# Package: auRoc (via r-universe)

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**Title** Various Methods to Estimate the AUC

**Version** 0.2-1

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**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.

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**Depends** R (>= 3.0.2), rjags (>= 3-11), ProbYX(>= 1.1)

**Imports** coda(>= 0.16-1), MBESS(>= 3.3.3)

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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*

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## 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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