of mean parameters for the NB variables; order the same as in <code>size</code>
<code>p_zinb</code>	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if $p_{\text{zinb}} = 0$, Y_{nb} has a regular NB distribution; if p_{zinb} is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_{zinb} is not a probability; if $p_{\text{zinb}} = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if $\text{length}(p_{\text{zinb}}) < \text{length}(\text{size})$, the missing values are set to 0 (and ordered 1st)
<code>nrand</code>	the number of random numbers to generate in calculating the bound (default = 10000)
<code>seed</code>	the seed used in random number generation (default = 1234)

Value

a $k_{\text{cat}} \times k_{\text{nb}}$ matrix whose rows represent the k_{cat} ordinal variables and columns represent the k_{nb} Negative Binomial variables

References

Please see references for [intercorr_cat_pois](#)

See Also

[intercorr](#), [corrvar](#)

intercorr_cat_pois	<i>Calculate Intermediate MVN Correlation for Ordinal - Poisson Variables: Correlation Method 1</i>
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Description

This function calculates a $k_{\text{cat}} \times k_{\text{pois}}$ intermediate matrix of correlations for the k_{cat} ordinal ($r \geq 2$ categories) and k_{pois} Poisson variables required to produce the target correlations in `rho_cat_pois`. It extends the method of Amatya & Demirtas (2015, doi: [10.1080/00949655.2014.953534](https://doi.org/10.1080/00949655.2014.953534)) to ordinal - Poisson pairs and allows for regular or zero-inflated Poisson variables. Here, the intermediate correlation between Z1 and Z2 (where Z1 is the standard normal variable discretized to produce an ordinal variable Y1, and Z2 is the standard normal variable used to generate a Poisson variable via the inverse CDF method) is calculated by dividing the target correlation by a correction factor. The correction factor is the product of the upper Frechet-Hoeffding bound on the correlation between a Poisson variable and the normal variable used to generate it and a simulated GSC upper bound on the correlation between an ordinal variable and the normal variable used to generate it (see Demirtas & Hedeker, 2011, doi: [10.1198/tast.2011.10090](https://doi.org/10.1198/tast.2011.10090)). The function is used in `intercorr` and `corrvar`. This function would not ordinarily be called by the user.

Usage

```
intercorr_cat_pois(rho_cat_pois = NULL, marginal = list(), lam = NULL,
  p_zip = 0, nrand = 1e+05, seed = 1234)
```

Arguments

<code>rho_cat_pois</code>	a $k_{\text{cat}} \times k_{\text{pois}}$ matrix of target correlations among ordinal and Poisson variables; the Poisson variables should be ordered 1st regular, 2nd zero-inflated
<code>marginal</code>	a list of length equal to k_{cat} ; the i -th element is a vector of the cumulative probabilities defining the marginal distribution of the i -th variable; if the variable can take r values, the vector will contain $r - 1$ probabilities (the r -th is assumed to be 1)
<code>lam</code>	a vector of lambda (mean > 0) constants for the Poisson variables (see <code>dpois</code>); order should be 1st regular, 2nd zero-inflated
<code>p_zip</code>	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see <code>dzipois</code>); if <code>p_zip</code> = 0, Y_{pois} has a regular Poisson distribution; if <code>p_zip</code> is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if <code>p_zip</code> is in $(-(\exp(\text{lam}) - 1)^{-1}), 0)$, Y_{pois} has a zero-deflated Poisson distribution and <code>p_zip</code> is not a probability; if <code>p_zip</code> = $-(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see <code>dpospois</code>); if <code>length(p_zip) < length(lam)</code> , the missing values are set to 0 (and ordered 1st)
<code>nrand</code>	the number of random numbers to generate in calculating the bound (default = 10000)
<code>seed</code>	the seed used in random number generation (default = 1234)

Value

a $k_{\text{cat}} \times k_{\text{pois}}$ matrix whose rows represent the k_{cat} ordinal variables and columns represent the k_{pois} Poisson variables

References

- Amatya A & Demirtas H (2015). Simultaneous generation of multivariate mixed data with Poisson and normal marginals. *Journal of Statistical Computation and Simulation*, 85(15):3129-39. doi: [10.1080/00949655.2014.953534](https://doi.org/10.1080/00949655.2014.953534).
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- Yee TW (2017). VGAM: Vector Generalized Linear and Additive Models. <https://CRAN.R-project.org/package=VGAM>.

See Also

[intercorr](#), [corrvar](#)

intercorr_cont_nb	<i>Calculate Intermediate MVN Correlation for Continuous - Negative Binomial Variables: Correlation Method 1</i>
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Description

This function calculates a $k_{\text{cont}} \times k_{\text{nb}}$ intermediate matrix of correlations for the k_{cont} continuous and k_{nb} Negative Binomial variables. It extends the method of Amatya & Demirtas (2015, doi: [10.1080/00949655.2014.953534](https://doi.org/10.1080/00949655.2014.953534)) to continuous variables generated using Headrick's fifth-order polynomial transformation and regular or zero-inflated NB variables. Here, the intermediate correlation between Z1 and Z2 (where Z1 is the standard normal variable transformed using Headrick's fifth-order or Fleishman's third-order method to produce a continuous variable Y1, and Z2 is the standard normal variable used to generate a Negative Binomial variable via the inverse CDF method) is calculated by dividing the target correlation by a correction factor. The correction factor is the product of the upper Frechet-Hoeffding bound on the correlation between a Negative Binomial variable and the normal variable used to generate it and the power method correlation (described in Headrick & Kowalchuk, 2007, doi: [10.1080/10629360600605065](https://doi.org/10.1080/10629360600605065)) between Y1 and Z1. The function is used in [intercorr](#) and [corrvar](#). This function would not ordinarily be called by the user.

Usage

```
intercorr_cont_nb(method = c("Fleishman", "Polynomial"), constants = NULL,
  rho_cont_nb = NULL, size = NULL, mu = NULL, p_zinb = 0,
  nrand = 1e+05, seed = 1234)
```

Arguments

method	the method used to generate the k_cont continuous variables. "Fleishman" uses a third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
constants	a matrix with k_cont rows, each a vector of constants c0, c1, c2, c3 (if method = "Fleishman") or c0, c1, c2, c3, c4, c5 (if method = "Polynomial"), like that returned by find_constants
rho_cont_nb	a k_cont x k_nb matrix of target correlations among continuous and Negative Binomial variables; the NB variables should be ordered 1st regular, 2nd zero-inflated
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
mu	a vector of mean parameters for the NB variables; order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if p_zinb = 0, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if p_zinb = $-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if length(p_zinb) < length(size), the missing values are set to 0 (and ordered 1st)
nrand	the number of random numbers to generate in calculating the bound (default = 10000)
seed	the seed used in random number generation (default = 1234)

Value

a k_cont x k_nb matrix whose rows represent the k_cont continuous variables and columns represent the k_nb Negative Binomial variables

References

Please see references for [intercorr_cont_pois](#).

See Also

[find_constants](#), [intercorr](#), [corrvar](#)

intercorr_cont_nb2	<i>Calculate Intermediate MVN Correlation for Continuous - Negative Binomial Variables: Correlation Method 2</i>
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Description

This function calculates a k_cont x k_nb intermediate matrix of correlations for the k_cont continuous and k_nb Negative Binomial variables. It extends the methods of Demirtas et al. (2012, doi: [10.1002/sim.5362](#)) and Barbiero & Ferrari (2015, doi: [10.1002/asmb.2072](#)) by:

- 1) including non-normal continuous and regular or zero-inflated Negative Binomial variables
- 2) allowing the continuous variables to be generated via Fleishman's third-order or Headrick's fifth-order transformation, and

3) since the count variables are treated as ordinal, using the point-polyserial and polyserial correlations to calculate the intermediate correlations (similar to [findintercorr_cont_cat](#) in [SimMultiCorrData-package](#)).

Here, the intermediate correlation between Z1 and Z2 (where Z1 is the standard normal variable transformed using Headrick's fifth-order or Fleishman's third-order method to produce a continuous variable Y1, and Z2 is the standard normal variable used to generate a Negative Binomial variable via the inverse CDF method) is calculated by dividing the target correlation by a correction factor. The correction factor is the product of the point-polyserial correlation between Y2 and Z2 (described in Olsson et al., 1982, doi: [10.1007/BF02294164](#)) and the power method correlation (described in Headrick & Kowalchuk, 2007, doi: [10.1080/10629360600605065](#)) between Y1 and Z1. After the maximum support value has been found using [maxcount_support](#), the point-polyserial correlation is given by:

$$\rho_{Y2,Z2} = \frac{1}{\sigma_{Y2}} \sum_{j=1}^{r-1} \phi(\tau_j)(y_{2j+1} - y_{2j})$$

where

$$\phi(\tau) = (2\pi)^{-1/2} * \exp(-0.5\tau^2)$$

Here, y_j is the j -th support value and τ_j is $\Phi^{-1}(\sum_{i=1}^j Pr(Y = y_i))$. The power method correlation is given by:

$$\rho_{Y1,Z1} = c_1 + 3c_3 + 15c_5,$$

where $c_5 = 0$ if method = "Fleishman". The function is used in [intercorr2](#) and [corrvar2](#). This function would not ordinarily be called by the user.

Usage

```
intercorr_cont_nb2(method = c("Fleishman", "Polynomial"), constants = NULL,
  rho_cont_nb = NULL, nb_marg = list(), nb_support = list())
```

Arguments

method	the method used to generate the <code>k_cont</code> continuous variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
constants	a matrix with <code>k_cont</code> rows, each a vector of constants <code>c0</code> , <code>c1</code> , <code>c2</code> , <code>c3</code> (if method = "Fleishman") or <code>c0</code> , <code>c1</code> , <code>c2</code> , <code>c3</code> , <code>c4</code> , <code>c5</code> (if method = "Polynomial"), like that returned by find_constants
rho_cont_nb	a <code>k_cont</code> x <code>k_nb</code> matrix of target correlations among continuous and Negative Binomial variables; the NB variables should be ordered 1st regular, 2nd zero-inflated
nb_marg	a list of length equal to <code>k_nb</code> ordered 1st regular and 2nd zero-inflated; the i -th element is a vector of the cumulative probabilities defining the marginal distribution of the i -th variable; if the variable can take r values, the vector will contain $r - 1$ probabilities (the r -th is assumed to be 1); this is created within intercorr2 and corrvar2
nb_support	a list of length equal to <code>k_nb</code> ordered 1st regular and 2nd zero-inflated; the i -th element is a vector of containing the r ordered support values, with a minimum of 0 and maximum determined via maxcount_support

Value

a `k_cont` x `k_nb` matrix whose rows represent the `k_cont` continuous variables and columns represent the `k_nb` Negative Binomial variables

References

Please see references in [intercorr_cont_pois2](#).

See Also

[find_constants](#), [power_norm_corr](#), [intercorr2](#), [corrvar2](#)

intercorr_cont_pois	<i>Calculate Intermediate MVN Correlation for Continuous - Poisson Variables: Correlation Method 1</i>
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Description

This function calculates a $k_{\text{cont}} \times k_{\text{pois}}$ intermediate matrix of correlations for the k_{cont} continuous and k_{pois} Poisson variables. It extends the method of Amatya & Demirtas (2015, doi: [10.1080/00949655.2014.953534](#)) to continuous variables generated using Headrick's fifth-order polynomial transformation and zero-inflated Poisson variables. Here, the intermediate correlation between Z1 and Z2 (where Z1 is the standard normal variable transformed using Headrick's fifth-order or Fleishman's third-order method to produce a continuous variable Y1, and Z2 is the standard normal variable used to generate a Poisson variable via the inverse CDF method) is calculated by dividing the target correlation by a correction factor. The correction factor is the product of the upper Frechet-Hoeffding bound on the correlation between a Poisson variable and the normal variable used to generate it and the power method correlation (described in Headrick & Kowalchuk, 2007, doi: [10.1080/10629360600605065](#)) between Y1 and Z1. The function is used in [intercorr](#) and [corrvar](#). This function would not ordinarily be called by the user.

