Package 'dmetatools'

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Type Package

Title Computational Tools for Meta-Analysis of Diagnostic Accuracy Test

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Description Computational tools for meta-analysis of diagnostic accuracy test. Bootstrap-based computational methods of the confidence interval for AUC of summary ROC curve and some related AUC-based inference methods are available (Noma et al. (2021) <doi:10.1080/23737484.2021.1894408>).

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Contents

dmetatools-package *The 'dmetatools' package.*

Description

Computational tools for meta-analysis of diagnostic accuracy test. Bootstrap-based computational methods of the confidence interval for AUC of summary ROC curve and some related AUC-based inference methods are available.

Author(s)

Hisashi Noma <noma@ism.ac.jp>

References

Noma, H., Matsushima, Y., and Ishii, R. (2021). Confidence interval for the AUC of SROC curve and some related methods using bootstrap for meta-analysis of diagnostic accuracy studies. *Communications in Statistics: Case Studies and Data Analysis* **7**: 344-358. doi:10.1080/23737484.2021.1894408

asthma *Korevaar et al. (2015)'s data of minimally invasive markers for detection of airway eosinophilia in asthma*

Description

- `TP`: A vector of the number of true positives (TP)
- `FP`: A vector of the number of false positives (FP)
- `FN`: A vector of the number of false negatives (FN)
- `TN`: A vector of the number of true negatives (TN)

Usage

```
data(asthma)
```

Format

A data frame with 12 rows and 4 variables

References

Korevaar, D. A., Westerhof, G. A., Wang, J., et al. (2015). Diagnostic accuracy of minimally invasive markers for detection of airway eosinophilia in asthma: a systematic review and meta-analysis. *Lancet Respiratory Medicine.* **3**: 290-300. doi:10.1016/S22132600(15)000508

Noma, H., Matsushima, Y., and Ishii, R. (2021). Confidence interval for the AUC of SROC curve and some related methods using bootstrap for meta-analysis of diagnostic accuracy studies. *Communications in Statistics: Case Studies and Data Analysis* **7**: 344-358. doi:10.1080/23737484.2021.1894408

`AUC_boot` *Confidence interval for AUC of summary ROC curve*

Description

Calculating the confidence interval for AUC of summary ROC curve by parametric bootstrap.

Usage

```
AUC_boot(TP, FP, FN, TN, B=2000, alpha=0.95)
```

Arguments

`TP`	A vector of the number of true positives (TP)
`FP`	A vector of the number of false positives (FP)
`FN`	A vector of the number of false negatives (FN)
`TN`	A vector of the number of true negatives (TN)
`B`	The number of bootstrap resampling (default: 2000)
`alpha`	The confidence level (default: 0.95)

Value

The confidence interval for AUC of summary ROC curve is calculated.

- `AUC`: The AUC of the summary ROC curve.
- `AUC_CI`: The 95% confidence interval for the AUC of the summary ROC curve (the confidence level can be changed by `alpha`).

Author(s)

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References

Noma, H., Matsushima, Y., and Ishii, R. (2021). Confidence interval for the AUC of SROC curve and some related methods using bootstrap for meta-analysis of diagnostic accuracy studies. *Communications in Statistics: Case Studies and Data Analysis* **7**: 344-358. doi:10.1080/23737484.2021.1894408

Examples

```
require(mada)

data(cervical)

CT <- cervical[cervical$method==1,]
LAG <- cervical[cervical$method==2,]
MRI <- cervical[cervical$method==3,]

fit1 <- reitsma(CT)    # DTA meta-analysis using the Reitsma model
summary(fit1)
fit2 <- reitsma(LAG)
summary(fit2)
fit3 <- reitsma(MRI)
summary(fit3)

plot(fit1)    # Plot the SROC curves
lines(sroc(fit2), lty=2, col="blue")
ROCellipse(fit2, lty=2, pch=2, add=TRUE, col="blue")
lines(sroc(fit3), lty=3, col="red")
ROCellipse(fit3, lty=3, pch=3, add=TRUE, col="red")
points(fpr(CT), sens(CT), cex = .5)
points(fpr(LAG), sens(LAG), pch = 2, cex = 0.5, col="blue")
points(fpr(MRI), sens(MRI), pch = 3, cex = 0.5, col="red")
legend("bottomright", c("CT", "LAG", "MRI"), pch = 1:3, lty = 1:3, col=c("black","blue","red"))

AUC_boot(CT$TP,CT$FP,CT$FN,CT$TN,B=5)
AUC_boot(LAG$TP,LAG$FP,LAG$FN,LAG$TN,B=5)
AUC_boot(MRI$TP,MRI$FP,MRI$FN,MRI$TN,B=5)
# These are example commands for illustration. B should be >= 1000.
```

