Package ‘fuel’

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Title Framework for Unified Estimation in Lognormal Models

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Description Lognormal models have broad applications in various research areas such as economics, actuarial science, biology, environmental science and psychology. The estimation problem in lognormal models has been extensively studied. This R package 'fuel' implements thirty-nine existing and newly proposed estimators. See Zhang, F., and Gou, J. (2020), A unified framework for estimation in lognormal models, Technical report.

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`lognormalest` *Lognormal Estimators*

Description

Lognormal models are also widely applied in various branches of natural, social and applied sciences. Given a pair of known constants in the parametric function for the statistics in the lognormal distribution, sample size, degree of freedom of the variance estimation of the log-transformed data, standardized variance of the sampling distribution of the log-transformed data, mean of the log-transformed data and standard deviation of the log-transformed data, this function returns an estimation for the lognormal distribution, including a total of thirty-nine different estimation methods, under a newly proposed unified framework in Zhang and Gou (2020).

Usage

```
lognormalest(n, m = n - 1, d = 1/n, mean.rn, sd.rn, a, b, estimator)
```

Arguments

`n`	sample size.
`m`	degree of freedom of the variance estimation of the log-transformed data.
`d`	standardized variance of the sampling distribution of the log-transformed data.
`mean.rn`	mean of the log-transformed data.
`sd.rn`	standard deviation of the log-transformed data.
`a`	the first known constants in the parametric function for the statistics.
`b`	the second known constants in the parametric function for the statistics.
`estimator`	a total of thirty-eight different estimation methods. See more descriptions in Section Details.

Details

Consider a parametric function in the original scale we are interested in estimating $\theta(a, b) = exp(a\mu + b\sigma^2/2)$,where constants *a* and *b* are known. Specifically, $\theta(1, 1)$ is the mean of the lognormal distribution, $\theta(2, 4)$ is the second moment, $\theta(2, 4) - \theta(2, 2)$ is the variance, and $(\theta(0, 2) - 1)^{1/2}$ is the coeficient of variation.

1. `unbiased`: Unbiased estimator (Finney, 1941)
2. `qml`: Quasi maximum likelihood estimator
3. `ml`: Maximum likelihood estimator
4. `sa`: Simple adjustment estimator
5. `f`: Finney's unbiased estimator (Finney, 1941)
6. `z`: Zellner's estimator (Zellner, 1971)
7. `es`: Evans and Shaban's estimator (Evans and Shaban, 1974, 1976)

8. `r-s`: Rukhin's simple estimator (Rukhin, 1986)
9. `r-f`: Rukhin's estimator using Finney's function (Rukhin, 1986)
10. `r-lo`: Rukhin's locally optimal estimator (Rukhin, 1986)
11. `r-b`: Rukhin's Bayes estimator (Rukhin, 1986)
12. `ev`: El-Shaarawi and Viveros' estimator (El-Shaarawi and Viveros, 1997)
13. `zh`: Zhou's estimator (Zhou, 1998)
14. `sz-mm`: Shen and Zhu's MM estimator (Shen and Zhu, 2008)
15. `sz-mb`: Shen and Zhu's MB estimator (Shen and Zhu, 2008)
16. `l-ub`: Longford's UB estimator (Longford, 2009)
17. `l-ms`: Longford's MS estimator (Longford, 2009)
18. `ft`: Fabrizi and Trivisano's Simplified Bayes estimator (Fabrizi and Trivisano, 2012)
19. `ft-s`: Fabrizi and Trivisano's Simplified Bayes estimator (Fabrizi and Trivisano, 2012)
20. `ft-b`: Fabrizi and Trivisano's Bayes estimator (Fabrizi and Trivisano, 2012)
21. `gt-f`: Gou and Tamhane's estimator using Finney's function (Gou and Tamhane, 2017)
22. `gt-es`: Gou and Tamhane's estimator using Evans and Shaban's function (Gou and Tamhane, 2017)
23. `gt-r`: Gou and Tamhane's estimator using Rukhin's function (Gou and Tamhane, 2017)
24. `zg-1`: Zhang and Gou's first estimator (Zhang and Gou, 2020)
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40. `zg-17`: Zhang and Gou's seventeenth estimator (Zhang and Gou, 2020)
41. `zg-18`: Zhang and Gou's eighteenth estimator (Zhang and Gou, 2020)
42. `zg-19`: Zhang and Gou's nineteenth estimator (Zhang and Gou, 2020)

Value

estimation using a specific estimating method.