Usage

```
intercorr_cont_pois(method = c("Fleishman", "Polynomial"), constants = NULL,
  rho_cont_pois = NULL, lam = NULL, p_zip = 0, nrand = 1e+05,
  seed = 1234)
```

Arguments

method	the method used to generate the k_{cont} continuous variables. "Fleishman" uses a third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
constants	a matrix with k_{cont} rows, each a vector of constants c_0, c_1, c_2, c_3 (if method = "Fleishman") or $c_0, c_1, c_2, c_3, c_4, c_5$ (if method = "Polynomial"), like that returned by find_constants
rho_cont_pois	a $k_{\text{cont}} \times k_{\text{pois}}$ matrix of target correlations among continuous and Poisson variables; the Poisson variables should be ordered 1st regular, 2nd zero-inflated
lam	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); order should be 1st regular, 2nd zero-inflated
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if $p_{\text{zip}} = 0$, Y_{pois} has a regular Poisson distribution; if p_{zip} is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_{zip} is in $(-(\exp(\text{lam}) - 1)^{-1}), 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_{zip} is not a probability; if $p_{\text{zip}} = -(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution

	(see dpospois); if <code>length(p_zip) < length(lam)</code> , the missing values are set to 0 (and ordered 1st)
<code>nrand</code>	the number of random numbers to generate in calculating the bound (default = 10000)
<code>seed</code>	the seed used in random number generation (default = 1234)

Value

a `k_cont` x `k_pois` matrix whose rows represent the `k_cont` continuous variables and columns represent the `k_pois` Poisson variables

References

- Amatya A & Demirtas H (2015). Simultaneous generation of multivariate mixed data with Poisson and normal marginals. *Journal of Statistical Computation and Simulation*, 85(15):3129-39. doi: [10.1080/00949655.2014.953534](#).
- Demirtas H & Hedeker D (2011). A practical way for computing approximate lower and upper correlation bounds. *American Statistician*, 65(2):104-109. doi: [10.1198/tast.2011.10090](#).
- Frechet M (1951). Sur les tableaux de correlation dont les marges sont donnees. *Ann. l'Univ. Lyon SectA*, 14:53-77.
- Headrick TC, Kowalchuk RK (2007). The Power Method Transformation: Its Probability Density Function, Distribution Function, and Its Further Use for Fitting Data. *Journal of Statistical Computation and Simulation*, 77:229-249. doi: [10.1080/10629360600605065](#).
- Hoeffding W. Scale-invariant correlation theory. In: Fisher NI, Sen PK, editors. *The collected works of Wassily Hoeffding*. New York: Springer-Verlag; 1994. p. 57-107.
- Yahav I & Shmueli G (2012). On Generating Multivariate Poisson Data in Management Science Applications. *Applied Stochastic Models in Business and Industry*, 28(1):91-102. doi: [10.1002/asmb.901](#).
- Yee TW (2017). VGAM: Vector Generalized Linear and Additive Models. <https://CRAN.R-project.org/package=VGAM>.

See Also

[power_norm_corr](#), [find_constants](#), [intercorr](#), [corrvar](#)

<code>intercorr_cont_pois2</code>	<i>Calculate Intermediate MVN Correlation for Continuous - Poisson Variables: Correlation Method 2</i>
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Description

This function calculates a `k_cont` x `k_pois` intermediate matrix of correlations for the `k_cont` continuous and `k_pois` Poisson variables. It extends the methods of Demirtas et al. (2012, doi: [10.1002/sim.5362](#)) and Barbiero & Ferrari (2015, doi: [10.1002/asmb.2072](#)) by:

- 1) including non-normal continuous and regular or zero-inflated Poisson variables
- 2) allowing the continuous variables to be generated via Fleishman's third-order or Headrick's fifth-order transformation, and

3) since the count variables are treated as ordinal, using the point-polyserial and polyserial correlations to calculate the intermediate correlations (similar to [findintercorr_cont_cat](#)) in [SimMultiCorrData-package](#)).

Here, the intermediate correlation between Z1 and Z2 (where Z1 is the standard normal variable transformed using Headrick's fifth-order or Fleishman's third-order method to produce a continuous variable Y1, and Z2 is the standard normal variable used to generate a Poisson variable via the inverse CDF method) is calculated by dividing the target correlation by a correction factor. The correction factor is the product of the point-polyserial correlation between Y2 and Z2 (described in Olsson et al., 1982, doi: [10.1007/BF02294164](#)) and the power method correlation (described in Headrick & Kowalchuk, 2007, doi: [10.1080/10629360600605065](#)) between Y1 and Z1. After the maximum support value has been found using [maxcount_support](#), the point-polyserial correlation is given by:

$$\rho_{Y2,Z2} = \frac{1}{\sigma_{Y2}} \sum_{j=1}^{r-1} \phi(\tau_j)(y_{2j+1} - y_{2j})$$

where

$$\phi(\tau) = (2\pi)^{-1/2} * \exp(-0.5\tau^2)$$

Here, y_j is the j -th support value and τ_j is $\Phi^{-1}(\sum_{i=1}^j Pr(Y = y_i))$. The power method correlation is given by:

$$\rho_{Y1,Z1} = c_1 + 3c_3 + 15c_5,$$

where $c_5 = 0$ if method = "Fleishman". The function is used in [intercorr2](#) and [corrvar2](#). This function would not ordinarily be called by the user.

Usage

```
intercorr_cont_pois2(method = c("Fleishman", "Polynomial"),
  constants = NULL, rho_cont_pois = NULL, pois_marg = list(),
  pois_support = list())
```

Arguments

method	the method used to generate the <code>k_cont</code> continuous variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
constants	a matrix with <code>k_cont</code> rows, each a vector of constants <code>c0</code> , <code>c1</code> , <code>c2</code> , <code>c3</code> (if method = "Fleishman") or <code>c0</code> , <code>c1</code> , <code>c2</code> , <code>c3</code> , <code>c4</code> , <code>c5</code> (if method = "Polynomial"), like that returned by find_constants
rho_cont_pois	a <code>k_cont</code> x <code>k_pois</code> matrix of target correlations among continuous and Poisson variables; the Poisson variables should be ordered 1st regular, 2nd zero-inflated
pois_marg	a list of length equal to <code>k_pois</code> ordered 1st regular and 2nd zero-inflated; the i -th element is a vector of the cumulative probabilities defining the marginal distribution of the i -th variable; if the variable can take r values, the vector will contain $r - 1$ probabilities (the r -th is assumed to be 1); this is created within intercorr2 and corrvar2
pois_support	a list of length equal to <code>k_pois</code> ordered 1st regular and 2nd zero-inflated; the i -th element is a vector of containing the r ordered support values, with a minimum of 0 and maximum determined via maxcount_support

Value

a `k_cont` x `k_pois` matrix whose rows represent the `k_cont` continuous variables and columns represent the `k_pois` Poisson variables

References

Please see additional references in [intercorr_cont_pois](#).

Barbiero A & Ferrari PA (2015). Simulation of correlated Poisson variables. Applied Stochastic Models in Business and Industry, 31:669-80. doi: [10.1002/asmb.2072](#).

See Also

[find_constants](#), [power_norm_corr](#), [intercorr2](#), [corrvar2](#)

intercorr_nb	<i>Calculate Intermediate MVN Correlation for Negative Binomial Variables: Correlation Method 1</i>
--------------	---

Description

This function calculates a $k_nb \times k_nb$ intermediate matrix of correlations for the Negative Binomial variables by extending the method of Yahav & Shmueli (2012, doi: [10.1002/asmb.901](#)). The intermediate correlation between Z1 and Z2 (the standard normal variables used to generate the Negative Binomial variables Y1 and Y2 via the inverse CDF method) is calculated using a logarithmic transformation of the target correlation. First, the upper and lower Frechet-Hoeffding bounds (mincor, maxcor) on $\rho_{Y1,Y2}$ are simulated. Then the intermediate correlation is found as follows:

$$\rho_{Z1,Z2} = \frac{1}{b} * \log\left(\frac{\rho_{Y1,Y2} - c}{a}\right),$$

where $a = -(maxcor * mincor)/(maxcor + mincor)$, $b = \log((maxcor + a)/a)$, and $c = -a$. The function adapts code from Amatya & Demirtas' (2016) package [PoisNor](#) by:

- 1) allowing specifications for the number of random variates and the seed for reproducibility
- 2) providing the following checks: if $\text{Sigma_}(Z1, Z2) > 1$, $\text{Sigma_}(Z1, Z2)$ is set to 1; if $\text{Sigma_}(Z1, Z2) < -1$, $\text{Sigma_}(Z1, Z2)$ is set to -1
- 3) simulating regular and zero-inflated Negative Binomial variables.

The function is used in [intercorr](#) and [corrvar](#) and would not ordinarily be called by the user.

Usage

```
intercorr_nb(rho_nb = NULL, size = NULL, mu = NULL, p_zinb = 0,
             nrand = 1e+05, seed = 1234)
```

Arguments

rho_nb	a $k_nb \times k_nb$ matrix of target correlations ordered 1st regular and 2nd zero-inflated
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
mu	a vector of mean parameters for the NB variables; order the same as in size

p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if p_zinb = 0, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if p_zinb = $-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if $\text{length}(\text{p_zinb}) < \text{length}(\text{size})$, the missing values are set to 0 (and ordered 1st)
nrand	the number of random numbers to generate in calculating the bound (default = 10000)
seed	the seed used in random number generation (default = 1234)

Value

the $k_{nb} \times k_{nb}$ intermediate correlation matrix for the Negative Binomial variables

References

Please see references for [intercorr_pois](#).

See Also

[intercorr_pois](#), [intercorr_pois_nb](#), [intercorr](#), [corrvar](#)

intercorr_pois	<i>Calculate Intermediate MVN Correlation for Poisson Variables: Correlation Method 1</i>
----------------	---

Description

This function calculates a $k_{\text{pois}} \times k_{\text{pois}}$ intermediate matrix of correlations for the Poisson variables using the method of Yahav & Shmueli (2012, doi: [10.1002/asmb.901](#)). The intermediate correlation between Z1 and Z2 (the standard normal variables used to generate the Poisson variables Y1 and Y2 via the inverse CDF method) is calculated using a logarithmic transformation of the target correlation. First, the upper and lower Frechet-Hoeffding bounds (mincor, maxcor) on $\rho_{Y1,Y2}$ are simulated. Then the intermediate correlation is found as follows:

$$\rho_{Z1,Z2} = \frac{1}{b} * \log\left(\frac{\rho_{Y1,Y2} - c}{a}\right),$$

where $a = -(maxcor * mincor)/(maxcor + mincor)$, $b = \log((maxcor + a)/a)$, and $c = -a$. The function adapts code from Amatya & Demirtas' (2016) package [PoisNor](#) by:

- 1) allowing specifications for the number of random variates and the seed for reproducibility
- 2) providing the following checks: if $\text{Sigma_}(Z1, Z2) > 1$, $\text{Sigma_}(Z1, Z2)$ is set to 1; if $\text{Sigma_}(Z1, Z2) < -1$, $\text{Sigma_}(Z1, Z2)$ is set to -1
- 3) simulating regular and zero-inflated Poisson variables.

The function is used in [intercorr](#) and [corrvar](#) and would not ordinarily be called by the user.

