

Package ‘cvcqv’

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Type Package

Title Coefficient of Variation (CV) with Confidence Intervals (CI)

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Description Provides some easy-to-use functions and classes to calculate variability measures such as coefficient of variation with confidence intervals provided with all available methods. References are 'Panichkitkosolkul' (2013) <doi:10.1155/2013/324940>, 'Altunkaynak' & 'Gamgam' (2018) <doi:10.1080/03610918.2018.1435800>, 'Albatineh', 'Kibria', Wilcox & 'Zogheib' (2014) <doi:10.1080/02664763.2013.847405>.

Depends R (>= 3.5.0), dplyr (>= 0.8.0.1)

Imports R6, SciViews, boot, MBESS

Suggests testthat, knitr, rmarkdown, covr

VignetteBuilder knitr

URL <https://github.com/MaaniBeigy/cvcqv>

BugReports <https://github.com/MaaniBeigy/cvcqv/issues>

License GPL-3

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BootCoefQuartVar	<i>R6 Bootstrap Resampling for Coefficient of Quartile Variation</i>
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Description

The R6 class `BootCoefQuartVar` produces the bootstrap resampling for the coefficient of quartile variation (cqv) of the given numeric vectors. It uses `boot` from the package `boot`. Also, it produces the bootstrap confidence intervals for the cqv based on the `boot.ci` from the package `boot`.

Arguments

<code>x</code>	An R object. Currently there are methods for numeric vectors
<code>na.rm</code>	a logical value indicating whether NA values should be stripped before the computation proceeds.
<code>alpha</code>	The allowed type I error probability
<code>R</code>	integer indicating the number of bootstrap replicates.

References

- Canty, A., & Ripley, B., 2017, `boot`: Bootstrap R (S-Plus) Functions. R package version 1.3-20.
- Davison, AC., & Hinkley, DV., 1997, *Bootstrap Methods and Their Applications*. Cambridge University Press, Cambridge. ISBN 0-521-57391-2
- Altunkaynak, B., Gangam, H., 2018, Bootstrap confidence intervals for the coefficient of quartile variation, *Simulation and Computation*, 1-9, DOI: [doi:10.1080/03610918.2018.1435800](https://doi.org/10.1080/03610918.2018.1435800)

Examples

```
x <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
cqv_x <- BootCoefQuartVar$new(x)
cqv_x$boot_cqv()
```

```

cqv_x$boot_basic_ci()
cqv_x$boot_norm_ci()
cqv_x$boot_perc_ci()
cqv_x$boot_bca_ci()
R6::is.R6(cqv_x)

```

 BootCoefVar

R6 Bootstrap Resampling for Coefficient of Variation

Description

The R6 class `BootCoefVar` produces the bootstrap resampling for the coefficient of variation (cv) of the given numeric vectors. It uses `boot` and `boot.ci` from the package `boot`.

Arguments

<code>x</code>	An R object. Currently there are methods for numeric vectors
<code>na.rm</code>	a logical value indicating whether NA values should be stripped before the computation proceeds.
<code>alpha</code>	The allowed type I error probability
<code>R</code>	integer indicating the number of bootstrap replicates.

References

Canty, A., & Ripley, B, 2017, `boot`: Bootstrap R (S-Plus) Functions. R package version 1.3-20.
 Davison, AC., & Hinkley, DV., 1997, *Bootstrap Methods and Their Applications*. Cambridge University Press, Cambridge. ISBN 0-521-57391-2

Examples

```

x <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
cv_x <- BootCoefVar$new(x)
cv_x$boot_cv()
cv_x$boot_cv_corr()
cv_x$boot_basic_ci_cv()
cv_x$boot_norm_ci_cv()
cv_x$boot_perc_ci_cv()
cv_x$boot_bca_ci_cv()
cv_x$boot_basic_ci_cv_corr()
cv_x$boot_norm_ci_cv_corr()
cv_x$boot_perc_ci_cv_corr()
cv_x$boot_bca_ci_cv_corr()
R6::is.R6(cv_x)

```

CoefQuartVar	<i>R6 Coefficient of Quartile Variation (cqv)</i>
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Description

The R6 class `CoefQuartVar` for the coefficient of quartile variation (`cqv`)

Arguments

<code>x</code>	An R object. Currently there are methods for numeric vectors
<code>na.rm</code>	a logical value indicating whether NA values should be stripped before the computation proceeds.
<code>digits</code>	integer indicating the number of decimal places to be used.

Details

Coefficient of Quartile Variation `cqv` is a measure of relative dispersion that is based on interquartile range (`iqr`). Since `cqv` is unitless, it is useful for comparison of variables with different units. It is also a measure of homogeneity [1].

