Package ‘auRoc’

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Title Various Methods to Estimate the AUC

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Author Dai Feng [aut, cre], Damjan Manevski [auc], Maja Pohar Perme [auc]

Description Estimate the AUC using a variety of methods as follows:
(1) frequentist nonparametric methods based on the Mann-Whitney statistic or kernel methods.
(2) frequentist parametric methods using the likelihood ratio test based on higher-order asymptotic results, the signed log-likelihood ratio test, the Wald test, or the approximate "t" solution to the Behrens-Fisher problem.
(3) Bayesian parametric MCMC methods.

Maintainer Dai Feng <daifeng.stat@gmail.com>

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R topics documented:

`auc.nonpara.kernel` *AUC by Kernel Methods*

Description

Obtain the point estimate and the confidence interval of the AUC using kernel methods.

Usage

```
auc.nonpara.kernel(x, y, conf.level=0.95,
                   integration=c("FALSE","TRUE"),
                   bw=c("nrd0", "sj"), nint=512,
                  method=c("mw", "jackknife", "bootstrapP", "bootstrapBCa"),
                   nboot)
```

Arguments

`x`	a vector of observations from class P.
`y`	a vector of observations from class N.
`conf.level`	confidence level of the interval. The default is 0.95.
`integration`	a logical value. If its value is `FALSE` then the results are based on the kernel estimates of the CDF; otherwise the PDF. The default values is `FALSE`.
`bw`	method used for bandwidth selection. `nrd0` uses a rule-of-thumb for choosing the bandwidth of a Gaussian kernel density estimation; `sj` uses the method of Sheather & Jones (1991). The default if `nrd0`.
`nint`	the number of equally spaced points at which the density is to be estimated. The default if 512.
`method`	a method used to construct the CI. `mw` uses the sd based on the Mann-Whitney statistic; `jackknife` uses the jackknife method; `bootstrapP` uses the bootstrap with percentile CI; `bootstrapBCa` uses bootstrap with bias-corrected and accelerated CI. The default is `mw`. It can be abbreviated.
`nboot`	number of bootstrap iterations.

Details

The AUC essentially depends on the CDFs of two classes N and P. We could use kernel smoothing methods to obtain the CDFs. The methods implemented in this function construct the CI based on two different strategies: the first uses kernel smoothing to estimate the PDFs and then the CDFs; and the second starts from the estimate of the CDFs directly. Gaussian kernel is used.

Value

Point estimate and lower and upper bounds of the CI of the AUC.

Note

The observations from class P tend to have larger values then that from class N.

Author(s)

Dai Feng

References

Dai Feng, Giuliana Cortese, and Richard Baumgartner (2015) A comparison of confidence/credible interval methods for the area under the ROC curve for continuous diagnostic tests with small sample size. *Statistical Methods in Medical Research* DOI: 10.1177/0962280215602040

Simon Sheather and Michael Jones (1991) A reliable data-based bandwidth selection method for kernel density estimation. *Journal of the Royal Statistical Society. Series B (Methodological)* **53** 683-690

Examples

```
  #Example 1
  data(petBrainGlioma)
  y <- subset(petBrainGlioma, grade==1, select="FDG", drop=TRUE)
  x <- subset(petBrainGlioma, grade==2, select="FDG", drop=TRUE)
  auc.nonpara.kernel(x, y)


  ## Not run:
  #Example 2
  data(petBrainGlioma)
  y <- subset(petBrainGlioma, grade==1, select="ACE", drop=TRUE)
  x <- subset(petBrainGlioma, grade==2, select="ACE", drop=TRUE)
  auc.nonpara.kernel(x, y, integration="TRUE",
                     bw="sj",  method="bootstrapBCa", nboot=999)

## End(Not run)
```

`auc.nonpara.mw` *AUC Based on the Mann-Whitney Statistic*

Description

Obtain the point estimate and the confidence interval of the AUC by various methods based on the Mann-Whitney statistic.