Usage

```
intercorr_pois(rho_pois = NULL, lam = NULL, p_zip = 0, nrand = 1e+05,
  seed = 1234)
```

Arguments

rho_pois	a k_pois x k_pois matrix of target correlations ordered 1st regular and 2nd zero-inflated
lam	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); order should be 1st regular, 2nd zero-inflated
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if p_zip = 0, Y_{pois} has a regular Poisson distribution; if p_zip is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if $p_zip = -(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if $\text{length}(p_zip) < \text{length}(lam)$, the missing values are set to 0 (and ordered 1st)
nrand	the number of random numbers to generate in calculating the bound (default = 10000)
seed	the seed used in random number generation (default = 1234)

Value

the k_pois x k_pois intermediate correlation matrix for the Poisson variables

References

- Amatya A & Demirtas H (2015). Simultaneous generation of multivariate mixed data with Poisson and normal marginals. *Journal of Statistical Computation and Simulation*, 85(15):3129-39. doi: [10.1080/00949655.2014.953534](#).
- Demirtas H & Hedeker D (2011). A practical way for computing approximate lower and upper correlation bounds. *American Statistician*, 65(2):104-109.
- Frechet M (1951). Sur les tableaux de correlation dont les marges sont donnees. *Ann. l'Univ. Lyon SectA*, 14:53-77.
- Hoeffding W. Scale-invariant correlation theory. In: Fisher NI, Sen PK, editors. *The collected works of Wassily Hoeffding*. New York: Springer-Verlag; 1994. p. 57-107.
- Yahav I & Shmueli G (2012). On Generating Multivariate Poisson Data in Management Science Applications. *Applied Stochastic Models in Business and Industry*, 28(1):91-102. doi: [10.1002/asmb.901](#).
- Yee TW (2017). VGAM: Vector Generalized Linear and Additive Models. <https://CRAN.R-project.org/package=VGAM>.

See Also

[intercorr_nb](#), [intercorr_pois_nb](#), [intercorr](#), [corrvar](#)

intercorr_pois_nb	<i>Calculate Intermediate MVN Correlation for Poisson - Negative Binomial Variables: Correlation Method 1</i>
-------------------	---

Description

This function calculates a $k_{\text{pois}} \times k_{\text{nb}}$ intermediate matrix of correlations for the Poisson and Negative Binomial variables by extending the method of Yahav & Shmueli (2012, doi: [10.1002/asmb.901](https://doi.org/10.1002/asmb.901)). The intermediate correlation between Z1 and Z2 (the standard normal variables used to generate the Poisson and Negative Binomial variables Y1 and Y2 via the inverse CDF method) is calculated using a logarithmic transformation of the target correlation. First, the upper and lower Frechet-Hoeffding bounds (mincor, maxcor) on $\rho_{Y1,Y2}$ are simulated. Then the intermediate correlation is found as follows:

$$\rho_{Z1,Z2} = \frac{1}{b} * \log\left(\frac{\rho_{Y1,Y2} - c}{a}\right),$$

where $a = -(maxcor * mincor)/(maxcor + mincor)$, $b = \log((maxcor + a)/a)$, and $c = -a$. The function adapts code from Amatya & Demirtas' (2016) package [PoisNor](#) by:

- 1) allowing specifications for the number of random variates and the seed for reproducibility
- 2) providing the following checks: if $\text{Sigma_}(Z1, Z2) > 1$, $\text{Sigma_}(Z1, Z2)$ is set to 1; if $\text{Sigma_}(Z1, Z2) < -1$, $\text{Sigma_}(Z1, Z2)$ is set to -1
- 3) simulating regular and zero-inflated Poisson and Negative Binomial variables.

The function is used in [intercorr](#) and [corrvar](#) and would not ordinarily be called by the user.

Usage

```
intercorr_pois_nb(rho_pois_nb = NULL, lam = NULL, p_zip = 0,
  size = NULL, mu = NULL, p_zinb = 0, nrand = 1e+05, seed = 1234)
```

Arguments

rho_pois_nb	a $k_{\text{pois}} \times k_{\text{nb}}$ matrix of target correlations; order of each type should be 1st regular, 2nd zero-inflated
lam	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); order should be 1st regular, 2nd zero-inflated
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if p_zip = 0, Y_{pois} has a regular Poisson distribution; if p_zip is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if p_zip = $-(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if length(p_zip) < length(lam), the missing values are set to 0 (and ordered 1st)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
mu	a vector of mean parameters for the NB variables; order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if p_zinb = 0, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}),$

	0), Y_{nb} has a zero-deflated NB distribution and p_{zinb} is not a probability; if $p_{zinb} = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if $\text{length}(p_{zinb}) < \text{length}(\text{size})$, the missing values are set to 0 (and ordered 1st)
nrand	the number of random numbers to generate in calculating the bound (default = 10000)
seed	the seed used in random number generation (default = 1234)

Value

the $k_{\text{pois}} \times k_{\text{nb}}$ intermediate correlation matrix whose rows represent the k_{pois} Poisson variables and columns represent the k_{nb} Negative Binomial variables

References

Please see references for [intercorr_pois](#).

See Also

[intercorr_pois](#), [intercorr_nb](#), [intercorr](#), [corrvar](#)

maxcount_support	<i>Calculate Maximum Support Value for Count Variables: Correlation Method 2</i>
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Description

This function calculates the maximum support value for count variables by extending the method of Barbiero & Ferrari (2015, doi: [10.1002/asmb.2072](#)) to include regular and zero-inflated Poisson and Negative Binomial variables. In order for count variables to be treated as ordinal in the calculation of the intermediate MVN correlation matrix, their infinite support must be truncated (made finite). This is done by setting the total cumulative probability equal to 1 - a small user-specified value (`pois_eps` or `nb_eps`). The maximum support value equals the inverse CDF applied to this result. The truncation values may differ for each variable. The function is used in [intercorr2](#) and [corrvar2](#) and would not ordinarily be called by the user.

Usage

```
maxcount_support(k_pois = 0, k_nb = 0, lam = NULL, pois_eps = NULL,
  p_zip = 0, size = NULL, prob = NULL, mu = NULL, nb_eps = NULL,
  p_zinb = 0)
```

Arguments

k_pois	the number of Poisson variables
k_nb	the number of Negative Binomial variables
lam	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); order should be 1st regular, 2nd zero-inflated
pois_eps	a vector of length <code>k_pois</code> containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable

p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if p_zip = 0, Y_{pois} has a regular Poisson distribution; if p_zip is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if p_zip = $-(\exp(\text{lam}) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if length(p_zip) < length(lam), the missing values are set to 0 (and ordered 1st)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
prob	a vector of success probability parameters for the NB variables; order the same as in size
mu	a vector of mean parameters for the NB variables (*Note: either prob or mu should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in size
nb_eps	a vector of length k_nb containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if p_zinb = 0, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if p_zinb = $-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if length(p_zinb) < length(size), the missing values are set to 0 (and ordered 1st)

Value

a data.frame with k_pois + k_nb rows; the column names are:

Distribution Poisson or Negative Binomial

Number the variable index

Max the maximum support value

References

Barbiero A & Ferrari PA (2015). Simulation of correlated Poisson variables. Applied Stochastic Models in Business and Industry, 31:669-80. doi: [10.1002/asmb.2072](#).

Ferrari PA, Barbiero A (2012). Simulating ordinal data, Multivariate Behavioral Research, 47(4):566-589. doi: [10.1080/00273171.2012.692630](#).

Yee TW (2017). VGAM: Vector Generalized Linear and Additive Models.
<https://CRAN.R-project.org/package=VGAM>.

See Also

[intercorr2](#), [corrvar2](#)

norm_ord	<i>Calculate Correlations of Ordinal Variables Obtained from Discretizing Normal Variables</i>
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Description

This function calculates the correlation of ordinal variables (or variables treated as "ordinal"), with given marginal distributions, obtained from discretizing standard normal variables with a specified correlation matrix. The function modifies Barbiero & Ferrari's [contord](#) function in [GenOrd-package](#). It uses [pmvnorm](#) function from the [mvtnorm](#) package to calculate multivariate normal cumulative probabilities defined by the normal quantiles obtained at marginal and the supplied correlation matrix Sigma. This function is used within [ord_norm](#) and would not ordinarily be called by the user.

Usage

```
norm_ord(marginal = list(), Sigma = NULL, support = list(),
         Spearman = FALSE)
```

Arguments

marginal	a list of length equal to the number of variables; the i-th element is a vector of the cumulative probabilities defining the marginal distribution of the i-th variable; if the variable can take r values, the vector will contain r - 1 probabilities (the r-th is assumed to be 1)
Sigma	the correlation matrix of the multivariate standard normal variable
support	a list of length equal to the number of variables; the i-th element is a vector of containing the r ordered support values; if not provided (i.e. support = list()), the default is for the i-th element to be the vector 1, ..., r
Spearman	if TRUE, Spearman's correlations are used (and support is not required); if FALSE (default) Pearson's correlations are used

Value

the correlation matrix of the ordinal variables

References

Please see references in [ord_norm](#).

Genz A, Bretz F, Miwa T, Mi X, Leisch F, Scheipl F, Hothorn T (2017). mvtnorm: Multivariate Normal and t Distributions. R package version 1.0-6. <http://CRAN.R-project.org/package=mvtnorm>

Genz A, Bretz F (2009), Computation of Multivariate Normal and t Probabilities. Lecture Notes in Statistics, Vol. 195., Springer-Verlag, Heidelberg. ISBN 978-3-642-01688-2

See Also

[ord_norm](#)

ord_norm	<i>Calculate Intermediate MVN Correlation to Generate Variables Treated as Ordinal</i>
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Description

This function calculates the intermediate MVN correlation needed to generate a variable described by a discrete marginal distribution and associated finite support. This includes ordinal ($r \geq 2$ categories) variables or variables that are treated as ordinal (i.e. count variables in the Barbiero & Ferrari, 2015 method used in [corrvar2](#), doi: [10.1002/asmb.2072](#)). The function is a modification of Barbiero & Ferrari's [ordcont](#) function in [GenOrd-package](#). It works by setting the intermediate MVN correlation equal to the target correlation and updating each intermediate pairwise correlation until the final pairwise correlation is within epsilon of the target correlation or the maximum number of iterations has been reached. This function uses [norm_ord](#) to calculate the ordinal correlation obtained from discretizing the normal variables generated from the intermediate correlation matrix. The [ordcont](#) has been modified in the following ways:

- 1) the initial correlation check has been removed because this is done within the simulation functions
- 2) the final positive-definite check has been removed
- 3) the intermediate correlation update function was changed to accomodate more situations

This function would not ordinarily be called by the user. Note that this will return a matrix that is NOT positive-definite because this is corrected for in the simulation functions [corrvar](#) and [corrvar2](#) using the method of Higham (2002) and the [nearPD](#) function.

Usage

```
ord_norm(marginal = list(), rho = NULL, support = list(),
         epsilon = 0.001, maxit = 1000, Spearman = FALSE)
```

Arguments

marginal	a list of length equal to the number of variables; the i-th element is a vector of the cumulative probabilities defining the marginal distribution of the i-th variable; if the variable can take r values, the vector will contain r - 1 probabilities (the r-th is assumed to be 1)
rho	the target correlation matrix
support	a list of length equal to the number of variables; the i-th element is a vector of containing the r ordered support values; if not provided (i.e. support = list()), the default is for the i-th element to be the vector 1, ..., r
epsilon	the maximum acceptable error between the final and target pairwise correlations (default = 0.001); smaller values take more time
maxit	the maximum number of iterations to use (default = 1000) to find the intermediate correlation; the correction loop stops when either the iteration number passes maxit or epsilon is reached
Spearman	if TRUE, Spearman's correlations are used (and support is not required); if FALSE (default) Pearson's correlations are used

Value

A list with the following components:

SigmaC the intermediate MVN correlation matrix

rho0 the calculated final correlation matrix generated from SigmaC

rho the target final correlation matrix

niter a matrix containing the number of iterations required for each variable pair

maxerr the maximum final error between the final and target correlation matrices

References

Barbiero A, Ferrari PA (2015). Simulation of correlated Poisson variables. Applied Stochastic Models in Business and Industry, 31:669-80. doi: [10.1002/asmb.2072](https://doi.org/10.1002/asmb.2072).

Barbiero A, Ferrari PA (2015). GenOrd: Simulation of Discrete Random Variables with Given Correlation Matrix and Marginal Distributions. R package version 1.4.0.
<https://CRAN.R-project.org/package=GenOrd>

Ferrari PA, Barbiero A (2012). Simulating ordinal data, Multivariate Behavioral Research, 47(4):566-589. doi: [10.1080/00273171.2012.692630](https://doi.org/10.1080/00273171.2012.692630).

