Package ‘NestMRMC’

October 21, 2022

Title Single Reader Between-Cases AUC Estimator in Nested Data

Version 1.0

Description This R package provides a calculation of between-cases AUC estimate, corresponding covariance, and variance estimate in the nested data problem. Also, the package has the function to simulate the nested data. The calculated between-cases AUC estimate is used to evaluate the reader's diagnostic performance in clinical tasks with nested data. For more details on the above methods, please refer to the paper by H Du, S Wen, Y Guo, F Jin, BD Gallas (2022) <doi:10.1177/09622802221111539>.

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License Encoding UTF-8

LazyData true

RoxygenNote 7.2.1

Imports magrittr, dplyr, mvtnorm, iMRMC, Rcpp

LinkingTo Rcpp

Depends R (>= 3.5.0)

NeedsCompilation yes

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**AUC_per_reader_nest**

Function for calculating 2 reader AUC covariance

**Description**

Function for calculating 2 reader AUC covariance

**Usage**

AUC_cov_2reader_nest(success_score)

**Arguments**

- **success_score**: The success score for nested data

**Value**

the covariance between two readers’ AUC

---

**AUC_per_reader_nest**

MRMC analysis in nested data problem

**Description**

This function takes nested data as a data frame and runs a multi-reader multi-case analysis for single reader in nested data problem based on modified U-statistics as described in the following paper:

**Usage**

AUC_per_reader_nest(data)

**Arguments**

- **data**: The nested data for analysis. This dataset should have specified columns: "patient","reader1","reader2","reader3","reader4","reader5","truth","mod","region".
This function returns a list containing three dataframes.

Here is a quick summary:

**AUC_per_reader [data.frame]** this data frame contains the AUC estimates for each reader under different modalities (Mod1 denotes modality 1 and Mod2 denotes modality 2).

**AUC_Var_per_reader [data.frame]** this data frame contains the AUC variance estimates for each reader under different modalities.

**numROI [data.frame]** this data frame contains the number of positive and negative ROIs in each case.

### Examples

```r
data = NestMRMC::expected_data
Outputs = AUC_per_reader_nest(data)
```

### Description

covariance 8th moment middle calculation part one

### Usage

cov_m8_f1(m)

### Arguments

- **m**: input matrix

### Value

the middle values for calculating covariance 8th moment
cov_m8_f2  covariance 8th moment middle calculation part two

Description

covariance 8th moment middle calculation part two

Usage

cov_m8_f2(m)

Arguments

m  input matrix

Value

the middle values for calculating covariance 8th moment

data_MRMC  Simulation function

Description

Simulation function

Usage

data_MRMC(sim.config)

Arguments

sim.config  list contains following parameters: I num The number of patients. k num The number of ROIs in each patient. R num The number of readers. correlation_t num The correlation for simulating truth label. potential_correlation_s num The correlation for simulating reading scores. AUC_all num The theoretical AUC values. sameclustersize boolean The binary variable to decide whether we have same number of ROIs in each patient. rho num The scale parameter that influence the covariance matrix in multivariate normal distribution. fix_design boolean Binary variable to decide whether fix the truth label in simulation. stream num The integer control the random number generator.

Value

A list and the only element in the list is the simulated data with following columns: "clusterID","unitID","reader1",...,"truth"
delete_diag

Description
Delete diagonal term function

Usage
delete_diag(m)

Arguments
m the input matrix for deleting diagonal term

Value
diagonal term removed matrix

expected_data The test demo data to be included in my package

Description
The test demo data to be included in my package

Author(s)
Hongfei Du <hongfei@gwu.edu>

m11_f function for calculating the 11th moment

Description
function for calculating the 11th moment

Usage
m11_f(m)

Arguments
m input matrix

Value
the 11th moment
m8_f  
*function for calculating the 8th moment*

**Description**

function for calculating the 8th moment

**Usage**

```r
m8_f(m)
```

**Arguments**

- `m`: input matrix

**Value**

the 8th moment

---

**simu_config**  
*Configuration function*

**Description**

Configuration function

**Usage**

```r
simu_config(
  I = 100,
  k = 10,
  R = 2,
  correlation_t = 0,
  potential_correlation_s = rep(0.5, 4),
  AUC_all = rep(0.7, 2),
  sameclustersize = TRUE,
  rho = 0.5,
  fix_design = FALSE,
  stream = 20220210,
  initial_seed = 20220222
)
```
success_score