References

[1] Bonett, DG., 2006, Confidence interval for a coefficient of quartile variation, Computational Statistics & Data Analysis, 50(11), 2953-7, DOI: [doi:10.1016/j.csda.2005.05.007](https://doi.org/10.1016/j.csda.2005.05.007)

Examples

```
x <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
CoefQuartVar$new(x)$est()
cqv_x <- CoefQuartVar$new(x, digits = 2)
cqv_x$est()
R6::is.R6(cqv_x)
```

CoefQuartVarCI	<i>R6 Confidence Intervals for the Coefficient of Quartile Variation (cqv)</i>
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Description

The R6 class `CoefQuartVarCI` for the confidence intervals of coefficient of quartile variation (`cqv`)

Arguments

<code>x</code>	An R object. Currently there are methods for numeric vectors
<code>na.rm</code>	a logical value indicating whether NA values should be stripped before the computation proceeds.
<code>digits</code>	integer indicating the number of decimal places to be used.
<code>methods</code>	the available computation methods of confidence intervals are: "bonett_ci", "norm_ci", "basic_ci", "perc_ci", "bca_ci" or "all_ci".
<code>R</code>	integer indicating the number of bootstrap replicates.

Details

Coefficient of Quartile Variation The *cqv* is a measure of relative dispersion that is based on interquartile range (*iqr*). Since *cqv* is unitless, it is useful for comparison of variables with different units. It is also a measure of homogeneity [1, 2].

Value

An object of type "list" which contains the estimate, the intervals, and the computation method. It has two components:

\$method A description of statistical method used for the computations.

\$statistics A data frame representing three vectors: est, lower and upper limits of 95% confidence interval (CI):

est: `cqv*100`

Bonett 95% CI: It uses a centering adjustment which helps to equalize the tail error probabilities [1, 2].

Normal approximation 95% CI: The intervals calculated by the normal approximation [3, 4], using [boot.ci](#).

Basic bootstrap 95% CI: The intervals calculated by the basic bootstrap method [3, 4], using [boot.ci](#).

Bootstrap percentile 95% CI: The intervals calculated by the bootstrap percentile method [3, 4], using [boot.ci](#).

Adjusted bootstrap percentile (BCa) 95% CI: The intervals calculated by the adjusted bootstrap percentile (BCa) method [3, 4], using [boot.ci](#).

References

- [1] Bonett, DG., 2006, Confidence interval for a coefficient of quartile variation, Computational Statistics & Data Analysis, 50(11), 2953-7, DOI: [doi:10.1016/j.csda.2005.05.007](https://doi.org/10.1016/j.csda.2005.05.007)
- [2] Altunkaynak, B., Gamgam, H., 2018, Bootstrap confidence intervals for the coefficient of quartile variation, Simulation and Computation, 1-9, DOI: [doi:10.1080/03610918.2018.1435800](https://doi.org/10.1080/03610918.2018.1435800)

[3] Canty, A., & Ripley, B, 2017, boot: Bootstrap R (S-Plus) Functions. R package version 1.3-20.

[4] Davison, AC., & Hinkley, DV., 1997, Bootstrap Methods and Their Applications. Cambridge University Press, Cambridge. ISBN 0-521-57391-2

Examples

```
y <- c(
0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
CoefQuartVarCI$new(x = y)$bonett_ci()
cqv_y <- CoefQuartVarCI$new(
  x = y,
  alpha = 0.05,
  R = 1000,
  digits = 2
)
cqv_y$bonett_ci()
R6::is.R6(cqv_y)
```

CoefVar

R6 Coefficient of Variation (cv)

Description

The R6 class CoefVar for the coefficient of variation (*cv*)

Arguments

<code>x</code>	An R object. Currently there are methods for numeric vectors
<code>na.rm</code>	a logical value indicating whether NA values should be stripped before the computation proceeds.
<code>digits</code>	integer indicating the number of decimal places to be used.

Details

Coefficient of Variation The *cv* is a measure of relative dispersion representing the degree of variability relative to the mean [1]. Since *cv* is unitless, it is useful for comparison of variables with different units. It is also a measure of homogeneity [1].