Author(s)

Jiangtao Gou

Fengqing (Zoe) Zhang

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Evans, I. G. and Shaban, S. A. (1974). A note on estimation in lognormal models. *Journal of the American Statistical Association*, **69**: 779-781. <https://doi.org/10.2307/2286017>

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Shen, H. and Zhu, Z. (2008). Efficient mean estimation in log-normal linear models. *Journal of Statistical Planning and Inference*, **138**: 552-567. <https://doi.org/10.1016/j.jspi.2006.10.016>

Longford, N. T. (2009). Inference with the lognormal distribution. *Journal of Statistical Planning and Inference*, **139**: 2329-2340. <https://doi.org/10.1016/j.jspi.2008.10.015>

Fabrizi, E. and Trivisano, C. (2012). Bayesian estimation of log-normal means with finite quadratic expected loss. *Bayesian Analysis*, **7**: 975-996. <https://doi.org/10.1214/12-BA733>

Gou, J. and Tamhane, A. C. (2017). Estimation of a parametric function associated with the lognormal distribution. *Communications in Statistics - Theory and Methods* **46**: 8134-8154. <https://doi.org/10.1080/03610926.201

Zhang, F. and Gou, J. (2020). A unified framework for estimation in lognormal models. Technical Report.

Examples

```
library(fuel)
# Unbiased Estimation (Finney, 1941)
fuel::lognormalest(n=10, m=9, d=1/10, mean.rn=1, sd.rn=1, a=1, b=1, estimator='unbiased')
# Longford's estimator, minimize the mean squared error (Longford, 2009)
fuel::lognormalest(n=10, m=9, d=1/10, mean.rn=1, sd.rn=1, a=1, b=1, estimator='l-ms')
# Gou and Tamhane's estimator, Rukhin type (Gou and Tamhane, 2017)
fuel::lognormalest(n=10, m=9, d=1/10, mean.rn=1, sd.rn=1, a=1, b=1, estimator='gt-r')
# Zhang and Gou's No.4 estimator (Zhang and Gou, 2020)
fuel::lognormalest(n=10, m=9, d=1/10, mean.rn=1, sd.rn=1, a=1, b=1, estimator='zg-4')
```

lognormalmean *Mean Estimation for Lognormal Distribution*

Description

Lognormal models are also widely applied in various branches of natural, social and applied sciences. Given a pair of known constants in the parametric function for the statistics in the lognormal distribution, sample size, degree of freedom of the variance estimation of the log-transformed data, standardized variance of the sampling distribution of the log-transformed data, mean of the log-transformed data and standard deviation of the log-transformed data, this function returns an estimation for the lognormal distribution, including a total of thirty-nine different estimation methods, under a newly proposed unified framework in Zhang and Gou (2020).

Usage

```
lognormalmean(
  data,
  estimator,
  base = exp(1),
  n = length(data),
  m = n - 1,
  d = 1/n
)
```

Arguments

`data`	original data vector
`estimator`	a total of thirty-eight different estimation methods. See more descriptions in Section Details.
`base`	the base with respect to which logarithms are computed. Defaults to *e*.
`n`	sample size.
`m`	degree of freedom of the variance estimation of the log-transformed data.
`d`	standardized variance of the sampling distribution of the log-transformed data.

Details

Consider a parametric function in the original scale we are interested in estimating $\theta(a, b) = exp(a\mu + b\sigma^2/2)$,where constants *a* and *b* are known. Specifically, $\theta(1, 1)$ is the mean of the lognormal distribution, $\theta(2, 4)$ is the second moment, $\theta(2, 4) - \theta(2, 2)$ is the variance, and $(\theta(0, 2) - 1)^{1/2}$ is the coeficient of variation.

