Package 'AHPtools'

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Type Package

Title Consistency in the Analytic Hierarchy Process

Version 0.2.1

URL https://CRAN.R-project.org/package=AHPtools

Description A Swiss Army knife of utility functions for users of the Analytic
Hierarchy Process (AHP) which will help you to assess the consistency of a
PCM as well as to improve its consistency ratio, to compute the sensitivity
of a PCM, create a logical, not a random PCM, from the preferences you
provide for the alternatives, and a function that helps evaluate the actual
consistency of a PCM based on objective, fair bench marking. The various
functions in the toolkit additionally provide the flexibility to users to
specify only the upper triangular comparison ratios of the PCM in order to
performs its assigned task.

License GPL-3

Suggests knitr, rmarkdown, testthat (>= 3.0.0)

VignetteBuilder knitr

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Language en-US

RoxygenNote 7.2.3

NeedsCompilation no

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R topics documented:

CR   *Saaty CR Consistency*

Description

Computes and returns the Consistency Ratio for an input PCM and its boolean status of consistency based on Consistency Ratio

Usage

```
CR(PCM, typePCM = TRUE)
```

Arguments

PCM   A pairwise comparison matrix

typePCM   boolean flag indicating if the first argument is a PCM or a vector of upper triangular elements

Value

A list of 3 elements, a boolean for the 'CR' consistency of the input 'PCM', the 'CR' consistency value and the principal eigenvector

Examples

```
CR.pcm1 <- CR(matrix(
                c(1,1,7,1,1, 1,1,5,1,1/3, 1/7,1/5,1,1/7,1/8, 1,1,7,1,1,
                1,3,8,1,1), nrow=5, byrow=TRUE))
CR.pcm1
CR.pcm1a <- CR(c(1,7,1,1, 5,1,1/3, 1/7,1/8, 1), typePCM=FALSE)
CR.pcm1a
CR.pcm2 <- CR(matrix(
                c(1,1/4,1/4,7,1/5, 4,1,1,9,1/4, 4,1,1,8,1/4,
                1/7,1/9,1/8,1,1/9, 5,4,4,9,1), nrow=5, byrow=TRUE))
CR.pcm2
CR.pcm2a <- CR(c(1/4,1/4,7,1/5, 1,9,1/4, 8,1/4, 1/9),typePCM=FALSE)
CR.pcm2a
```

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createLogicalPCM	*Simulated Logical Pairwise Comparison Matrix for the Analytic Hierarchy Process*

Description

Creates a logical pairwise comparison matrix for the Analytic Hierarchy Process such as would be created by a rational decision maker based on a relative vector of preferences for the alternatives involved. Choices of the pairwise comparison ratios are from the Fundamental Scale and simulate a reasonable degree of error. The algorithm is modified from a paper by Bose, A [2022], doi: 10.1002/mcda.1784

Usage

```
createLogicalPCM(ord, prefVec = rep(NA, ord), granularityLow = TRUE)
```

Arguments

ord	The desired order of the Pairwise Comparison Matrix
prefVec	The preference vector of length as the order of the input matrix
granularityLow	The Scale for pairwise comparisons; default (TRUE) is the fundamental scale; else uses a more find grained scale, derived from pairwise ratios of the elements of the Fundamental Scale.

Value

A Logical Pairwise Comparison Matrix

Examples

```
lPCM <- createLogicalPCM(3,c(1,2,3));
lPCM <- createLogicalPCM(5,c(0.25,0.4,0.1,0.05,0.2));
```

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createPCM	*Create a Pairwise Comparison Matrix of order n for Analytic Hierarchy Process from a vector of length n(n-1)/2 comparison ratios*

Description

Create a Pairwise Comparison Matrix of order n from a vector of length n(n-1)/2 independent upper triangular elements

Usage

```
createPCM(vec)
```

Arguments

vec   The preference vector of length as the order of the 'PCM'

Value

A Pairwise Comparison Matrix corresponding to the upper triangular elements

Examples

```
PCM <- createPCM(c(1,2,0.5,3,0.5,2));
PCM <- createPCM(c(1,.5,2,1/3,4,2,.25,1/3,.5,1,.2,6,2,3,1/3));
```

---

improveCR   *Improve the CR consistency of a PCM*

Description

For an input pairwise comparison matrix, PCM that is inconsistent, this function returns a consistent
PCM if possible, with the relative preference for its alternatives as close as possible to the original
preferences, as in the principal right eigenvector.