References

[1] Albatineh, AN., Kibria, BM., Wilcox, ML., & Zogheib, B, 2014, Confidence interval estimation for the population coefficient of variation using ranked set sampling: A simulation study, Journal of Applied Statistics, 41(4), 733–751, DOI: [doi:10.1080/02664763.2013.847405](https://doi.org/10.1080/02664763.2013.847405)

Examples

```
x <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
CoefVar$new(x)$est()
cv_x <- CoefVar$new(x, digits = 2)
cv_x$est()
cv_x$est_corr()
R6::is.R6(cv_x)
```

CoefVarCI

*R6 Confidence Intervals for the Coefficient of Variation (cv)***Description**

The R6 class CoefVarCI for the confidence intervals of coefficient of variation (cv)

Arguments

x	An R object. Currently there are methods for numeric vectors
na.rm	a logical value indicating whether NA values should be stripped before the computation proceeds.
digits	integer indicating the number of decimal places to be used.
method	a scalar representing the type of confidence intervals required. The value should be any of the values "kelley_ci", "mckay_ci", "miller_ci", "vangel_ci", "mahmoudvand_hassani_ci", "equal_tailed_ci", "shortest_length_ci", "normal_approximation_ci", "norm_ci", "basic_ci", or "all_ci".
alpha	The allowed type I error probability
R	integer indicating the number of bootstrap replicates.
correction	returns the unbiased estimate of the coefficient of variation if TRUE is determined.

Details

Coefficient of Variation The *cv* is a measure of relative dispersion representing the degree of variability relative to the mean [1]. Since *cv* is unitless, it is useful for comparison of variables with different units. It is also a measure of homogeneity [1].

Value

An object of type "list" which contains the estimate, the intervals, and the computation method. It has two main components:

\$method A description of statistical method used for the computations.

\$statistics A data frame representing three vectors: *est*/, lower and upper limits of confidence interval (CI); additional description vector is provided when "all" is selected:

est: `cv*100`

Kelley Confidence Interval: Thanks to package **MBESS** [2] for the computation of confidence limits for the noncentrality parameter from a *t* distribution [conf.limits.nct](#) [3].

McKay Confidence Interval: The intervals calculated by the method introduced by McKay [4], using chi-square distribution.

Miller Confidence Interval: The intervals calculated by the method introduced by Miller [5], using the standard normal distribution.

Vangel Confidence Interval: Vangel [6] proposed a method for the calculation of CI for *cv*; which is a modification on McKay's CI.

Mahmoudvand-Hassani Confidence Interval: Mahmoudvand and Hassani [7] proposed a new CI for *cv*; which is obtained using ranked set sampling (*RSS*)

Normal Approximation Confidence Interval: Wararit Panichkitkosolkul [8] proposed another CI for *cv*; which is a normal approximation.

Shortest-Length Confidence Interval: Wararit Panichkitkosolkul [8] proposed another CI for *cv*; which is obtained through minimizing the length of CI.

Equal-Tailed Confidence Interval: Wararit Panichkitkosolkul [8] proposed another CI for *cv*; which is obtained using chi-square distribution.

Bootstrap Confidence Intervals: Thanks to package **boot** by Canty & Ripley [9] we can obtain bootstrap CI around *cv* using [boot.ci](#).

References

- [1] Albatineh, AN., Kibria, BM., Wilcox, ML., & Zogheib, B, 2014, Confidence interval estimation for the population coefficient of variation using ranked set sampling: A simulation study, *Journal of Applied Statistics*, 41(4), 733–751, DOI: [doi:10.1080/02664763.2013.847405](#)
- [2] Kelley, K., 2018, **MBESS**: The MBESS R Package. R package version 4.4. 3.
- [3] Kelley, K., 2007, Sample size planning for the coefficient of variation from the accuracy in parameter estimation approach, *Behavior Research Methods*, 39(4), 755–766, DOI: [doi:10.3758/BF03192966](#)
- [4] McKay, AT., 1932, Distribution of the Coefficient of Variation and the Extended“ t” Distribution, *Journal of the Royal Statistical Society*, 95(4), 695–698
- [5] Miller, E., 1991, Asymptotic test statistics for coefficients of variation, *Communications in Statistics-Theory and Methods*, 20(10), 3351–3363

[6] Vangel, MG., 1996, Confidence intervals for a normal coefficient of variation, *The American Statistician*, 50(1), 21–26

[7] Mahmoudvand, R., & Hassani, H., 2009, Two new confidence intervals for the coefficient of variation in a normal distribution, *Journal of Applied Statistics*, 36(4), 429–442

[8] Panichkitkosolkul, W., 2013, Confidence Intervals for the Coefficient of Variation in a Normal Distribution with a Known Population Mean, *Journal of Probability and Statistics*, 2013, 1–11, [doi:10.1155/2013/324940](https://doi.org/10.1155/2013/324940)

[9] Canty, A., & Ripley, B., 2017, boot: Bootstrap R (S-Plus) Functions, R package version 1.3-20