Usage

```
auc.nonpara.mw(x, y, conf.level=0.95,
               method=c("newcombe", "pepe", "delong", "DL.corr",
                        "jackknife", "bootstrapP", "bootstrapBCa"),
               nboot)
```

Arguments

`x`	a vector of observations from class P.
`y`	a vector of observations from class N.
`conf.level`	confidence level of the interval. The default is 0.95.
`method`	a method used to construct the CI. `newcombe` is the method recommended in Newcombe (2006); `pepe` is the method proposed in Pepe (2003); `delong` is the method proposed in Delong et al. (1988); `DL.corr` is a method proposed in Perme and Manevski (2018); `jackknife` uses the jackknife method; `bootstrapP` uses the bootstrap with percentile CI; `bootstrapBCa` uses bootstrap with bias-corrected and accelerated CI. The default is `newcombe`. It can be abbreviated.
`nboot`	number of bootstrap iterations.

Details

The function implements various methods based on the Mann-Whitney statistic.

Value

Point estimate and lower and upper bounds of the CI of the AUC.

Note

The observations from class P tend to have larger values then that from class N.

Author(s)

Dai Feng, Damjan Manevski, Maja Pohar Perme

References

Elizabeth R Delong, David M Delong, and Daniel L Clarke-Pearson (1988) Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics* **44** 837-845

Dai Feng, Giuliana Cortese, and Richard Baumgartner (2017) A comparison of confidence/credible interval methods for the area under the ROC curve for continuous diagnostic tests with small sample size. *Statistical Methods in Medical Research* **26(6)** 2603-2621 DOI: 10.1177/0962280215602040

Robert G Newcombe (2006) Confidence intervals for an effect size measure based on the Mann-Whitney statistic. Part 2: asymptotic methods and evaluation. *Statistics in Medicine* **25(4)** 559-573

Margaret Sullivan Pepe (2003) The statistical evaluation of medical tests for classification and prediction. *Oxford University Press*

Maja Pohar Perme and Damjan Manevski (2018) Confidence intervals for the Mann-Whitney test. *Statistical Methods in Medical Research* DOI: 10.1177/0962280218814556

Examples

```
data(petBrainGlioma)
y <- subset(petBrainGlioma, grade==1, select="FDG", drop=TRUE)
x <- subset(petBrainGlioma, grade==2, select="FDG", drop=TRUE)
auc.nonpara.mw(x, y)
auc.nonpara.mw(x, y, method="delong")
```

---

auc.para.bayes *AUC by the Bayesian MCMC*

Description

Obtain the point estimate and the credible interval of the AUC using the Bayesian MCMC.

Usage

```
auc.para.bayes(x, y, conf.level=0.95,
               dist=c("normalDV", "normalEV", "exponential"),
               nburn=1000, niter=10000, nthin=1, seed=100)
```

Arguments

`x`	a vector of observations from class P.
`y`	a vector of observations from class N.
`conf.level`	confidence level of the interval. The default is 0.95.
`dist`	the name of a parametric distribution. `normalEV` stands for normal distributions with equal variance; `normalDV` stands for normal distributions with unequal variances; `exponential` stands for exponential distributions. The default is `normalDV`. It can be abbreviated.
`nburn`	number of burn-in. The default is 1000.
`niter`	number of iterations. The default is 10000.
`nthin`	number of thinnng interval. The default is 1.
`seed`	the seed. The default is 100.

Details

Use the Bayesian MCMC to estimate the parameters of the distributions and hence the AUC values.

Value

Point estimate and lower and upper bounds of the CI of the AUC.

Note

The observations from class P tend to have larger values then that from class N.