`AUC_comparison` *Bootstrap test for the difference of AUCs of summary ROC curves for multiple diagnostic tests*

Description

Calculating the difference of AUCs of summary ROC curves (`dAUC`) and its confidence interval, and the p-value for the test of "`dAUC=0`" by parametric bootstrap.

Usage

```
AUC_comparison(TP1, FP1, FN1, TN1, TP2, FP2, FN2, TN2, B=2000, alpha=0.05)
```

Arguments

`TP1`	A vector of the number of true positives (TP) of test 1
`FP1`	A vector of the number of false positives (FP) of test 1

FN1	A vector of the number of false negatives (FN) of test 1
TN1	A vector of the number of true negatives (TN) of test 1
TP2	A vector of the number of true positives (TP) of test 2
FP2	A vector of the number of false positives (FP) of test 2
FN2	A vector of the number of false negatives (FN) of test 2
TN2	A vector of the number of true negatives (TN) of test 2
B	The number of bootstrap resampling (default: 2000)
alpha	The significance level (default: 0.05)

Value

The AUCs of the summary ROC curves and their confidence intervals are calculated. Also, the difference of the AUCs (dAUC) and its confidence interval, and the p-value for the test of "dAUC=0" are provided.

- AUC1: The AUC of the summary ROC curve for test 1.
- AUC1_CI: The 95% confidence interval for the AUC of the summary ROC curve for test 1 (the confidence level can be changed by alpha).
- AUC2: The AUC of the summary ROC curve for test 2.
- AUC2_CI: The 95% confidence interval for the AUC of the summary ROC curve for test 2 (the confidence level can be changed by alpha).
- dAUC: The difference of the AUC1 and AUC2.
- dAUC_CI: The 95% confidence interval for dAUC (the confidence level can be changed by alpha).
- pvalue: The p-value of the test of dAUC=0.

Author(s)

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References

Noma, H., Matsushima, Y., and Ishii, R. (2021). Confidence interval for the AUC of SROC curve and some related methods using bootstrap for meta-analysis of diagnostic accuracy studies. *Communications in Statistics: Case Studies and Data Analysis* **7**: 344-358. doi:10.1080/23737484.2021.1894408

Examples

```
require(mada)

data(cervical)

CT <- cervical[cervical$method==1,]
LAG <- cervical[cervical$method==2,]
MRI <- cervical[cervical$method==3,]
```

```
fit1 <- reitsma(CT)    # DTA meta-analysis using the Reitsma model
summary(fit1)
fit2 <- reitsma(LAG)
summary(fit2)
fit3 <- reitsma(MRI)
summary(fit3)

plot(fit1)    # Plot the SROC curves
lines(sroc(fit2), lty=2, col="blue")
ROCellipse(fit2, lty=2, pch=2, add=TRUE, col="blue")
lines(sroc(fit3), lty=3, col="red")
ROCellipse(fit3, lty=3, pch=3, add=TRUE, col="red")
points(fpr(CT), sens(CT), cex = .5)
points(fpr(LAG), sens(LAG), pch = 2, cex = 0.5, col="blue")
points(fpr(MRI), sens(MRI), pch = 3, cex = 0.5, col="red")
legend("bottomright", c("CT", "LAG", "MRI"), pch = 1:3, lty = 1:3, col=c("black","blue","red"))

AUC_comparison(CT$TP,CT$FP,CT$FN,CT$TN,LAG$TP,LAG$FP,LAG$FN,LAG$TN,B=5)
AUC_comparison(MRI$TP,MRI$FP,MRI$FN,MRI$TN,LAG$TP,LAG$FP,LAG$FN,LAG$TN,B=5)
AUC_comparison(MRI$TP,MRI$FP,MRI$FN,MRI$TN,CT$TP,CT$FP,CT$FN,CT$TN,B=5)
# These are example commands for illustration. B should be >= 1000.
```