Arguments

I  The number of patients.
k  The number of ROIs in each patient.
R  The number of readers.
correlation_t  The correlation for simulating truth label.
potential_correlation_s  The correlation for simulating reading scores.
AUC_all  The theoretical AUC values.
sameclustersize  The binary variable to decide whether we have same number of ROIs in each patient.
rho  The scale parameter that influence the covariance matrix in multivariate normal distribution.
fix_design  Binary variable to decide whether fix the truth label in simulation.
stream  The integer control the random number generator.
initial_seed  The integer control the random seed for truth label generation.

Value

A list of above parameters

| success_score | Calculate the success score |

Description

Calculate the success score

Usage

success_score(data)

Arguments

data  the nested MRMC data

Value

The success score and number of ROIs in each case
true_AUC_var_abitrary

Description

Calculate the between-cases AUC estimator’s theoretical variance and covariance

Usage

true_AUC_var_abitrary(
    numROI,
    AUC = 0.7,
    cov = 0.5,
    rho = 0.5,
    sigma_pos = 1,
    sigma_neg = 1
)

sum_diag

sum the diagonal terms

Description

sum the diagonal terms

Usage

sum_diag(m)

Arguments

m input matrix

Value

sum of diagonal terms
**true_AUC_var_abitrary_Rcpp**

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>numROI</td>
<td>The number of positive and negative ROIs in all the patients.</td>
</tr>
<tr>
<td>AUC</td>
<td>The AUC values used in simulated data.</td>
</tr>
<tr>
<td>cov</td>
<td>The covariance used in simulating reading scores.</td>
</tr>
<tr>
<td>rho</td>
<td>The scale factor used in simulating reading scores.</td>
</tr>
<tr>
<td>sigma_pos</td>
<td>The variance for positive ROI’s reading score, default is 1.</td>
</tr>
<tr>
<td>sigma_neg</td>
<td>The variance for negative ROI’s reading score, default is 1.</td>
</tr>
</tbody>
</table>

**Value**

The theoretical AUC estimator’s (co)variance based on the simulation settings.

**true_AUC_var_abitrary_Rcpp**

*Calculate the between-cases AUC estimator’s theoretical variance and covariance*

**Description**

This function calculates between-cases AUC estimator’s theoretical variance and covariance based on all the truths, namely, the ROI’s truth labels, AUC values, covariance between ROI scores within same reader, scale factor that influences the covariance between ROI scores between readers and the variances for positive and negative ROI scores. Detailed formulas are available in following paper: Single Reader Between-Cases AUC Estimator with Nested Data. Statistical Methods in Medical Research. [https://doi.org/10.1177/09622802221111539](https://doi.org/10.1177/09622802221111539). There is also a none Rcpp version of this function in this package. The function name is ‘true_AUC_var_abitrary’, which is slower but no need to install Rcpp. They produce the exact same results.

**Usage**

```r
true_AUC_var_abitrary_Rcpp(
    numROI, AUC = 0.7, cov = 0.5, rho = 0.5, sigma_pos = 1, sigma_neg = 1
)
```

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>numROI</td>
<td>The number of positive and negative ROIs in all the patients.</td>
</tr>
<tr>
<td>AUC</td>
<td>The AUC values used in simulated data.</td>
</tr>
<tr>
<td>cov</td>
<td>The covariance used in simulating reading scores.</td>
</tr>
<tr>
<td>rho</td>
<td>The scale factor used in simulating reading scores.</td>
</tr>
<tr>
<td>sigma_pos</td>
<td>The variance for positive ROI’s reading score, default is 1.</td>
</tr>
<tr>
<td>sigma_neg</td>
<td>The variance for negative ROI’s reading score, default is 1.</td>
</tr>
</tbody>
</table>
Value

The theoretical AUC estimator’s (co)variance based on the simulation settings.

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var_coef

*Calculate the each moments coefficient in variance*

---

Description

Calculate the each moments coefficient in variance

Usage

`var_coef(numROI)`

Arguments

- `numROI`: number of ROIs in each case

Value

- all the coefficients
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