Author(s)

Dai Feng

References

Dai Feng, Giuliana Cortese, and Richard Baumgartner (2015) A comparison of confidence/credible interval methods for the area under the ROC curve for continuous diagnostic tests with small sample size. *Statistical Methods in Medical Research* DOI: 10.1177/0962280215602040

Examples

```
#Example 1
data(petBrainGlioma)
y <- subset(petBrainGlioma, grade==1, select="FDG", drop=TRUE)
x <- subset(petBrainGlioma, grade==2, select="FDG", drop=TRUE)
auc.para.bayes(x, y, dist="exp")


#Example 2
data(petBrainGlioma)
y <- subset(petBrainGlioma, grade==1, select="ACE", drop=TRUE)
x <- subset(petBrainGlioma, grade==2, select="ACE", drop=TRUE)
auc.para.bayes(x, y, dist="normalDV")
```

---

auc.para.frequentist *AUC by Frequentist Parametric Methods*

Description

Obtain the point estimate and the confidence interval of the AUC using some frequentist parametric methods.

Usage

```
auc.para.frequentist(x, y, conf.level=0.95,
                     dist=c("normalDV", "normalEV", "exponential"),
                     method=c("lrstar", "lr", "wald", "RG1", "RG2"))
```

Arguments

`x`	a vector of observations from class P.
`y`	a vector of observations from class N.
`conf.level`	confidence level of the interval. The default is 0.95.
`dist`	the name of a parametric distribution. `normalEV` stands for normal distributions with equal variance; `normalDV` stands for normal distributions with unequal variances; `exponential` stands for exponential distributions. The default is `normalDV`. It can be abbreviated.
`method`	a method used to construct the CI. `lrstar` uses the likelihood ratio test based on higher-order asymptotic results; `lr` uses the signed log-likelihood ratio test; `wald` uses the Wald test; `RG1` is the approximate "t" solution to the Behrens-Fisher problem; `RG2` is the normal approximation to `RG1`. `RG1` and `RG2` are for normal distributions. The default is `lrstar`. It can be abbreviated.

Details

Use a variety of frequentist methods for different parametric models to estimate the AUC.

Value

Point estimate and lower and upper bounds of the CI of the AUC.

Note

The observations from class P tend to have larger values then that from class N.

Author(s)

Dai Feng

References

Giuliana Cortese and Laura Ventura (2013) Accurate higher-order likelihood inference on P(Y < X). *Computational Statistics* **28(3)** 1035-1059

Dai Feng, Giuliana Cortese, and Richard Baumgartner (2015) A comparison of confidence/credible interval methods for the area under the ROC curve for continuous diagnostic tests with small sample size. *Statistical Methods in Medical Research* DOI: 10.1177/0962280215602040

Benjamin Reiser and Irwin Guttman (1986) Statistical inference for Pr(Y < X): The normal case. *Technometrics* **28(3)** 253-257

Examples

```
#Example 1
data(petBrainGlioma)
y <- subset(petBrainGlioma, grade==1, select="FDG", drop=TRUE)
x <- subset(petBrainGlioma, grade==2, select="FDG", drop=TRUE)
auc.para.frequentist(x, y, dist="exp")
```

```
#Example 2
data(petBrainGlioma)
y <- subset(petBrainGlioma, grade==1, select="ACE", drop=TRUE)
x <- subset(petBrainGlioma, grade==2, select="ACE", drop=TRUE)
auc.para.frequentist(x, y, method="RG1")
```

`petBrainGlioma` *Standard Uptake Value (SUV) for Brain Glioma Grading*

Description

SUVs from FDG PET and ACE PET used in differentiating brain tumors.

Usage

```
petBrainGlioma
```

Format

A data-frame presenting the SUVs.

Source

Tatsuro Tsuchida, Hiroaki Takeuchi, Hidehiko Okazawa, Tetsuya Tsujikawa, and Yasuhisa Fujibayashi (2008) Grading of brain glioma with 1-^{11}C-acetate PET: comparison with ^{18}F-FDG PET. *Nuclear medicine and biology* **35(2)** 171-176

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