AUC_IF *Influence diagnostics based on the AUC of summary ROC curve*

Description

Influence diagnostics based on AUC of the summary ROC curve by leave-one-out analysis. The threshold to determine influential outlying study is computed by parametric bootstrap.

Usage

```
AUC_IF(TP, FP, FN, TN, B=2000, alpha=0.95)
```

Arguments

TP	A vector of the number of true positives (TP)
FP	A vector of the number of false positives (FP)
FN	A vector of the number of false negatives (FN)
TN	A vector of the number of true negatives (TN)
B	The number of bootstrap resampling (default: 2000)
alpha	The error level to be calculated for the bootstrap interval of deltaAUC (default: 0.95)

Value

Influence diagnostic statistics based on the AUC of the summary ROC curve. The output is sorted by the absolute size of `deltaAUC`.

- `AUC`: The AUC of the summary ROC curve.
- `id`: identification number.
- `AUC(-i)`: The AUC estimate if `i`th study is excluded.
- `deltaAUC`: The difference of AUC estimates for all study and for the subpopulation that `i`th study is excluded.
- `Q1`: Default 2.5th percentile of the bootstrap distribution of `deltaAUC` (can be changed by `alpha`).
- `Q2`: Default 97.5th percentile of the bootstrap distribution of `deltaAUC` (can be changed by `alpha`).

Author(s)

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References

Noma, H., Matsushima, Y., and Ishii, R. (2021). Confidence interval for the AUC of SROC curve and some related methods using bootstrap for meta-analysis of diagnostic accuracy studies. *Communications in Statistics: Case Studies and Data Analysis* **7**: 344-358. doi:10.1080/23737484.2021.1894408

Examples

```
require(mada)

data(asthma)

fit1 <- reitsma(asthma)    # DTA analysis using the Reitsma model
summary(fit1)

plot(fit1) # Plot the SROC curves
points(fpr(asthma), sens(asthma), cex = .5)

attach(asthma)
AUC_IF(TP, FP, FN, TN, B=2)    # Influential analysis based on the AUC
detach(asthma)
# This is an example command for illustration. B should be >= 1000.
```

`cervical` *Scheidler et al. (1997)'s cervical cancer data*

Description

- `id`: identification number
- `author`: The first author name of the corresponding study
- `year`: The published year of the corresponding study
- `method`: The diagnostic method; 1=CT (computed tomography), 2=LAG (lymphangiography), 3=MRI (magnetic resonance imaging)
- `TP`: A vector of the number of true positives (TP)
- `FP`: A vector of the number of false positives (FP)
- `FN`: A vector of the number of false negatives (FN)
- `TN`: A vector of the number of true negatives (TN)

Usage

```
data(cervical)
```

Format

A data frame with 44 rows and 8 variables

References

Scheidler, J., Hricak, H., Yu, K. K., Subak, L., and Segal, M. R. (1997). Radiological evaluation of lymph node metastases in patients with cervical cancer. A meta-analysis. *JAMA* **278**: 1096-1101.

Reitsma, J. B., Glas, A. S., Rutjes, A. W., Scholten, R. J., Bossuyt, P. M., and Zwinderman, A. H. (2005). Bivariate analysis of sensitivity and specificity produces informative summary measures in diagnostic reviews. *Journal of Clinical Epidemiology* **58**: 982-990. doi:10.1016/j.jclinepi.2005.02.022

Noma, H., Matsushima, Y., and Ishii, R. (2021). Confidence interval for the AUC of SROC curve and some related methods using bootstrap for meta-analysis of diagnostic accuracy studies. *Communications in Statistics: Case Studies and Data Analysis* **7**: 344-358. doi:10.1080/23737484.2021.1894408

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