Examples

```
y <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
CoefVarCI$new(x = y)$kelley_ci()
cv_y <- CoefVarCI$new(
  x = y,
  alpha = 0.05,
  R = 1000,
  digits = 2,
  correction = TRUE
)
cv_y$kelley_ci()
cv_y$mckay_ci()
R6::is.R6(cv_y)
```

cqv_versatile

Coefficient of Quartile Variation (cqv)

Description

Versatile function for the coefficient of quartile variation (cqv)

Arguments

x	An R object. Currently there are methods for numeric vectors
na.rm	a logical value indicating whether NA values should be stripped before the computation proceeds.
digits	integer indicating the number of decimal places to be used.
method	a scalar representing the type of confidence intervals required. The value should be any of the values "bonett", "norm", "basic", "perc", "bca" or "all".
R	integer indicating the number of bootstrap replicates.

Details

Coefficient of Quartile Variation The *cqv* is a measure of relative dispersion that is based on interquartile range (*iqr*). Since *cqv* is unitless, it is useful for comparison of variables with different units. It is also a measure of homogeneity [1, 2].

Value

An object of type "list" which contains the estimate, the intervals, and the computation method. It has two components:

\$method A description of statistical method used for the computations.

\$statistics A data frame representing three vectors: est, lower and upper limits of 95% confidence interval (CI):

est: `cqv*100`

Bonett 95% CI: It uses a centering adjustment which helps to equalize the tail error probabilities [1, 2].

Normal approximation 95% CI: The intervals calculated by the normal approximation [3, 4], using [boot.ci](#).

Basic bootstrap 95% CI: The intervals calculated by the basic bootstrap method [3, 4], using [boot.ci](#).

Bootstrap percentile 95% CI: The intervals calculated by the bootstrap percentile method [3, 4], using [boot.ci](#).

Adjusted bootstrap percentile (BCa) 95% CI: The intervals calculated by the adjusted bootstrap percentile (BCa) method [3, 4], using [boot.ci](#).

References

- [1] Bonett, DG., 2006, Confidence interval for a coefficient of quartile variation, Computational Statistics & Data Analysis, 50(11), 2953-7, DOI: [doi:10.1016/j.csda.2005.05.007](https://doi.org/10.1016/j.csda.2005.05.007)
- [2] Altunkaynak, B., Gamgam, H., 2018, Bootstrap confidence intervals for the coefficient of quartile variation, Simulation and Computation, 1-9, DOI: [doi:10.1080/03610918.2018.1435800](https://doi.org/10.1080/03610918.2018.1435800)
- [3] Canty, A., & Ripley, B, 2017, boot: Bootstrap R (S-Plus) Functions. R package version 1.3-20.
- [4] Davison, AC., & Hinkley, DV., 1997, Bootstrap Methods and Their Applications. Cambridge University Press, Cambridge. ISBN 0-521-57391-2

Examples

```
x <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
cqv_versatile(x)
```

```
cqv_versatile(x, na.rm = TRUE, digits = 2)
cqv_versatile(x, na.rm = TRUE, digits = 2, method = "bonett")
```

cv_versatile	<i>Coefficient of Variation (cv)</i>
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Description

Versatile function for the coefficient of variation (*cv*)

Arguments

<code>x</code>	An R object. Currently there are methods for numeric vectors
<code>na.rm</code>	a logical value indicating whether NA values should be stripped before the computation proceeds.
<code>digits</code>	integer indicating the number of decimal places to be used.
<code>method</code>	a scalar representing the type of confidence intervals required. The value should be any of the values "kelley", "mckay", "miller", "vangel", "mahmoudvand_hassani", "equal_tailed", "shortest_length", "normal_approximation", "norm", "basic", or "all".
<code>correction</code>	returns the unbiased estimate of the coefficient of variation
<code>alpha</code>	The allowed type I error probability
<code>R</code>	integer indicating the number of bootstrap replicates.

Details

Coefficient of Variation The *cv* is a measure of relative dispersion representing the degree of variability relative to the mean [1]. Since *cv* is unitless, it is useful for comparison of variables with different units. It is also a measure of homogeneity [1].

Value

An object of type "list" which contains the estimate, the intervals, and the computation method. It has two main components:

\$method A description of statistical method used for the computations.

\$statistics A data frame representing three vectors: est, lower and upper limits of confidence interval (CI); additional description vector is provided when "all" is selected:

est: $cv \times 100$

Kelley Confidence Interval: Thanks to package **MBESS** [2] for the computation of confidence limits for the noncentrality parameter from a *t* distribution [conf.limits.nct](#) [3].

McKay Confidence Interval: The intervals calculated by the method introduced by McKay

[4], using chi-square distribution.