See Also

[corrvar](#), [corrvar2](#), [norm_ord](#), [intercorr](#), [intercorr2](#)

plot_simpdf_theory	<i>Plot Simulated Probability Density Function and Target PDF by Distribution Name or Function for Continuous or Count Variables</i>
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Description

This plots the PDF of simulated continuous or count (regular or zero-inflated, Poisson or Negative Binomial) data and overlays the target PDF (if `overlay = TRUE`), which is specified by distribution name (plus up to 4 parameters) or PDF function `fx` (plus support bounds). If a continuous target distribution is provided (`cont_var = TRUE`), the simulated data y is scaled and then transformed (i.e. $y = \sigma * \text{scale}(y) + \mu$) so that it has the same mean (μ) and variance (σ^2) as the target distribution. The PDF's of continuous variables are shown as lines (using [geom_density](#) and [geom_line](#)). It works for valid or invalid power method PDF's. The PMF's of count variables are shown as vertical bar graphs (using [geom_col](#)). The function returns a [ggplot2](#) object so the user can save it or modify it as necessary. The graph parameters (i.e. `title`, `power_color`, `target_color`, `target_lty`, `legend.position`, `legend.justification`, `legend.text.size`, `title.text.size`, `axis.text.size`, and `axis.title.size`) are inputs to the [ggplot2](#) functions so information about valid inputs can be obtained from that package's documentation.

Usage

```
plot_simpdf_theory(sim_y, title = "Simulated Probability Density Function",
  ylower = NULL, yupper = NULL, power_color = "dark blue",
  overlay = TRUE, cont_var = TRUE, target_color = "dark green",
  target_lty = 2, Dist = c("Benini", "Beta", "Beta-Normal",
    "Birnbaum-Saunders", "Chisq", "Dagum", "Exponential", "Exp-Geometric",
    "Exp-Logarithmic", "Exp-Poisson", "F", "Fisk", "Frechet", "Gamma", "Gaussian",
```

```
"Gompertz", "Gumbel", "Kumaraswamy", "Laplace", "Lindley", "Logistic",
"Loggamma", "Lognormal", "Lomax", "Makeham", "Maxwell", "Nakagami",
"Paralogistic", "Pareto", "Perks", "Rayleigh", "Rice", "Singh-Maddala",
"Skewnormal", "t", "Topp-Leone", "Triangular", "Uniform", "Weibull",
"Poisson", "Negative_Binomial"), params = NULL, fx = NULL, lower = NULL,
upper = NULL, legend.position = c(0.975, 0.9),
legend.justification = c(1, 1), legend.text.size = 10,
title.text.size = 15, axis.text.size = 10, axis.title.size = 13)
```

Arguments

<code>sim_y</code>	a vector of simulated data
<code>title</code>	the title for the graph (default = "Simulated Probability Density Function")
<code>ylower</code>	the lower y value to use in the plot (default = NULL, uses minimum simulated y value) on the x-axis
<code>yupper</code>	the upper y value (default = NULL, uses maximum simulated y value) on the x-axis
<code>power_color</code>	the line color for the simulated variable (or column fill color in the case of <code>Dist</code> = "Poisson" or "Negative_Binomial")
<code>overlay</code>	if TRUE (default), the target distribution is also plotted given either a distribution name (and parameters) or PDF function <code>fx</code> (with bounds = <code>ylower</code> , <code>yupper</code>)
<code>cont_var</code>	TRUE (default) for continuous variables, FALSE for count variables
<code>target_color</code>	the line color for the target PDF (or column fill color in the case of <code>Dist</code> = "Poisson" or "Negative_Binomial")
<code>target_lty</code>	the line type for the target PDF (default = 2, dashed line)
<code>Dist</code>	name of the distribution. The possible values are: "Benini", "Beta", "Beta-Normal", "Birnbaum-Saunders", "Chisq", "Exponential", "Exp-Geometric", "Exp-Logarithmic", "Exp-Poisson", "F", "Fisk", "Frechet", "Gamma", "Gaussian", "Gompertz", "Gumbel", "Kumaraswamy", "Laplace", "Lindley", "Logistic", "Loggamma", "Lognormal", "Lomax", "Makeham", "Maxwell", "Nakagami", "Paralogistic", "Pareto", "Perks", "Rayleigh", "Rice", "Singh-Maddala", "Skewnormal", "t", "Topp-Leone", "Triangular", "Uniform", "Weibull", "Poisson", and "Negative_Binomial". Please refer to the documentation for each package (either stats , VGAM , or triangle) for information on appropriate parameter inputs.
<code>params</code>	a vector of parameters (up to 4) for the desired distribution (keep NULL if <code>fx</code> supplied instead); for Poisson variables, must be lambda (mean) and the probability of a structural zero (use 0 for regular Poisson variables); for Negative Binomial variables, must be size, mean and the probability of a structural zero (use 0 for regular NB variables)
<code>fx</code>	a PDF input as a function of <code>x</code> only, i.e. <code>fx = function(x) 0.5 * (x - 1)^2</code> ; must return a scalar (keep NULL if <code>Dist</code> supplied instead)
<code>lower</code>	the lower support bound for <code>fx</code>
<code>upper</code>	the upper support bound for <code>fx</code>
<code>legend.position</code>	the position of the legend
<code>legend.justification</code>	the justification of the legend

`legend.text.size`
 the size of the legend labels
`title.text.size`
 the size of the plot title
`axis.text.size` the size of the axes text (tick labels)
`axis.title.size`
 the size of the axes titles

Value

A [ggplot2](#) object.

References

Please see the references for [plot_simtheory](#).

Wickham H. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2009.

See Also

[calc_theory](#), [ggplot](#), [geom_line](#), [geom_density](#), [geom_col](#)

Examples

```
## Not run:
# Mixture of Beta(6, 3), Beta(4, 1.5), and Beta(10, 20)
Stcum1 <- calc_theory("Beta", c(6, 3))
Stcum2 <- calc_theory("Beta", c(4, 1.5))
Stcum3 <- calc_theory("Beta", c(10, 20))
mix_pis <- c(0.5, 0.2, 0.3)
mix_mus <- c(Stcum1[1], Stcum2[1], Stcum3[1])
mix_sigmas <- c(Stcum1[2], Stcum2[2], Stcum3[2])
mix_skews <- c(Stcum1[3], Stcum2[3], Stcum3[3])
mix_skurts <- c(Stcum1[4], Stcum2[4], Stcum3[4])
mix_fifths <- c(Stcum1[5], Stcum2[5], Stcum3[5])
mix_sixths <- c(Stcum1[6], Stcum2[6], Stcum3[6])
mix_Six <- list(seq(0.01, 10, 0.01), c(0.01, 0.02, 0.03),
  seq(0.01, 10, 0.01))
Bstcum <- calc_mixmoments(mix_pis, mix_mus, mix_sigmas, mix_skews,
  mix_skurts, mix_fifths, mix_sixths)
Bmix <- contmixvar1(n = 10000, "Polynomial", Bstcum[1], Bstcum[2]^2,
  mix_pis, mix_mus, mix_sigmas, mix_skews, mix_skurts, mix_fifths,
  mix_sixths, mix_Six)
plot_simpdf_theory(Bmix$Y_mix[, 1], title = "Mixture of Beta Distributions",
  fx = function(x) mix_pis[1] * dbeta(x, 6, 3) + mix_pis[2] *
    dbeta(x, 4, 1.5) + mix_pis[3] * dbeta(x, 10, 20), lower = 0, upper = 1)

## End(Not run)
```

plot_simtheory

Plot Simulated Data and Target Distribution Data by Name or Function for Continuous or Count Variables

Description

This plots simulated continuous or count (regular or zero-inflated, Poisson or Negative Binomial) data and overlays data (if `overlay = TRUE`) generated from the target distribution. The target is specified by name (plus up to 4 parameters) or PDF function `fx` (plus support bounds). Due to the integration involved in finding the CDF from the PDF supplied by `fx`, only continuous `fx` may be supplied. Both are plotted as histograms (using `geom_histogram`). If a continuous target distribution is specified (`cont_var = TRUE`), the simulated data y is scaled and then transformed (i.e. $y = \sigma * \text{scale}(y) + \mu$) so that it has the same mean (μ) and variance (σ^2) as the target distribution. It works for valid or invalid power method PDF's. It returns a `ggplot2` object so the user can save it or modify it as necessary. The graph parameters (i.e. `title`, `power_color`, `target_color`, `target_lty`, `legend.position`, `legend.justification`, `legend.text.size`, `title.text.size`, `axis.text.size`, and `axis.title.size`) are inputs to the `ggplot2` functions so information about valid inputs can be obtained from that package's documentation.

Usage

```
plot_simtheory(sim_y, title = "Simulated Data Values", ylower = NULL,
  yupper = NULL, power_color = "dark blue", overlay = TRUE,
  cont_var = TRUE, target_color = "dark green", nbins = 100,
  Dist = c("Benini", "Beta", "Beta-Normal", "Birnbaum-Saunders", "Chisq",
    "Dagum", "Exponential", "Exp-Geometric", "Exp-Logarithmic", "Exp-Poisson",
    "F", "Fisk", "Frechet", "Gamma", "Gaussian", "Gompertz", "Gumbel",
    "Kumaraswamy", "Laplace", "Lindley", "Logistic", "Loggamma", "Lognormal",
    "Lomax", "Makeham", "Maxwell", "Nakagami", "Paralogistic", "Pareto", "Perks",
    "Rayleigh", "Rice", "Singh-Maddala", "Skewnormal", "t", "Topp-Leone",
    "Triangular", "Uniform", "Weibull", "Poisson", "Negative_Binomial"),
  params = NULL, fx = NULL, lower = NULL, upper = NULL, seed = 1234,
  sub = 1000, legend.position = c(0.975, 0.9), legend.justification = c(1,
    1), legend.text.size = 10, title.text.size = 15, axis.text.size = 10,
  axis.title.size = 13)
```

Arguments

<code>sim_y</code>	a vector of simulated data
<code>title</code>	the title for the graph (default = "Simulated Data Values")
<code>ylower</code>	the lower y value to use in the plot (default = NULL, uses minimum simulated y value) on the y-axis
<code>yupper</code>	the upper y value (default = NULL, uses maximum simulated y value) on the y-axis
<code>power_color</code>	the histogram fill color for the simulated variable (default = "dark blue")
<code>overlay</code>	if TRUE (default), the target distribution is also plotted given either a distribution name (and parameters) or PDF function <code>fx</code> (with support bounds = lower, upper)
<code>cont_var</code>	TRUE (default) for continuous variables, FALSE for count variables
<code>target_color</code>	the histogram fill color for the target distribution (default = "dark green")

nbins	the number of bins to use when creating the histograms (default = 100)
Dist	name of the distribution. The possible values are: "Benini", "Beta", "Beta-Normal", "Birnbaum-Saunders", "Chisq", "Exponential", "Exp-Geometric", "Exp-Logarithmic", "Exp-Poisson", "F", "Fisk", "Frechet", "Gamma", "Gaussian", "Gompertz", "Gumbel", "Kumaraswamy", "Laplace", "Lindley", "Logistic", "Loggamma", "Lognormal", "Lomax", "Makeham", "Maxwell", "Nakagami", "Paralogistic", "Pareto", "Perks", "Rayleigh", "Rice", "Singh-Maddala", "Skewnormal", "t", "Topp-Leone", "Triangular", "Uniform", "Weibull", "Poisson", and "Negative_Binomial". Please refer to the documentation for each package (either stats , VGAM , or triangle) for information on appropriate parameter inputs.
params	a vector of parameters (up to 4) for the desired distribution (keep NULL if fx supplied instead); for Poisson variables, must be lambda (mean) and the probability of a structural zero (use 0 for regular Poisson variables); for Negative Binomial variables, must be size, mean and the probability of a structural zero (use 0 for regular NB variables)
fx	a PDF input as a function of x only, i.e. <code>fx = function(x) 0.5 * (x - 1)^2</code> ; must return a scalar (keep NULL if Dist supplied instead)
lower	the lower support bound for a supplied fx, else keep NULL (note: if an error is thrown from uniroot, try a slightly higher lower bound; i.e., 0.0001 instead of 0)
upper	the upper support bound for a supplied fx, else keep NULL (note: if an error is thrown from uniroot, try a lower upper bound; i.e., 100000 instead of Inf)
seed	the seed value for random number generation (default = 1234)
sub	the number of subdivisions to use in the integration to calculate the CDF from fx; if no result, try increasing sub (requires longer computation time; default = 1000)
legend.position	the position of the legend
legend.justification	the justification of the legend
legend.text.size	the size of the legend labels
title.text.size	the size of the plot title
axis.text.size	the size of the axes text (tick labels)
axis.title.size	the size of the axes titles

Value

A [ggplot2](#) object.

