

Package ‘subscore’

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Title Computing Subscores in Classical Test Theory and Item Response Theory

Version 2.0

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Description Functions for computing subscores for a test using different methods in both classical test theory (CTT) and item response theory (IRT). This package enables three sets of subscore methods within the framework of CTT and IRT: Wainer's augmentation method, Haberman's three subscore methods, and Yen's objective performance index (OPI). The package also includes the function to compute Proportional Reduction of Mean Squared Errors (PRMSEs) in Haberman's methods which are used to examine whether test subscores are of added value.

Depends CTT, stats, irtoys

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CTTsub	<i>This main function estimates true subscores using different methods based on original CTT scores.</i>
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Description

This function estimates true subscores using methods introduced in Haberman (2008), and Wainer et al. (2001).

Usage

```
CTTsub(test.data, method = "Haberman")
```

Arguments

test.data	A list that contains item responses of all subtests and the total test, which can be obtained using function 'data.prep'.
method	Subscore estimation methods. method="Haberman" (by default) represents the three methods propose by Harberman (2008). method="Wainer" represents Wainer's augmented method.

Value

summary	Summary of estimated subscores (e.g., mean, sd).
PRMSE	(a) PRMSE values of estimated subscores (for Haberman's methods only).(b) Decisions on whether subscores have added value - added.value.s (or added.value.sx) = 1 means subscore.s (or subscore.sx) has added value, and added.value.s (or added.value.sx) = 0 vice versa.
subscore.original	Original subscores and total score.
estimated.subscores	Subscores computed using selected method. Three sets of subscores will be returned if method = "Haberman".

References

Haberman, S. J. (2008). "When can subscores have value?." *Journal of Educational and Behavioral Statistics*, 33(2), 204-229.

Wainer, H., Vevea, J., Camacho, F., Reeve, R., Rosa, K., Nelson, L., Swygert, K., & Thissen, D. (2001). "Augmented scores - "Borrowing strength" to compute scores based on small numbers of items" In Thissen, D. & Wainer, H. (Eds.), *Test scoring* (pp.343 - 387). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Examples

```

# Transferring original scored data to a list format
# that can be used in other functions.
test.data<-data.prep(scored.data,c(3,15,15,20))
#-----
# Estimating subscores using Haberman's methods
CTTsub(test.data,method="Haberman") # Estimating subscores using Haberman's methods

# Obtaining PRMSEs for the three methods
CTTsub(test.data,method="Haberman")$PRMSE

# Obtaining descriptive statistics summary for estimated subscores
CTTsub(test.data,method="Haberman")$summary

# Obtaining raw subscores
CTTsub(test.data,method="Haberman")$subscore.original

# Obtaining subscores that are estimated as a function of the observed subscores
CTTsub(test.data,method="Haberman")$subscore.s

# Obtaining subscores that are estimated as a function of the observed total score
CTTsub(test.data,method="Haberman")$subscore.x

# Obtaining subscores that are estimated as a function of
# both the observed subscores and the observed total score.
CTTsub(test.data,method="Haberman")$subscore.sx

#-----
# Estimating subscores using Wainer's method
CTTsub(test.data,method="Wainer")

# Obtaining descriptive statistics summary for subscores
CTTsub(test.data,method="Wainer")$summary

# Obtaining original subscores
CTTsub(test.data,method="Wainer")$subscore.original

# Obtaining subscores that are estimated using Wainer's augmentation method
CTTsub(test.data,method="Wainer")$subscore.augmented

```

data.prep

This function prepares data into a required list format

Description

This function generates a list of datasets using the scored original dataset, which can be used as objects in subscore computing functions.

Usage

```
data.prep(scored.data, subtest.infor)
```

Arguments

scored.data Original scored dataset with rows as individuals and columns as items.
subtest.infor A numerical vector. The first number indicates the number of subtests, followed by numbers of items on each subscale.

Value

A list that contains subscale responses and the total test response.

Examples

```
subtest.infor<-c(3,15,15,20)  
# This test consists of 3 subtests, which have 15, 15 and 20 items respectively.  
test.data<-data.prep(scored.data,subtest.infor)
```

scored.data	<i>Sample scored data</i>
-------------	---------------------------

Description

This dataset contains responses of 150 examinees to three subscales. These subscales consist of 15, 15, and 20 items respectively.