Miller Confidence Interval: The intervals calculated by the method introduced by Miller [5], using the standard normal distribution.

Vangel Confidence Interval: Vangel [6] proposed a method for the calculation of CI for cv ; which is a modification on McKay's CI.

Mahmoudvand-Hassani Confidence Interval: Mahmoudvand and Hassani [7] proposed a new CI for cv ; which is obtained using ranked set sampling (*RSS*)

Normal Approximation Confidence Interval: Wararit Panichkitkosolkul [8] proposed another CI for cv ; which is a normal approximation.

Shortest-Length Confidence Interval: Wararit Panichkitkosolkul [8] proposed another CI for cv ; which is obtained through minimizing the length of CI.

Equal-Tailed Confidence Interval: Wararit Panichkitkosolkul [8] proposed another CI for cv ; which is obtained using chi-square distribution.

Bootstrap Confidence Intervals: Thanks to package **boot** by Canty & Ripley [9] we can obtain bootstrap CI around cv using [boot.ci](#).

References

- [1] Albatineh, AN., Kibria, BM., Wilcox, ML., & Zogheib, B, 2014, Confidence interval estimation for the population coefficient of variation using ranked set sampling: A simulation study, *Journal of Applied Statistics*, 41(4), 733–751, DOI: [doi:10.1080/02664763.2013.847405](https://doi.org/10.1080/02664763.2013.847405)
- [2] Kelley, K., 2018, MBESS: The MBESS R Package. R package version 4.4. 3.
- [3] Kelley, K., 2007, Sample size planning for the coefficient of variation from the accuracy in parameter estimation approach, *Behavior Research Methods*, 39(4), 755–766, DOI: [doi:10.3758/BF03192966](https://doi.org/10.3758/BF03192966)
- [4] McKay, AT., 1932, Distribution of the Coefficient of Variation and the Extended“ t” Distribution, *Journal of the Royal Statistical Society*, 95(4), 695–698
- [5] Miller, E., 1991, Asymptotic test statistics for coefficients of variation, *Communications in Statistics-Theory and Methods*, 20(10), 3351–3363
- [6] Vangel, MG., 1996, Confidence intervals for a normal coefficient of variation, *The American Statistician*, 50(1), 21–26
- [7] Mahmoudvand, R., & Hassani, H., 2009, Two new confidence intervals for the coefficient of variation in a normal distribution, *Journal of Applied Statistics*, 36(4), 429–442
- [8] Panichkitkosolkul, W., 2013, Confidence Intervals for the Coefficient of Variation in a Normal Distribution with a Known Population Mean, *Journal of Probability and Statistics*, 2013, 1–11, [doi:10.1155/2013/324940](https://doi.org/10.1155/2013/324940)
- [9] Canty, A., & Ripley, B., 2017, boot: Bootstrap R (S-Plus) Functions, R package version 1.3-20

Examples

```
x <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
cv_versatile(x)
cv_versatile(x, correction = TRUE)
cv_versatile(x, na.rm = TRUE, digits = 3, method = "kelley", correction = TRUE)
cv_versatile(x, na.rm = TRUE, method = "mahmoudvand_hassani", correction = TRUE)
```

SampleQuantiles

*R6 Sample Quantiles***Description**

The R6 class `SampleQuantiles` produces the sample quantiles corresponding to the given probabilities. It uses `quantile` from the package `stats`.

Arguments

<code>x</code>	An R object. Currently there are methods for numeric vectors
<code>na.rm</code>	a logical value indicating whether NA values should be stripped before the computation proceeds.
<code>digits</code>	integer indicating the number of decimal places to be used.
<code>probs</code>	numeric vector of probabilities with values in $[0, 1]$.
<code>names</code>	logical; if TRUE, the result has a <code>names</code> attribute regarding the percentiles.
<code>type</code>	an integer between 1 and 9 selecting one of the nine quantile algorithms explained in <code>quantile</code> to be used.

Examples

```
x <- c(
  0.2, 0.5, 1.1, 1.4, 1.8, 2.3, 2.5, 2.7, 3.5, 4.4,
  4.6, 5.4, 5.4, 5.7, 5.8, 5.9, 6.0, 6.6, 7.1, 7.9
)
SampleQuantiles$new(x)$qx()
percentile_95 <- SampleQuantiles$new(x, na.rm = TRUE, digits = 2, probs = 0.95)
percentile_95$qx()
percentile_75 <- SampleQuantiles$new(x, na.rm = TRUE, digits = 3, probs = 0.75)
percentile_75$qx()
R6::is.R6(percentile_95)
```

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