References

- Carnell R (2017). triangle: Provides the Standard Distribution Functions for the Triangle Distribution. R package version 0.11. <https://CRAN.R-project.org/package=triangle>.
- Headrick TC, Sheng Y, & Hodis FA (2007). Numerical Computing and Graphics for the Power Method Transformation Using Mathematica. Journal of Statistical Software, 19(3):1-17. doi: [10.18637/jss.v019.i03](https://doi.org/10.18637/jss.v019.i03).

Wickham H. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2009.

Yee TW (2017). VGAM: Vector Generalized Linear and Additive Models.

<https://CRAN.R-project.org/package=VGAM>.

See Also

[calc_theory](#), [ggplot](#), [geom_histogram](#)

Examples

```
## Not run:
# Mixture of Beta(6, 3), Beta(4, 1.5), and Beta(10, 20)
Stcum1 <- calc_theory("Beta", c(6, 3))
Stcum2 <- calc_theory("Beta", c(4, 1.5))
Stcum3 <- calc_theory("Beta", c(10, 20))
mix_pis <- c(0.5, 0.2, 0.3)
mix_mus <- c(Stcum1[1], Stcum2[1], Stcum3[1])
mix_sigmas <- c(Stcum1[2], Stcum2[2], Stcum3[2])
mix_skews <- c(Stcum1[3], Stcum2[3], Stcum3[3])
mix_skurts <- c(Stcum1[4], Stcum2[4], Stcum3[4])
mix_fifths <- c(Stcum1[5], Stcum2[5], Stcum3[5])
mix_sixths <- c(Stcum1[6], Stcum2[6], Stcum3[6])
mix_Six <- list(seq(0.01, 10, 0.01), c(0.01, 0.02, 0.03),
  seq(0.01, 10, 0.01))
Bstcum <- calc_mixmoments(mix_pis, mix_mus, mix_sigmas, mix_skews,
  mix_skurts, mix_fifths, mix_sixths)
Bmix <- contmixvar1(n = 10000, "Polynomial", Bstcum[1], Bstcum[2]^2,
  mix_pis, mix_mus, mix_sigmas, mix_skews, mix_skurts, mix_fifths,
  mix_sixths, mix_Six)
plot_simtheory(Bmix$Y_mix[, 1], title = "Mixture of Beta Distributions",
  fx = function(x) mix_pis[1] * dbeta(x, 6, 3) + mix_pis[2] *
    dbeta(x, 4, 1.5) + mix_pis[3] * dbeta(x, 10, 20), lower = 0, upper = 1)

## End(Not run)
```

rho_M1M2

*Theoretical Correlation between Two Continuous Mixture Variables
M1 and M2*

Description

This function calculates the expected correlation between two continuous mixture variables $M1$ and $M2$ based on their mixing proportions, component means, component standard deviations, and correlations between components across variables. The equations can be found in the **Expected Cumulants and Correlations for Continuous Mixture Variables** vignette. This function can be used to see what combination of component correlations gives a desired correlation between $M1$ and $M2$.

Usage

```
rho_M1M2(mix_pis = list(), mix_mus = list(), mix_sigmas = list(),
  p_M1M2 = NULL)
```

Arguments

mix_pis	a list of length 2 with 1st component a vector of mixing probabilities that sum to 1 for component distributions of $M1$ and likewise for 2nd component and $M2$
mix_mus	a list of length 2 with 1st component a vector of means for component distributions of $M1$ and likewise for 2nd component and $M2$
mix_sigmas	a list of length 2 with 1st component a vector of standard deviations for component distributions of $M1$ and likewise for 2nd component and $M2$
p_M1M2	a matrix of correlations with rows corresponding to $M1$ and columns corresponding to $M2$; i.e., $p_M1M2[1, 2]$ is the correlation between the 1st component of $M1$ and the 2nd component of $M2$

References

- Davenport JW, Bezder JC, & Hathaway RJ (1988). Parameter Estimation for Finite Mixture Distributions. *Computers & Mathematics with Applications*, 15(10):819-28.
- Pearson RK (2011). *Exploring Data in Engineering, the Sciences, and Medicine*. In. New York: Oxford University Press.
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See Also

[rho_M1Y](#)

Examples

```
# M1 is mixture of N(-2, 1) and N(2, 1);
# M2 is mixture of Logistic(0, 1), Chisq(4), and Beta(4, 1.5)
# pairwise correlation between components across M1 and M2 set to 0.35
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))
mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
p_M11M21 <- p_M11M22 <- p_M11M23 <- 0.35
p_M12M21 <- p_M12M22 <- p_M12M23 <- 0.35
p_M1M2 <- matrix(c(p_M11M21, p_M11M22, p_M11M23, p_M12M21, p_M12M22,
  p_M12M23), 2, 3, byrow = TRUE)
rhoM1M2 <- rho_M1M2(mix_pis, mix_mus, mix_sigmas, p_M1M2)
rhoM1M2
```

Description

This function calculates the expected correlation between a continuous mixture variables $M1$ and another random variable Y based on the mixing proportions, component means, and component standard deviations of $M1$ and correlations between components of $M1$ and Y . The equations can be found in the **Expected Cumulants and Correlations for Continuous Mixture Variables** vignette. This function can be used to see what combination of correlations between components of $M1$ and Y gives a desired correlation between $M1$ and Y .

Usage

```
rho_M1Y(mix_pis = NULL, mix_mus = NULL, mix_sigmas = NULL, p_M1Y = NULL)
```

Arguments

<code>mix_pis</code>	a vector of mixing probabilities that sum to 1 for component distributions of $M1$
<code>mix_mus</code>	a vector of means for component distributions of $M1$
<code>mix_sigmas</code>	a vector of standard deviations for component distributions of $M1$
<code>p_M1Y</code>	a vector of correlations between the components of $M1$ and Y ; i.e., <code>p_M1Y[1]</code> is the correlation between the 1st component of $M1$ and Y

References

Please see references for [rho_M1Y](#).

See Also

[rho_M1Y](#)

Examples

```
# M1 is mixture of N(-2, 1) and N(2, 1); C1 is a continuous non-mixture
# variable (but could also be an ordinal or count variable)
# pairwise correlation between components of M1 and C1 set to 0.35
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))
mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
p_M11C1 <- p_M12C1 <- 0.35
p_M1C1 <- c(p_M11C1, p_M12C1)
rho_M1C1 <- rho_M1Y(mix_pis[[1]], mix_mus[[1]], mix_sigmas[[1]], p_M1C1)
rho_M1C1
```


Description

SimCorrMix generates continuous (normal, non-normal, or mixture distributions), binary, ordinal, and count (Poisson or Negative Binomial, regular or zero-inflated) variables with a specified correlation matrix, or one continuous variable with a mixture distribution. This package can be used to simulate data sets that mimic real-world clinical or genetic data sets (i.e. plasmodes, as in Vaughan et al., 2009, doi: [10.1016/j.csda.2008.02.032](https://doi.org/10.1016/j.csda.2008.02.032)). The methods extend those found in the **SimMultiCorrData** package. Standard normal variables with an imposed intermediate correlation matrix are transformed to generate the desired distributions. Continuous variables are simulated using either Fleishman's third-order (doi: [10.1007/BF02293811](https://doi.org/10.1007/BF02293811)) or Headrick's fifth-order (doi: [10.1016/S0167-9473\(02\)000725](https://doi.org/10.1016/S0167-9473(02)000725)) power method transformation (PMT). Non-mixture distributions require the user to specify mean, variance, skewness, standardized kurtosis, and standardized fifth and sixth cumulants. Mixture distributions require these inputs for the component distributions plus the mixing probabilities. Simulation occurs at the component-level for continuous mixture distributions. The target correlation matrix is specified in terms of correlations with components of continuous mixture variables. Binary and ordinal variables are simulated using a modification of **GenOrd**-package's `ordsample` function. Count variables are simulated using the inverse CDF method. There are two simulation pathways which calculate intermediate correlations involving count variables differently. Correlation Method 1 adapts Yahav and Shmueli's 2012 method (doi: [10.1002/asmb.901](https://doi.org/10.1002/asmb.901)). Correlation Method 2 adapts Barbiero and Ferrari's 2015 modification of **GenOrd**-package (doi: [10.1002/asmb.2072](https://doi.org/10.1002/asmb.2072)). The optional error loop may be used to improve the accuracy of the final correlation matrix. The package also provides functions to calculate the standardized cumulants of continuous mixture distributions, determine expected correlations with continuous mixture variables given target correlations with the components, check parameter inputs, calculate feasible correlation boundaries, and plot simulated variables.

Vignettes

There are several vignettes which accompany this package that may help the user understand the simulation and analysis methods.

- 1) **Calculation of Correlation Boundaries** explains how the feasible correlation boundaries are calculated for each of the two simulation pathways.
- 2) **Comparison of Correlation Methods 1 and 2** describes the two simulation pathways that can be followed for generation of correlated data.
- 3) **Continuous Mixture Distributions** demonstrates how to simulate one continuous mixture variable using `contmixvar1` and gives a step-by-step guideline for comparing a simulated distribution to the target distribution.
- 4) **Error Loop Algorithm** details the algorithm involved in the optional error loop that helps to minimize correlation errors.
- 5) **Expected Cumulants and Correlations for Continuous Mixture Variables** derives the equations used by the function `calc_mixmoments` to find the mean, standard deviation, skew, standardized kurtosis, and standardized fifth and sixth cumulants for a continuous mixture variable. The vignette also explains how the functions `rho_M1M2` and `rho_M1Y` calculate the expected correlations with continuous mixture variables based on the target correlations with the components.

6) **Overall Workflow for Generation of Correlated Data** gives a step-by-step guideline to follow with an example containing continuous non-mixture and mixture, ordinal, zero-inflated Poisson, and zero-inflated Negative Binomial variables. It executes both correlated data simulation functions with and without the error loop.

7) **Variable Types** describes the different types of variables that can be simulated in **SimCorrMix**.

Functions

This package contains 3 *simulation* functions:

`contmixvar1`, `corrvar`, and `corrvar2`

3 data description (*summary*) function:

`calc_mixmoments`, `rho_M1M2`, `rho_M1Y`

2 *graphing* functions:

`plot_simpdf_theory`, `plot_simtheory`

3 *support* functions:

`validpar`, `validcorr`, `validcorr2`

and 15 *auxiliary* functions (should not normally be called by the user, but are called by other functions):

`corr_error`, `intercorr`, `intercorr2`, `intercorr_cat_nb`, `intercorr_cat_pois`,
`intercorr_cont_nb`, `intercorr_cont_nb2`, `intercorr_cont_pois`, `intercorr_cont_pois2`,
`intercorr_nb`, `intercorr_pois`, `intercorr_pois_nb`, `maxcount_support`, `ord_norm`, `norm_ord`

References

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See Also

Useful link: <https://github.com/AFialkowski/SimMultiCorrData>

validcorr

Determine Correlation Bounds for Ordinal, Continuous, Poisson, and/or Negative Binomial Variables: Correlation Method 1

Description

This function calculates the lower and upper correlation bounds for the given distributions and checks if a given target correlation matrix ρ is within the bounds. It should be used before simulation with [corrvar](#). However, even if all pairwise correlations fall within the bounds, it is still possible that the desired correlation matrix is not feasible. This is particularly true when ordinal variables ($r \geq 2$ categories) are generated or negative correlations are desired. Therefore, this function should be used as a general check to eliminate pairwise correlations that are obviously not reproducible. It will help prevent errors when executing the simulation. The *ordering* of the variables in ρ must be 1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixture, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, and 7th zero-inflated NB. Note that it is possible for k_{cat} , k_{cont} , k_{mix} , k_{pois} , and/or k_{nb} to be 0. The target correlations are specified with respect to the components of the continuous mixture variables. There are no parameter input checks in order to decrease simulation time. All inputs should be checked prior to simulation with [validpar](#).