Usage

```
data("scored.data")
```

Format

A data frame with 150 observations on the following 50 variables.

V1 Item 1
V2 Item 2
V3 Item 3
V4 Item 4
V5 Item 5
V6 Item 6
V7 Item 7
V8 Item 8
V9 Item 9
V10 Item 10

V11 Item 11
V12 Item 12
V13 Item 13
V14 Item 14
V15 Item 15
V16 Item 16
V17 Item 17
V18 Item 18
V19 Item 19
V20 Item 20
V21 Item 21
V22 Item 22
V23 Item 23
V24 Item 24
V25 Item 25
V26 Item 26
V27 Item 27
V28 Item 28
V29 Item 29
V30 Item 30
V31 Item 31
V32 Item 32
V33 Item 33
V34 Item 34
V35 Item 35
V36 Item 36
V37 Item 37
V38 Item 38
V39 Item 39
V40 Item 40
V41 Item 41
V42 Item 42
V43 Item 43
V44 Item 44
V45 Item 45
V46 Item 46
V47 Item 47
V48 Item 48
V49 Item 49
V50 Item 50

Details

A dataset containing responses of 150 examinees to a total number of 50 items on three subscales (15, 15, 20 items respectively).

Examples

```
#read data
data(scored.data)
## maybe str(scored.data) ; plot(scored.data) ...
```

subscore.s	<i>Computing subscores using Haberman's method based on observed subscores.</i>
------------	---

Description

This function estimate true subscores based on observed subscores, using the method introduced by Haberman (2008).

Usage

```
subscore.s(test.data)
```

Arguments

test.data	A list that contains subscale responses and the total test responses. It can be obtained using the function 'data.prep'.
-----------	--

Value

summary	Summary of obtained subscores (e.g., mean, sd).
PRMSE	PRMSEs of obtained subscores (for Haberman's methods only).
subscore.original	Original subscores and total score.
subscore.s	Subscores that are estimated based on the observed subscore.

References

Haberman, S. J. (2008). "When can subscores have value?." *Journal of Educational and Behavioral Statistics*, 33(2), 204-229.

Examples

```
# Transferring scored response data to the required list format
test.data<-data.prep(scored.data,c(3,15,15,20))

#Estimate true subscores using Hamerman's method based on observed subscores
subscore.s(test.data)

subscore.s(test.data)$summary
subscore.s(test.data)$PRMSE
subscore.s(test.data)$subscore.s
```

subscore.sx	<i>Computing subscores using Haberman's method based on both observed total scores and observed subscores.</i>
-------------	--

Description

This function estimate true subscores based on both observed stotal scores and observed subscores using the method introduced by Haberman (2008).

Usage

```
subscore.sx(test.data)
```

Arguments

test.data	A list that contains subscale responses and the total test responses. It can be obtained using the function 'data.prep'.
-----------	--

Value

summary	Summary of obtained subscores (e.g., mean, sd).
PRMSE	PRMSEs of obtained subscores (for Haberman's methods only).
subscore.original	Original observed subscores and total score.
subscore.sx	Subscores that are estimated based on both the observed total score and observed subscore.

References

Haberman, S. J. (2008). "When can subscores have value?." *Journal of Educational and Behavioral Statistics*, 33(2), 204-229.

Examples

```
test.data<-data.prep(scored.data,c(3,15,15,20))

subscore.sx(test.data)

subscore.sx(test.data)$summary
subscore.sx(test.data)$PRMSE
subscore.sx(test.data)$subscore.sx
```

subscore.Wainer *Estimating true subscores using Wainer's augmentation method*

Description

This function estimates subscores using Wainer's augmentation method (Wainer et. al., 2001). The central idea of this procedure is that, the estimation of subscores will be improved by shrinking the individual observed subscores towards some aggregate values (i.e., group mean subscores). The extent of the shrinkage depends on the closeness of the subscale being estimated with other subscales as well as reliabilities of all the subscales. Wainer's augmentation is a multivariate version of Kelly's formula (Kelly, 1947). For details of Wainer's augmentation subscoreing method, please refer to Wainer et al. (2001).

