Package: cvcqv (via r-universe)

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Type Package

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

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Maintainer Maani Beigy <manibeygi@gmail.com>

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 (>= 4.1.0), 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` *R6 Bootstrap Resampling for Coefficient of Quartile Variation*

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

`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.
`alpha`	The allowed type I error probability
`R`	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., Gamgam, H., 2018, Bootstrap confidence intervals for the coefficient of quartile variation, Simulation and Computation, 1-9, DOI: doi: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

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.
alpha	The allowed type I error probability
R	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 *R6 Coefficient of Quartile Variation (cqv)*

Description

The R6 class `CoefQuartVar` 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.

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

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 *R6 Confidence Intervals for the Coefficient of Quartile Variation (cqv)*

Description

The R6 class `CoefQuartVarCI` for the confidence intervals of 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.
methods	the available computation methods of confidence intervals are: "bonett_ci", "norm_ci", "basic_ci", "perc_ci", "bca_ci" or "all_ci".
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

[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

[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

`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.

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

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", "aak_adj_ci", "aak_ls_ci", "aak_als_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.

Abu-Shawiesh-Akyuz-Kibria Confidence Intervals: Abu-Shawiesh, Akyuz, & Kibria [10] proposed three CIs for the population *cv* that adjust for non-normality through the sample kurtosis: the adjusted-degrees-of-freedom CI (`aak_adj_ci`) derived from Hummel et al.'s CI for the variance, the large-sample CI (`aak_ls_ci`) derived from the log-transformed CI for the variance, and the augmented-large-sample CI (`aak_als_ci`) derived from Burch's CI for the variance.

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

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

[10] Abu-Shawiesh, MOA., Akyuz, HE., & Kibria, BG., 2019, Performance of Some Confidence Intervals for Estimating the Population Coefficient of Variation under both Symmetric and Skewed Distributions, Statistics, Optimization & Information Computing, 7(2), 277-290, DOI: doi:10.19139/soic.v7i2.630

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

[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

[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 *Coefficient of Variation (cv)*

Description

Versatile function for the 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", "mckay", "miller", "vangel", "mahmoudvand_hassani", "equal_tailed", "shortest_length", "normal_approximation", "norm","basic", "aak_adj", "aak_ls", "aak_als", or "all".
correction	returns the unbiased estimate of the coefficient of variation
alpha	The allowed type I error probability
R	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*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.

Abu-Shawiesh-Akyuz-Kibria Confidence Intervals: Abu-Shawiesh, Akyuz, & Kibria [10] proposed three CIs for the population *cv* that adjust for non-normality through the sample kurtosis: the adjusted-degrees-of-freedom CI (`aak_adj`), the large-sample CI (`aak_ls`), and the augmented-large-sample CI (`aak_als`).

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

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

[10] Abu-Shawiesh, MOA., Akyuz, HE., & Kibria, BG., 2019, Performance of Some Confidence Intervals for Estimating the Population Coefficient of Variation under both Symmetric and Skewed Distributions, Statistics, Optimization & Information Computing, 7(2), 277-290, DOI: doi:10.19139/soic.v7i2.630

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

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.
probs	numeric vector of probabilities with values in [0,1].
names	logical; if TRUE, the result has a names attribute regarding the percentiles.
type	an integer between 1 and 9 selecting one of the nine quantile algorithms explained in quantile 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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