Please see the **Comparison of Correlation Methods 1 and 2** vignette for the differences between the two correlation methods, and the **Calculation of Correlation Boundaries** vignette for a detailed explanation of how the correlation boundaries are calculated.

Usage

```
validcorr(n = 10000, k_cat = 0, k_cont = 0, k_mix = 0, k_pois = 0,
  k_nb = 0, method = c("Fleishman", "Polynomial"), means = NULL,
  vars = NULL, skews = NULL, skurts = NULL, fifths = NULL,
  sixths = NULL, Six = list(), mix_pis = list(), mix_mus = list(),
  mix_sigmas = list(), mix_skews = list(), mix_skurts = list(),
  mix_fifths = list(), mix_sixths = list(), mix_Six = list(),
  marginal = list(), lam = NULL, p_zip = 0, size = NULL, prob = NULL,
  mu = NULL, p_zinb = 0, rho = NULL, seed = 1234, use.nearPD = TRUE)
```

Arguments

<code>n</code>	the sample size (i.e. the length of each simulated variable; default = 10000)
<code>k_cat</code>	the number of ordinal ($r \geq 2$ categories) variables (default = 0)
<code>k_cont</code>	the number of continuous non-mixture variables (default = 0)
<code>k_mix</code>	the number of continuous mixture variables (default = 0)
<code>k_pois</code>	the number of regular Poisson and zero-inflated Poisson variables (default = 0)
<code>k_nb</code>	the number of regular Negative Binomial and zero-inflated Negative Binomial variables (default = 0)
<code>method</code>	the method used to generate the <code>k_cont</code> non-mixture and <code>k_mix</code> mixture continuous variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
<code>means</code>	a vector of means for the <code>k_cont</code> non-mixture and <code>k_mix</code> mixture continuous variables (i.e. <code>rep(0, (k_cont + k_mix))</code>)
<code>vars</code>	a vector of variances for the <code>k_cont</code> non-mixture and <code>k_mix</code> mixture continuous variables (i.e. <code>rep(1, (k_cont + k_mix))</code>)
<code>skews</code>	a vector of skewness values for the <code>k_cont</code> non-mixture continuous variables
<code>skurts</code>	a vector of standardized kurtoses (kurtosis - 3, so that normal variables have a value of 0) for the <code>k_cont</code> non-mixture continuous variables
<code>fifths</code>	a vector of standardized fifth cumulants for the <code>k_cont</code> non-mixture continuous variables (not necessary for <code>method = "Fleishman"</code>)
<code>sixths</code>	a vector of standardized sixth cumulants for the <code>k_cont</code> non-mixture continuous variables (not necessary for <code>method = "Fleishman"</code>)
<code>Six</code>	a list of vectors of sixth cumulant correction values for the <code>k_cont</code> non-mixture continuous variables if no valid PDF constants are found, ex: <code>Six = list(seq(0.01, 2, 0.01), seq(1, 10, 0.5))</code> ; if no correction is desired for variable Y_{cont_i} , set the i -th list component equal to <code>NULL</code> ; if no correction is desired for any of the Y_{cont} keep as <code>Six = list()</code> (not necessary for <code>method = "Fleishman"</code>)
<code>mix_pis</code>	a list of length <code>k_mix</code> with i -th component a vector of mixing probabilities that sum to 1 for component distributions of Y_{mix_i}
<code>mix_mus</code>	a list of length <code>k_mix</code> with i -th component a vector of means for component distributions of Y_{mix_i}
<code>mix_sigmas</code>	a list of length <code>k_mix</code> with i -th component a vector of standard deviations for component distributions of Y_{mix_i}
<code>mix_skews</code>	a list of length <code>k_mix</code> with i -th component a vector of skew values for component distributions of Y_{mix_i}
<code>mix_skurts</code>	a list of length <code>k_mix</code> with i -th component a vector of standardized kurtoses for component distributions of Y_{mix_i}
<code>mix_fifths</code>	a list of length <code>k_mix</code> with i -th component a vector of standardized fifth cumulants for component distributions of Y_{mix_i} (not necessary for <code>method = "Fleishman"</code>)
<code>mix_sixths</code>	a list of length <code>k_mix</code> with i -th component a vector of standardized sixth cumulants for component distributions of Y_{mix_i} (not necessary for <code>method = "Fleishman"</code>)

<code>mix_Six</code>	a list of length <code>k_mix</code> with <i>i</i> -th component a list of vectors of sixth cumulant correction values for component distributions of Y_{mix_i} ; use NULL if no correction is desired for a given component or mixture variable; if no correction is desired for any of the Y_{mix} keep as <code>mix_Six = list()</code> (not necessary for <code>method = "Fleishman"</code>)
<code>marginal</code>	a list of length equal to <code>k_cat</code> ; the <i>i</i> -th element is a vector of the cumulative probabilities defining the marginal distribution of the <i>i</i> -th variable; if the variable can take <i>r</i> values, the vector will contain <i>r</i> - 1 probabilities (the <i>r</i> -th is assumed to be 1); for binary variables, these should be input the same as for ordinal variables with more than 2 categories (i.e. the user-specified probability is the probability of the 1st category, which has the smaller support value)
<code>lam</code>	a vector of <code>lambda</code> (> 0) constants for the Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
<code>p_zip</code>	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if <code>p_zip = 0</code> , Y_{pois} has a regular Poisson distribution; if <code>p_zip</code> is in $(0, 1)$, Y_{pois} has a zero-inflated Poisson distribution; if <code>p_zip</code> is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and <code>p_zip</code> is not a probability; if <code>p_zip = -(\exp(\text{lam}) - 1)^{-1}</code> , Y_{pois} has a positive-Poisson distribution (see dpospois); if <code>length(p_zip) < length(lam)</code> , the missing values are set to 0 (and ordered 1st)
<code>size</code>	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
<code>prob</code>	a vector of success probability parameters for the NB variables; order the same as in <code>size</code>
<code>mu</code>	a vector of mean parameters for the NB variables (*Note: either <code>prob</code> or <code>mu</code> should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in <code>size</code>
<code>p_zinb</code>	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if <code>p_zinb = 0</code> , Y_{nb} has a regular NB distribution; if <code>p_zinb</code> is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and <code>p_zinb</code> is not a probability; if <code>p_zinb = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})</code> , Y_{nb} has a positive-NB distribution (see dposnegbin); if <code>length(p_zinb) < length(size)</code> , the missing values are set to 0 (and ordered 1st)
<code>rho</code>	the target correlation matrix which must be ordered <i>1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixtures, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, 7th zero-inflated NB</i> ; note that <code>rho</code> is specified in terms of the components of Y_{mix}
<code>seed</code>	the seed value for random number generation (default = 1234)
<code>use.nearPD</code>	TRUE to convert <code>rho</code> to the nearest positive definite matrix with <code>Matrix::nearPD</code> if necessary

Value

A list with components:

`rho` the target correlation matrix, which will differ from the supplied matrix (if provided) if it was converted to the nearest positive-definite matrix

`L_rho` the lower correlation bound

U_rho the upper correlation bound

If continuous variables are desired, additional components are:

constants the calculated constants

sixth_correction a vector of the sixth cumulant correction values

valid.pdf a vector with i-th component equal to "TRUE" if variable Y_i has a valid power method PDF, else "FALSE"

If a target correlation matrix rho is provided, each pairwise correlation is checked to see if it is within the lower and upper bounds. If the correlation is outside the bounds, the indices of the variable pair are given.

valid.rho TRUE if all entries of rho are within the bounds, else FALSE

Reasons for Function Errors

1) The most likely cause for function errors is that no solutions to [fleish](#) or [poly](#) converged when using [find_constants](#). If this happens, the function will stop. It may help to first use [find_constants](#) for each continuous variable to determine if a sixth cumulant correction value is needed. If the standardized cumulants are obtained from [calc_theory](#), the user may need to use rounded values as inputs (i.e. `skews = round(skews, 8)`). For example, in order to ensure that skew is exactly 0 for symmetric distributions.

2) The kurtosis may be outside the region of possible values. There is an associated lower boundary for kurtosis associated with a given skew (for Fleishman's method) or skew and fifth and sixth cumulants (for Headrick's method). Use [calc_lower_skurt](#) to determine the boundary for a given set of cumulants.

References

Please see [corrvar](#) for additional references.

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Yee TW (2017). VGAM: Vector Generalized Linear and Additive Models. <https://CRAN.R-project.org/package=VGAM>.

See Also

[find_constants](#), [corrvar](#), [validpar](#)

Examples

```
## Not run:
```

```
# 2 continuous mixture, 1 binary, 1 zero-inflated Poisson, and
```

```

# 1 zero-inflated NB variable
n <- 10000
seed <- 1234

# Mixture variables: Normal mixture with 2 components;
# mixture of Logistic(0, 1), Chisq(4), Beta(4, 1.5)
# Find cumulants of components of 2nd mixture variable
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))

skews <- skurts <- fifths <- sixths <- NULL
Six <- list()
mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
mix_skews <- list(rep(0, 2), c(L[3], C[3], B[3]))
mix_skurts <- list(rep(0, 2), c(L[4], C[4], B[4]))
mix_fifths <- list(rep(0, 2), c(L[5], C[5], B[5]))
mix_sixths <- list(rep(0, 2), c(L[6], C[6], B[6]))
mix_Six <- list(list(NULL, NULL), list(1.75, NULL, 0.03))
Nstcum <- calc_mixmoments(mix_pis[[1]], mix_mus[[1]], mix_sigmas[[1]],
  mix_skews[[1]], mix_skurts[[1]], mix_fifths[[1]], mix_sixths[[1]])
Mstcum <- calc_mixmoments(mix_pis[[2]], mix_mus[[2]], mix_sigmas[[2]],
  mix_skews[[2]], mix_skurts[[2]], mix_fifths[[2]], mix_sixths[[2]])
means <- c(Nstcum[1], Mstcum[1])
vars <- c(Nstcum[2]^2, Mstcum[2]^2)

marginal <- list(0.3)
support <- list(c(0, 1))
lam <- 0.5
p_zip <- 0.1
size <- 2
prob <- 0.75
p_zinb <- 0.2

k_cat <- k_pois <- k_nb <- 1
k_cont <- 0
k_mix <- 2
Rey <- matrix(0.39, 8, 8)
diag(Rey) <- 1
rownames(Rey) <- colnames(Rey) <- c("O1", "M1_1", "M1_2", "M2_1", "M2_2",
  "M2_3", "P1", "NB1")

# set correlation between components of the same mixture variable to 0
Rey["M1_1", "M1_2"] <- Rey["M1_2", "M1_1"] <- 0
Rey["M2_1", "M2_2"] <- Rey["M2_2", "M2_1"] <- Rey["M2_1", "M2_3"] <- 0
Rey["M2_3", "M2_1"] <- Rey["M2_2", "M2_3"] <- Rey["M2_3", "M2_2"] <- 0

# check parameter inputs
validpar(k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal, support,
  lam, p_zip, size, prob, mu = NULL, rho = Rey)

# check to make sure Rey is within the feasible correlation boundaries
validcorr(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,

```



```
vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal,
lam, p_zip, size, prob, mu = NULL, p_zinb, Rey, seed)

## End(Not run)
```

validcorr2

*Determine Correlation Bounds for Ordinal, Continuous, Poisson,
and/or Negative Binomial Variables: Correlation Method 2*

Description

This function calculates the lower and upper correlation bounds for the given distributions and checks if a given target correlation matrix ρ is within the bounds. It should be used before simulation with [corrvar2](#). However, even if all pairwise correlations fall within the bounds, it is still possible that the desired correlation matrix is not feasible. This is particularly true when ordinal variables ($r \geq 2$ categories) are generated or negative correlations are desired. Therefore, this function should be used as a general check to eliminate pairwise correlations that are obviously not reproducible. It will help prevent errors when executing the simulation. The *ordering* of the variables in ρ must be 1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixture, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, and 7th zero-inflated NB. Note that it is possible for k_{cat} , k_{cont} , k_{mix} , k_{pois} , and/or k_{nb} to be 0. The target correlations are specified with respect to the components of the continuous mixture variables. There are no parameter input checks in order to decrease simulation time. All inputs should be checked prior to simulation with [validpar](#).