Usage

```
subscore.Wainer(test.data)
```

Arguments

`test.data` A list that contains datasets of all subtests and the total test, which can be obtained using function 'data.prep'.

Value

`summary` It contains statistical summary of the augmented subscores (mean, sd, and reliability).

`Augmented.subscores`
It contains augmented subscores that are obtained using Wainer's method.

References

Wainer, H., Vevea, J., Camacho, F., Reeve, R., Rosa, K., Nelson, L., Swygert, K., & Thissen, D. (2001). "Augmented scores - "Borrowing strength" to compute scores based on small numbers of items" In Thissen, D. & Wainer, H. (Eds.), *Test scoring* (pp.343 - 387). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Examples

```
test.data<-data.prep(scored.data,c(3,15,15,20))

subscore.Wainer(test.data)

subscore.Wainer(test.data)$summary
subscore.Wainer(test.data)$subscore.augmented
```

subscore.x	<i>Computing subscores using Haberman's method based on observed total scores.</i>
------------	--

Description

This function estimates true subscores based on observed total scores using the method introduced by Haberman (2008).

Usage

```
subscore.x(test.data)
```

Arguments

test.data	A list that contains subscale responses and the total test responses. It can be obtained using the function 'data.prep'.
-----------	--

Value

summary	Summary of obtained subscores (e.g., mean, sd).
PRMSE	PRMSEs of obtained subscores (for Haberman's methods only).
subscore.original	Original observed subscores and total score.
subscore.x	Subscores that are estimated based on the observed total score.

References

Haberman, S. J. (2008). "When can subscores have value?." *Journal of Educational and Behavioral Statistics*, 33(2), 204-229.

Examples

```
test.data<-data.prep(scored.data,c(3,15,15,20))

subscore.x(test.data)

subscore.x(test.data)$summary
subscore.x(test.data)$PRMSE
subscore.x(test.data)$subscore.x
```

test.data	<i>A list of objects that include both test information and subscores.</i>
-----------	--

Description

This list consists of four objects. The first three objects are item responses on the three subscales. The fourth object is the response data on the whole test.

Usage

```
data(test.data)
```

Format

The format is:

List of 4

\$ subtest.1 :'data.frame': 150 obs. of 15 variables:

\$ subtest.2 :'data.frame': 150 obs. of 15 variables:

\$ subtest.3 :'data.frame': 150 obs. of 20 variables:

\$ total.test:'data.frame': 150 obs. of 50 variables:

Details

Object 1: Responses of 150 participants to 15 items; Object 2: Responses of 150 participants to 15 items. Object 3: Responses of 150 participants to 20 items; Object 4: Responses of 150 participants to 20 items.

Examples

```
data(test.data)
```

Yen.OPI	<i>Estimating true subscores using Yen's OPI</i>
---------	--

Description

This function estimates subscores using Yen's Objective Performance Index (OPI; Yen, 1987). Yen's OPI (Yen, 1987) is a procedure combining Bayesian method and item response theory (IRT; Embretson & Reise, 2000; Reckase, 1997). This method pulls an examinee's performance on a certain objective (i.e., subscale) towards his/her total test performance in order to get a more stable and precise objective subscore estimate.

Usage

```
Yen.OPI(test.data)
```

Arguments

`test.data` A list that contains datasets of all subtests and the total test, which can be obtained using function `'data.prep'`.

Value

`summary` It contains statistical summary of OPI (mean & sd).
`OPI` Estimated OPI values

References

Embretson, S. E., & Reise, S. P. (2013). "Item response theory". Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Reckase, M. D. (1997). "The past and future of multidimensional item response theory". *Applied Psychological Measurement*, 21(1), 25-36.

Yen, W. M. (1987, June). "A Bayesian/IRT index of objective performance". Paper presented at annual meeting of the Psychometric Society, Montreal, Quebec, Canada.

Examples

```
test.data<-data.prep(scored.data,c(3,15,15,20))
```

```
Yen.OPI(test.data)
```

```
Yen.OPI(test.data)$summary
```

```
Yen.OPI(test.data)$OPI
```

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