1. `unbiased`: Unbiased estimator (Finney, 1941)
2. `qml`: Quasi maximum likelihood estimator
3. `ml`: Maximum likelihood estimator
4. `sa`: Simple adjustment estimator

5. `f`: Finney's unbiased estimator (Finney, 1941)
6. `z`: Zellner's estimator (Zellner, 1971)
7. `es`: Evans and Shaban's estimator (Evans and Shaban, 1974, 1976)
8. `r-s`: Rukhin's simple estimator (Rukhin, 1986)
9. `r-f`: Rukhin's estimator using Finney's function (Rukhin, 1986)
10. `r-lo`: Rukhin's locally optimal estimator (Rukhin, 1986)
11. `r-b`: Rukhin's Bayes estimator (Rukhin, 1986)
12. `ev`: El-Shaarawi and Viveros' estimator (El-Shaarawi and Viveros, 1997)
13. `zh`: Zhou's estimator (Zhou, 1998)
14. `sz-mm`: Shen and Zhu's MM estimator (Shen and Zhu, 2008)
15. `sz-mb`: Shen and Zhu's MB estimator (Shen and Zhu, 2008)
16. `l-ub`: Longford's UB estimator (Longford, 2009)
17. `l-ms`: Longford's MS estimator (Longford, 2009)
18. `ft`: Fabrizi and Trivisano's Simplified Bayes estimator (Fabrizi and Trivisano, 2012)
19. `ft-s`: Fabrizi and Trivisano's Simplified Bayes estimator (Fabrizi and Trivisano, 2012)
20. `ft-b`: Fabrizi and Trivisano's Bayes estimator (Fabrizi and Trivisano, 2012)
21. `gt-f`: Gou and Tamhane's estimator using Finney's function (Gou and Tamhane, 2017)
22. `gt-es`: Gou and Tamhane's estimator using Evans and Shaban's function (Gou and Tamhane, 2017)
23. `gt-r`: Gou and Tamhane's estimator using Rukhin's function (Gou and Tamhane, 2017)
24. `zg-1`: Zhang and Gou's first estimator (Zhang and Gou, 2020)
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42. `zg-19`: Zhang and Gou's nineteenth estimator (Zhang and Gou, 2020)

Value

estimated mean. .

Author(s)

Jiangtao Gou

References

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Evans, I. G. and Shaban, S. A. (1974). A note on estimation in lognormal models. *Journal of the American Statistical Association*, **69**: 779-781. <https://doi.org/10.2307/2286017>

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El-Shaarawi, A. H. and Viveros, R. (1997). Inference about the mean in log-regression with environmental applications. *Environmetrics*, **8**: 569-582. <https://doi.org/10.1002/(SICI)1099-095X(199709/10)8:5<569::AID-ENV274>3.0.CO;2-I>

Shen, H. and Zhu, Z. (2008). Efficient mean estimation in log-normal linear models. *Journal of Statistical Planning and Inference*, **138**: 552-567. <https://doi.org/10.1016/j.jspi.2006.10.016>

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Fabrizi, E. and Trivisano, C. (2012). Bayesian estimation of log-normal means with finite quadratic expected loss. *Bayesian Analysis*, **7**: 975-996. <https://doi.org/10.1214/12-BA733>

Gou, J. and Tamhane, A. C. (2017). Estimation of a parametric function associated with the lognormal distribution. *Communications in Statistics - Theory and Methods* **46**: 8134-8154. <https://doi.org/10.1080/03610926.201

Zhang, F. and Gou, J. (2020). A unified framework for estimation in lognormal models. Technical Report.

Examples

```
library(fuel)
# Unbiased Estimation (Finney, 1941)
fuel::lognormalmean(data=c(1,4,6,7), estimator='unbiased')
# Longford's estimator, minimize the mean squared error (Longford, 2009)
fuel::lognormalmean(data=c(1,4,6,7), estimator='l-ms')
# Gou and Tamhane's estimator, Rukhin type (Gou and Tamhane, 2017)
fuel::lognormalmean(data=c(1,4,6,7), estimator='gt-r')
# Zhang and Gou's No.4 estimator (Zhang and Gou, 2020)
fuel::lognormalmean(data=c(1,4,6,7), estimator='zg-4')
```

`lognormalmedian` *Median Estimation for Lognormal Distribution*

Description

Lognormal models are also widely applied in various branches of natural, social and applied sciences. Given a pair of known constants in the parametric function for the statistics in the lognormal distribution, sample size, degree of freedom of the variance estimation of the log-transformed data, standardized variance of the sampling distribution of the log-transformed data, mean of the log-transformed data and standard deviation of the log-transformed data, this function returns an estimation for the lognormal distribution, including a total of thirty-nine different estimation methods, under a newly proposed unified framework in Zhang and Gou (2020).