Please see the **Comparison of Correlation Methods 1 and 2** vignette for the differences between the two correlation methods, and the **Calculation of Correlation Boundaries** vignette for a detailed explanation of how the correlation boundaries are calculated.

Usage

```
validcorr2(n = 10000, k_cat = 0, k_cont = 0, k_mix = 0, k_pois = 0,
k_nb = 0, method = c("Fleishman", "Polynomial"), means = NULL,
vars = NULL, skews = NULL, skurts = NULL, fifths = NULL,
sixths = NULL, Six = list(), mix_pis = list(), mix_mus = list(),
mix_sigmas = list(), mix_skews = list(), mix_skurts = list(),
mix_fifths = list(), mix_sixths = list(), mix_Six = list(),
marginal = list(), lam = NULL, p_zip = 0, size = NULL, prob = NULL,
mu = NULL, p_zinb = 0, pois_eps = 1e-04, nb_eps = 1e-04, rho = NULL,
seed = 1234, use.nearPD = TRUE)
```

Arguments

n	the sample size (i.e. the length of each simulated variable; default = 10000)
k_cat	the number of ordinal ($r \geq 2$ categories) variables (default = 0)
k_cont	the number of continuous non-mixture variables (default = 0)
k_mix	the number of continuous mixture variables (default = 0)
k_pois	the number of regular Poisson and zero-inflated Poisson variables (default = 0)
k_nb	the number of regular Negative Binomial and zero-inflated Negative Binomial variables (default = 0)

method	the method used to generate the k_{cont} non-mixture and k_{mix} mixture continuous variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
means	a vector of means for the k_{cont} non-mixture and k_{mix} mixture continuous variables (i.e. $\text{rep}(0, (k_{cont} + k_{mix}))$)
vars	a vector of variances for the k_{cont} non-mixture and k_{mix} mixture continuous variables (i.e. $\text{rep}(1, (k_{cont} + k_{mix}))$)
skews	a vector of skewness values for the k_{cont} non-mixture continuous variables
skurts	a vector of standardized kurtoses (kurtosis - 3, so that normal variables have a value of 0) for the k_{cont} non-mixture continuous variables
fifths	a vector of standardized fifth cumulants for the k_{cont} non-mixture continuous variables (not necessary for method = "Fleishman")
sixths	a vector of standardized sixth cumulants for the k_{cont} non-mixture continuous variables (not necessary for method = "Fleishman")
Six	a list of vectors of sixth cumulant correction values for the k_{cont} non-mixture continuous variables if no valid PDF constants are found, ex: $\text{Six} = \text{list}(\text{seq}(0.01, 2, 0.01), \text{seq}(1, 10, 0.5))$; if no correction is desired for variable Y_{cont_i} , set the i -th list component equal to NULL; if no correction is desired for any of the Y_{cont} keep as $\text{Six} = \text{list}()$ (not necessary for method = "Fleishman")
mix_pis	a list of length k_{mix} with i -th component a vector of mixing probabilities that sum to 1 for component distributions of Y_{mix_i}
mix_mus	a list of length k_{mix} with i -th component a vector of means for component distributions of Y_{mix_i}
mix_sigmas	a list of length k_{mix} with i -th component a vector of standard deviations for component distributions of Y_{mix_i}
mix_skews	a list of length k_{mix} with i -th component a vector of skew values for component distributions of Y_{mix_i}
mix_skurts	a list of length k_{mix} with i -th component a vector of standardized kurtoses for component distributions of Y_{mix_i}
mix_fifths	a list of length k_{mix} with i -th component a vector of standardized fifth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")
mix_sixths	a list of length k_{mix} with i -th component a vector of standardized sixth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")
mix_Six	a list of length k_{mix} with i -th component a list of vectors of sixth cumulant correction values for component distributions of Y_{mix_i} ; use NULL if no correction is desired for a given component or mixture variable; if no correction is desired for any of the Y_{mix} keep as $\text{mix_Six} = \text{list}()$ (not necessary for method = "Fleishman")
marginal	a list of length equal to k_{cat} ; the i -th element is a vector of the cumulative probabilities defining the marginal distribution of the i -th variable; if the variable can take r values, the vector will contain $r - 1$ probabilities (the r -th is assumed to be 1); for binary variables, these should be input the same as for ordinal variables with more than 2 categories (i.e. the user-specified probability is the probability of the 1st category, which has the smaller support value)

lam	a vector of lambda (> 0) constants for the Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
p_zip	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if $p_zip = 0$, Y_{pois} has a regular Poisson distribution; if p_zip is in $(0, 1)$, Y_{pois} has a zero-inflated Poisson distribution; if p_zip is in $(-(\exp(lam) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and p_zip is not a probability; if $p_zip = -(\exp(lam) - 1)^{-1}$, Y_{pois} has a positive-Poisson distribution (see dpospois); if $\text{length}(p_zip) < \text{length}(lam)$, the missing values are set to 0 (and ordered 1st)
size	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
prob	a vector of success probability parameters for the NB variables; order the same as in size
mu	a vector of mean parameters for the NB variables (*Note: either prob or mu should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in size
p_zinb	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbn); if $p_zinb = 0$, Y_{nb} has a regular NB distribution; if p_zinb is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and p_zinb is not a probability; if $p_zinb = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})$, Y_{nb} has a positive-NB distribution (see dposnegbin); if $\text{length}(p_zinb) < \text{length}(\text{size})$, the missing values are set to 0 (and ordered 1st)
pois_eps	a vector of length k_pois containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable
nb_eps	a vector of length k_nb containing total cumulative probability truncation values; if none are provided, the default is 0.0001 for each variable
rho	the target correlation matrix which must be ordered <i>1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixtures, 4th regular Poisson, 5th zero-inflated Poisson, 6th regular NB, 7th zero-inflated NB</i> ; note that rho is specified in terms of the components of Y_{mix}
seed	the seed value for random number generation (default = 1234)
use.nearPD	TRUE to convert rho to the nearest positive definite matrix with <code>Matrix::nearPD</code> if necessary

Value

A list with components:

rho the target correlation matrix, which will differ from the supplied matrix (if provided) if it was converted to the nearest positive-definite matrix

L_rho the lower correlation bound

U_rho the upper correlation bound

If continuous variables are desired, additional components are:

constants the calculated constants

sixth_correction a vector of the sixth cumulant correction values

valid.pdf a vector with i-th component equal to "TRUE" if variable Y_i has a valid power method PDF, else "FALSE"

If a target correlation matrix `rho` is provided, each pairwise correlation is checked to see if it is within the lower and upper bounds. If the correlation is outside the bounds, the indices of the variable pair are given.

`valid.rho` TRUE if all entries of `rho` are within the bounds, else FALSE

Reasons for Function Errors

1) The most likely cause for function errors is that no solutions to `fleish` or `poly` converged when using `find_constants`. If this happens, the function will stop. It may help to first use `find_constants` for each continuous variable to determine if a sixth cumulant correction value is needed. If the standardized cumulants are obtained from `calc_theory`, the user may need to use rounded values as inputs (i.e. `skews = round(skews, 8)`). For example, in order to ensure that skew is exactly 0 for symmetric distributions.

2) The kurtosis may be outside the region of possible values. There is an associated lower boundary for kurtosis associated with a given skew (for Fleishman's method) or skew and fifth and sixth cumulants (for Headrick's method). Use `calc_lower_skurt` to determine the boundary for a given set of cumulants.

References

Please see `corrvar2` and `validcorr` for references.

See Also

`find_constants`, `corrvar2`, `validpar`

Examples

```
## Not run:

# 2 continuous mixture, 1 binary, 1 zero-inflated Poisson, and
# 1 zero-inflated NB variable
n <- 10000
seed <- 1234

# Mixture variables: Normal mixture with 2 components;
# mixture of Logistic(0, 1), Chisq(4), Beta(4, 1.5)
# Find cumulants of components of 2nd mixture variable
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))

skews <- skurts <- fifths <- sixths <- NULL
Six <- list()
mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
mix_skews <- list(rep(0, 2), c(L[3], C[3], B[3]))
mix_skurts <- list(rep(0, 2), c(L[4], C[4], B[4]))
mix_fifths <- list(rep(0, 2), c(L[5], C[5], B[5]))
mix_sixths <- list(rep(0, 2), c(L[6], C[6], B[6]))
mix_Six <- list(list(NULL, NULL), list(1.75, NULL, 0.03))
Nstcum <- calc_mixmoments(mix_pis[[1]], mix_mus[[1]], mix_sigmas[[1]],
  mix_skews[[1]], mix_skurts[[1]], mix_fifths[[1]], mix_sixths[[1]])
Mstcum <- calc_mixmoments(mix_pis[[2]], mix_mus[[2]], mix_sigmas[[2]],
```

```

    mix_skews[[2]], mix_skurts[[2]], mix_fifths[[2]], mix_sixths[[2]])
means <- c(Nstcum[1], Mstcum[1])
vars <- c(Nstcum[2]^2, Mstcum[2]^2)

marginal <- list(0.3)
support <- list(c(0, 1))
lam <- 0.5
p_zip <- 0.1
pois_eps <- 0.0001
size <- 2
prob <- 0.75
p_zinb <- 0.2
nb_eps <- 0.0001

k_cat <- k_pois <- k_nb <- 1
k_cont <- 0
k_mix <- 2
Rey <- matrix(0.39, 8, 8)
diag(Rey) <- 1
rownames(Rey) <- colnames(Rey) <- c("01", "M1_1", "M1_2", "M2_1", "M2_2",
  "M2_3", "P1", "NB1")

# set correlation between components of the same mixture variable to 0
Rey["M1_1", "M1_2"] <- Rey["M1_2", "M1_1"] <- 0
Rey["M2_1", "M2_2"] <- Rey["M2_2", "M2_1"] <- Rey["M2_1", "M2_3"] <- 0
Rey["M2_3", "M2_1"] <- Rey["M2_2", "M2_3"] <- Rey["M2_3", "M2_2"] <- 0

# check parameter inputs
validpar(k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal, support,
  lam, p_zip, size, prob, mu = NULL, p_zinb, pois_eps, nb_eps, Rey)

# check to make sure Rey is within the feasible correlation boundaries
validcorr2(n, k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal,
  lam, p_zip, size, prob, mu = NULL, p_zinb, pois_eps, nb_eps, Rey, seed)

## End(Not run)

```

validpar

Parameter Check for Simulation or Correlation Validation Functions

Description

This function checks the parameter inputs to the simulation functions [contmixvar1](#), [corrvar](#), and [corrvar2](#) and to the correlation validation functions [validcorr](#) and [validcorr2](#). It should be used prior to execution of these functions to ensure all inputs are of the correct format. Those functions do not contain parameter checks in order to decrease simulation time. This would be important if the user is running several simulation repetitions so that the inputs only have to be checked once. Note that the inputs do not include all of the inputs to the simulation functions. See the appropriate function documentation for more details about parameter inputs.