Usage

```
lognormalmedian(
  data,
  estimator,
  base = exp(1),
  n = length(data),
  m = n - 1,
  d = 1/n
)
```

Arguments

`data`	original data vector
`estimator`	a total of thirty-eight different estimation methods. See more descriptions in Section Details.
`base`	the base with respect to which logarithms are computed. Defaults to *e*.
`n`	sample size.
`m`	degree of freedom of the variance estimation of the log-transformed data.
`d`	standardized variance of the sampling distribution of the log-transformed data.

Details

Consider a parametric function in the original scale we are interested in estimating $\theta(a, b) = exp(a\mu+b\sigma^2/2)$,where constants *a* and *b* are known. Specifically, $\theta(1, 1)$ is the mean of the lognormal distribution, $\theta(2, 4)$ is the second moment, $\theta(2, 4)-\theta(2, 2)$ is the variance, and $(\theta(0, 2)-1)^{1/2}$ is the coeficient of variation.

1. `unbiased`: Unbiased estimator (Finney, 1941)
2. `qml`: Quasi maximum likelihood estimator
3. `ml`: Maximum likelihood estimator
4. `sa`: Simple adjustment estimator

5. `f`: Finney's unbiased estimator (Finney, 1941)
6. `z`: Zellner's estimator (Zellner, 1971)
7. `es`: Evans and Shaban's estimator (Evans and Shaban, 1974, 1976)
8. `r-s`: Rukhin's simple estimator (Rukhin, 1986)
9. `r-f`: Rukhin's estimator using Finney's function (Rukhin, 1986)
10. `r-lo`: Rukhin's locally optimal estimator (Rukhin, 1986)
11. `r-b`: Rukhin's Bayes estimator (Rukhin, 1986)
12. `ev`: El-Shaarawi and Viveros' estimator (El-Shaarawi and Viveros, 1997)
13. `zh`: Zhou's estimator (Zhou, 1998)
14. `sz-mm`: Shen and Zhu's MM estimator (Shen and Zhu, 2008)
15. `sz-mb`: Shen and Zhu's MB estimator (Shen and Zhu, 2008)
16. `l-ub`: Longford's UB estimator (Longford, 2009)
17. `l-ms`: Longford's MS estimator (Longford, 2009)
18. `ft`: Fabrizi and Trivisano's Simplified Bayes estimator (Fabrizi and Trivisano, 2012)
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20. `ft-b`: Fabrizi and Trivisano's Bayes estimator (Fabrizi and Trivisano, 2012)
21. `gt-f`: Gou and Tamhane's estimator using Finney's function (Gou and Tamhane, 2017)
22. `gt-es`: Gou and Tamhane's estimator using Evans and Shaban's function (Gou and Tamhane, 2017)
23. `gt-r`: Gou and Tamhane's estimator using Rukhin's function (Gou and Tamhane, 2017)
24. `zg-1`: Zhang and Gou's first estimator (Zhang and Gou, 2020)
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Value

estimated median. .

Author(s)

Jiangtao Gou

References

Finney, D. J. (1941). On the distribution of a variate whose logarithm is normally distributed. Supplement to the *Journal of the Royal Statistical Society*, **7**: 155-161. <https://doi.org/10.2307/2983663>

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Examples

```
library(fuel)
# Unbiased Estimation (Finney, 1941)
fuel::lognormalmedian(data=c(1,4,6,7), estimator='unbiased')
# Longford's estimator, minimize the mean squared error (Longford, 2009)
fuel::lognormalmedian(data=c(1,4,6,7), estimator='l-ms')
# Gou and Tamhane's estimator, Rukhin type (Gou and Tamhane, 2017)
fuel::lognormalmedian(data=c(1,4,6,7), estimator='gt-r')
# Zhang and Gou's No.4 estimator (Zhang and Gou, 2020)
fuel::lognormalmedian(data=c(1,4,6,7), estimator='zg-4')
```

lognormalsd *Standard Deviation Estimation for Lognormal Distribution*

Description

Lognormal models are also widely applied in various branches of natural, social and applied sciences. Given a pair of known constants in the parametric function for the statistics in the lognormal distribution, sample size, degree of freedom of the variance estimation of the log-transformed data, standardized variance of the sampling distribution of the log-transformed data, mean of the log-transformed data and standard deviation of the log-transformed data, this function returns an estimation for the lognormal distribution, including a total of thirty-nine different estimation methods, under a newly proposed unified framework in Zhang and Gou (2020).

Usage

```
lognormalsd(
  data,
  estimator,
  base = exp(1),
  n = length(data),
  m = n - 1,
  d = 1/n
)
```

Arguments

data	original data vector
estimator	a total of thirty-eight different estimation methods. See more descriptions in Section Details.
base	the base with respect to which logarithms are computed. Defaults to *e*.
n	sample size.
m	degree of freedom of the variance estimation of the log-transformed data.
d	standardized variance of the sampling distribution of the log-transformed data.

Details

Consider a parametric function in the original scale we are interested in estimating $\theta(a, b) = exp(a\mu + b\sigma^2/2)$,where constants *a* and *b* are known. Specifically, $\theta(1, 1)$ is the mean of the lognormal distribution, $\theta(2, 4)$ is the second moment, $\theta(2, 4) - \theta(2, 2)$ is the variance, and $(\theta(0, 2) - 1)^{1/2}$ is the coeficient of variation.

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15. `sz-mb`: Shen and Zhu's MB estimator (Shen and Zhu, 2008)
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19. `ft-s`: Fabrizi and Trivisano's Simplified Bayes estimator (Fabrizi and Trivisano, 2012)
20. `ft-b`: Fabrizi and Trivisano's Bayes estimator (Fabrizi and Trivisano, 2012)
21. `gt-f`: Gou and Tamhane's estimator using Finney's function (Gou and Tamhane, 2017)
22. `gt-es`: Gou and Tamhane's estimator using Evans and Shaban's function (Gou and Tamhane, 2017)
23. `gt-r`: Gou and Tamhane's estimator using Rukhin's function (Gou and Tamhane, 2017)
24. `zg-1`: Zhang and Gou's first estimator (Zhang and Gou, 2020)
25. `zg-2`: Zhang and Gou's second estimator (Zhang and Gou, 2020)
26. `zg-3`: Zhang and Gou's third estimator (Zhang and Gou, 2020)
27. `zg-4`: Zhang and Gou's fourth estimator (Zhang and Gou, 2020)
28. `zg-5`: Zhang and Gou's fifth estimator (Zhang and Gou, 2020)
29. `zg-6`: Zhang and Gou's sixth estimator (Zhang and Gou, 2020)
30. `zg-7`: Zhang and Gou's seventh estimator (Zhang and Gou, 2020)
31. `zg-8`: Zhang and Gou's eighth estimator (Zhang and Gou, 2020)
32. `zg-9`: Zhang and Gou's ninth estimator (Zhang and Gou, 2020)
33. `zg-10`: Zhang and Gou's tenth estimator (Zhang and Gou, 2020)
34. `zg-11`: Zhang and Gou's eleventh estimator (Zhang and Gou, 2020)
35. `zg-12`: Zhang and Gou's twelveth estimator (Zhang and Gou, 2020)
36. `zg-13`: Zhang and Gou's thirteenth estimator (Zhang and Gou, 2020)
37. `zg-14`: Zhang and Gou's fourteenth estimator (Zhang and Gou, 2020)
38. `zg-15`: Zhang and Gou's fifteenth estimator (Zhang and Gou, 2020)
39. `zg-16`: Zhang and Gou's sixteenth estimator (Zhang and Gou, 2020)
40. `zg-17`: Zhang and Gou's seventeenth estimator (Zhang and Gou, 2020)
41. `zg-18`: Zhang and Gou's eighteenth estimator (Zhang and Gou, 2020)
42. `zg-19`: Zhang and Gou's nineteenth estimator (Zhang and Gou, 2020)

Value

estimated standard deviation. .

Author(s)

Jiangtao Gou

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Examples

```
library(fuel)
# Unbiased Estimation (Finney, 1941)
fuel::lognormalsd(data=c(1,4,6,7), estimator='unbiased')
# Longford's estimator, minimize the mean squared error (Longford, 2009)
fuel::lognormalsd(data=c(1,4,6,7), estimator='l-ms')
# Gou and Tamhane's estimator, Rukhin type (Gou and Tamhane, 2017)
fuel::lognormalsd(data=c(1,4,6,7), estimator='gt-r')
# Zhang and Gou's No.4 estimator (Zhang and Gou, 2020)
fuel::lognormalsd(data=c(1,4,6,7), estimator='zg-4')
```

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