Usage

```
validpar(k_cat = 0, k_cont = 0, k_mix = 0, k_pois = 0, k_nb = 0,
  method = c("Fleishman", "Polynomial"), means = NULL, vars = NULL,
  skews = NULL, skurts = NULL, fifths = NULL, sixths = NULL,
  Six = list(), mix_pis = list(), mix_mus = list(), mix_sigmas = list(),
  mix_skews = list(), mix_skurts = list(), mix_fifths = list(),
  mix_sixths = list(), mix_Six = list(), marginal = list(),
  support = list(), lam = NULL, p_zip = 0, size = NULL, prob = NULL,
  mu = NULL, p_zinb = 0, pois_eps = 1e-04, nb_eps = 1e-04, rho = NULL,
  Sigma = NULL, cstart = list())
```

Arguments

k_cat	the number of ordinal ($r \geq 2$ categories) variables (default = 0)
k_cont	the number of continuous non-mixture variables (default = 0)
k_mix	the number of continuous mixture variables (default = 0)
k_pois	the number of regular Poisson and zero-inflated Poisson variables (default = 0)
k_nb	the number of regular Negative Binomial and zero-inflated Negative Binomial variables (default = 0)
method	the method used to generate the k_cont non-mixture and k_mix mixture continuous variables. "Fleishman" uses Fleishman's third-order polynomial transformation and "Polynomial" uses Headrick's fifth-order transformation.
means	a vector of means for the k_cont non-mixture and k_mix mixture continuous variables (i.e. <code>rep(0, (k_cont + k_mix))</code>)
vars	a vector of variances for the k_cont non-mixture and k_mix mixture continuous variables (i.e. <code>rep(1, (k_cont + k_mix))</code>)
skews	a vector of skewness values for the k_cont non-mixture continuous variables
skurts	a vector of standardized kurtoses (kurtosis - 3, so that normal variables have a value of 0) for the k_cont non-mixture continuous variables
fifths	a vector of standardized fifth cumulants for the k_cont non-mixture continuous variables (not necessary for method = "Fleishman")
sixths	a vector of standardized sixth cumulants for the k_cont non-mixture continuous variables (not necessary for method = "Fleishman")
Six	a list of vectors of sixth cumulant correction values for the k_cont non-mixture continuous variables if no valid PDF constants are found, ex: <code>Six = list(seq(0.01, 2, 0.01), seq(1, 10, 0.5))</code> ; if no correction is desired for variable Y_{cont_i} , set the i-th list component equal to NULL; if no correction is desired for any of the Y_{cont} keep as <code>Six = list()</code> (not necessary for method = "Fleishman")
mix_pis	a vector or list of length k_mix with i-th component a vector of mixing probabilities that sum to 1 for component distributions of Y_{mix_i}
mix_mus	a vector or list of length k_mix with i-th component a vector of means for component distributions of Y_{mix_i}
mix_sigmas	a vector or list of length k_mix with i-th component a vector of standard deviations for component distributions of Y_{mix_i}
mix_skews	a vector or list of length k_mix with i-th component a vector of skew values for component distributions of Y_{mix_i}

<code>mix_skurts</code>	a vector or list of length <code>k_mix</code> with <i>i</i> -th component a vector of standardized kurtoses for component distributions of Y_{mix_i}
<code>mix_fifths</code>	a vector or list of length <code>k_mix</code> with <i>i</i> -th component a vector of standardized fifth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")
<code>mix_sixths</code>	a vector or list of length <code>k_mix</code> with <i>i</i> -th component a vector of standardized sixth cumulants for component distributions of Y_{mix_i} (not necessary for method = "Fleishman")
<code>mix_Six</code>	a list of length <code>k_mix</code> with <i>i</i> -th component a list of vectors of sixth cumulant correction values for component distributions of Y_{mix_i} ; use NULL if no correction is desired for a given component or mixture variable; if no correction is desired for any of the Y_{mix} keep as <code>mix_Six = list()</code> (not necessary for method = "Fleishman"); if checking for <code>contmixvar1</code> , a list of vectors
<code>marginal</code>	a list of length equal to <code>k_cat</code> ; the <i>i</i> -th element is a vector of the cumulative probabilities defining the marginal distribution of the <i>i</i> -th variable; if the variable can take <i>r</i> values, the vector will contain <i>r</i> - 1 probabilities (the <i>r</i> -th is assumed to be 1; default = <code>list()</code>); for binary variables, these should be input the same as for ordinal variables with more than 2 categories (i.e. the user-specified probability is the probability of the 1st category, which has the smaller support value)
<code>support</code>	a list of length equal to <code>k_cat</code> ; the <i>i</i> -th element is a vector containing the <i>r</i> ordered support values; if not provided (i.e. <code>support = list()</code>), the default is for the <i>i</i> -th element to be the vector 1, ..., <i>r</i>
<code>lam</code>	a vector of lambda (mean > 0) constants for the Poisson variables (see dpois); the order should be 1st regular Poisson variables, 2nd zero-inflated Poisson variables
<code>p_zip</code>	a vector of probabilities of structural zeros (not including zeros from the Poisson distribution) for the zero-inflated Poisson variables (see dzipois); if <code>p_zip = 0</code> , Y_{pois} has a regular Poisson distribution; if <code>p_zip</code> is in (0, 1), Y_{pois} has a zero-inflated Poisson distribution; if <code>p_zip</code> is in $(-(\exp(\text{lam}) - 1)^{-1}, 0)$, Y_{pois} has a zero-deflated Poisson distribution and <code>p_zip</code> is not a probability; if <code>p_zip = -(\exp(\text{lam}) - 1)^{-1}</code> , Y_{pois} has a positive-Poisson distribution (see dpospois); if <code>length(p_zip) < length(lam)</code> , the missing values are set to 0 (and ordered 1st)
<code>size</code>	a vector of size parameters for the Negative Binomial variables (see dnbinom); the order should be 1st regular NB variables, 2nd zero-inflated NB variables
<code>prob</code>	a vector of success probability parameters for the NB variables; order the same as in <code>size</code>
<code>mu</code>	a vector of mean parameters for the NB variables (*Note: either <code>prob</code> or <code>mu</code> should be supplied for all Negative Binomial variables, not a mixture; default = NULL); order the same as in <code>size</code>
<code>p_zinb</code>	a vector of probabilities of structural zeros (not including zeros from the NB distribution) for the zero-inflated NB variables (see dzinegbin); if <code>p_zinb = 0</code> , Y_{nb} has a regular NB distribution; if <code>p_zinb</code> is in $(-\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}}), 0)$, Y_{nb} has a zero-deflated NB distribution and <code>p_zinb</code> is not a probability; if <code>p_zinb = -\text{prob}^{\text{size}}/(1 - \text{prob}^{\text{size}})</code> , Y_{nb} has a positive-NB distribution (see dposnegbin); if <code>length(p_zinb) < length(size)</code> , the missing values are set to 0 (and ordered 1st)
<code>rho</code>	the target correlation matrix which must be ordered <i>1st ordinal, 2nd continuous non-mixture, 3rd components of continuous mixtures, 4th regular Poisson</i> ,

	<i>5th zero-inflated Poisson, 6th regular NB, 7th zero-inflated NB; note that rho is specified in terms of the components of Y_{mix}</i>
Sigma	an intermediate correlation matrix to use if the user wants to provide one, else it is calculated within by intercorr
cstart	a list of length equal to k_cont + the total number of mixture components containing initial values for root-solving algorithm used in find_constants . If user specified, each list element must be input as a matrix. For method = "Fleishman", each should have 3 columns for c_1, c_2, c_3 ; for method = "Polynomial", each should have 5 columns for c_1, c_2, c_3, c_4, c_5 . If no starting values are specified for a given component, that list element should be NULL.

Value

TRUE if all inputs are correct, else it will stop with a correction message

See Also

[contmixvar1](#), [corrvar](#), [corrvar2](#), [validcorr](#), [validcorr2](#)

Examples

```
## Not run:
# 2 continuous mixture, 1 binary, 1 zero-inflated Poisson, and
# 1 zero-inflated NB variable

# Mixture variables: Normal mixture with 2 components;
# mixture of Logistic(0, 1), Chisq(4), Beta(4, 1.5)
# Find cumulants of components of 2nd mixture variable
L <- calc_theory("Logistic", c(0, 1))
C <- calc_theory("Chisq", 4)
B <- calc_theory("Beta", c(4, 1.5))

skews <- skurts <- fifths <- sixths <- NULL
Six <- list()
mix_pis <- list(c(0.4, 0.6), c(0.3, 0.2, 0.5))
mix_mus <- list(c(-2, 2), c(L[1], C[1], B[1]))
mix_sigmas <- list(c(1, 1), c(L[2], C[2], B[2]))
mix_skews <- list(rep(0, 2), c(L[3], C[3], B[3]))
mix_skurts <- list(rep(0, 2), c(L[4], C[4], B[4]))
mix_fifths <- list(rep(0, 2), c(L[5], C[5], B[5]))
mix_sixths <- list(rep(0, 2), c(L[6], C[6], B[6]))
mix_Six <- list(list(NULL, NULL), list(1.75, NULL, 0.03))
Nstcum <- calc_mixmoments(mix_pis[[1]], mix_mus[[1]], mix_sigmas[[1]],
  mix_skews[[1]], mix_skurts[[1]], mix_fifths[[1]], mix_sixths[[1]])
Mstcum <- calc_mixmoments(mix_pis[[2]], mix_mus[[2]], mix_sigmas[[2]],
  mix_skews[[2]], mix_skurts[[2]], mix_fifths[[2]], mix_sixths[[2]])
means <- c(Nstcum[1], Mstcum[1])
vars <- c(Nstcum[2]^2, Mstcum[2]^2)

marginal <- list(0.3)
support <- list(c(0, 1))
lam <- 0.5
p_zip <- 0.1
size <- 2
prob <- 0.75
```



```

p_zinb <- 0.2

k_cat <- k_pois <- k_nb <- 1
k_cont <- 0
k_mix <- 2
Rey <- matrix(0.39, 8, 8)
diag(Rey) <- 1
rownames(Rey) <- colnames(Rey) <- c("O1", "M1_1", "M1_2", "M2_1", "M2_2",
  "M2_3", "P1", "NB1")

# set correlation between components of the same mixture variable to 0
Rey["M1_1", "M1_2"] <- Rey["M1_2", "M1_1"] <- 0
Rey["M2_1", "M2_2"] <- Rey["M2_2", "M2_1"] <- Rey["M2_1", "M2_3"] <- 0
Rey["M2_3", "M2_1"] <- Rey["M2_2", "M2_3"] <- Rey["M2_3", "M2_2"] <- 0

# use before contmixvar1 with 1st mixture variable:
# change mix_pis to not sum to 1

check1 <- validpar(k_mix = 1, method = "Polynomial", means = Nstcum[1],
  vars = Nstcum[2]^2, mix_pis = C(0.4, 0.5), mix_mus = mix_mus[[1]],
  mix_sigmas = mix_sigmas[[1]], mix_skews = mix_skews[[1]],
  mix_skurts = mix_skurts[[1]], mix_fifths = mix_fifths[[1]],
  mix_sixths = mix_sixths[[1]])

# use before validcorr: should return TRUE

# check to make sure Rey is within the feasible correlation boundaries
check2 <- validpar(k_cat, k_cont, k_mix, k_pois, k_nb, "Polynomial", means,
  vars, skews, skurts, fifths, sixths, Six, mix_pis, mix_mus, mix_sigmas,
  mix_skews, mix_skurts, mix_fifths, mix_sixths, mix_Six, marginal, support,
  lam, p_zip, size, prob, mu = NULL, p_zinb, rho = Rey)

## End(Not run)

```

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- validpar, [5](#), [7](#), [8](#), [15](#), [17](#), [23](#), [27](#), [30](#), [58](#), [60](#), [63](#), [65](#), [68](#), [69](#)
- VGAM, [50](#), [53](#)