Usage

```
improveCR(PCM, typePCM = TRUE)
```

Arguments

PCM   A pairwise comparison matrix

typePCM   boolean flag indicating if the first argument is a PCM or a vector of upper trian-
               gular elements

Value

A list of 4 elements, suggested PCM, a boolean for the CR consistency of the input PCM, the CR
consistency value, a boolean for the CR consistency of the suggested PCM, the CR consistency
value of the suggested PCM

Examples

```
CR.suggest2 <- improveCR(matrix(
                c(1,1/4,1/4,7,1/5, 4,1,1,9,1/4, 4,1,1,8,1/4,
                1/7,1/9,1/8,1,1/9, 5,4,4,9,1), nrow=5, byrow=TRUE))
CR.suggest2
CR.suggest2a <- improveCR(c(1/4,1/4,7,1/5, 1,9,1/4, 8,1/4, 1/9),
typePCM=FALSE)
CR.suggest2a
CR.suggest3 <- improveCR(matrix(
                c(1,7,1,9,8, 1/7,1,1/6,7,9, 1,6,1,9,9, 1/9,1/7,1/9,1,5,
                1/8,1/9,1/9,1/5,1), nrow=5, byrow=TRUE))
CR.suggest3
```

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revisedConsistency   *Evaluate Revised Consistency*

Description

This function returns the revised consistency classification for a PCM, evaluated by comparison with the threshold of consistency for intentional PCMs in the same preference heterogeneity quartile. The measure for inconsistency is the geometric mean of ratios in comparison with the corresponding benchmark PCM.

Usage

```
revisedConsistency(PCM, typePCM = TRUE)
```

Arguments

PCM   A pairwise comparison matrix

typePCM   boolean flag indicating if the first argument is a PCM or a vector of upper triangular elements

Value

A list of four elements, revCons = the revised consistency classification, inconGM = the Geometric Mean measure of inconsistency with the best 'PCM', dQrtl = the preference heterogeneity quartile for the normalized eigenvector, and diff = the preference heterogeneity measure

Examples

```
revCon1 <- revisedConsistency(matrix(
                c(1,1/4,1/4,7,1/5,  4,1,1,9,1/4,  4,1,1,8,1/4,
                1/7,1/9,1/8,1,1/9,  5,4,4,9,1), nrow=5, byrow=TRUE))
revCon1
revCon2 <- revisedConsistency(c(7,1,9,8, 1/6,7,9, 9,9, 5), typePCM=FALSE)
revCon2
```

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sensitivity   *Compute Sensitivity*

Description

This function returns a sensitivity measure for an input pairwise comparison matrix, PCM. Sensitivity is measured by Monte Carlo simulation of 500 PCMs which are perturbations of the input PCM. The perturbation algorithm makes a random choice from one of the 5 closest items in the Fundamental Scale {1/9, 1/8, ... 1/2, 1, 2, ... 8, 9} for each element in the PCM, ensuring the the pairwise reciprocity is maintained. The sensitivity measure is the average Spearman's rank correlation of the vector of ranks of the principal eigenvectors of (i) the input PCM and (ii) the perturbed PCM. The average of the 500 such rank correlations is reported as the measure of sensitivity.

Usage

```
sensitivity(PCM, typePCM = TRUE, granularityLow = TRUE)
```

Arguments

PCM	A pairwise comparison matrix
typePCM	boolean flag indicating if the first argument is a PCM or a vector of upper triangular elements
granularityLow	The Scale for pairwise comparisons; default (TRUE) is the fundamental scale; else uses a more find grained scale, derived from pairwise ratios of the elements of the Fundamental Scale.

Value

The average Spearman's rank correlation between the principal eigenvectors of the input and the perturbed 'PCMs'

Examples

```
revcons1 <- revisedConsistency(matrix(
                c(1,1/4,1/4,7,1/5, 4,1,1,9,1/4, 4,1,1,8,1/4,
                1/7,1/9,1/8,1,1/9, 5,4,4,9,1), nrow=5, byrow=TRUE))
revcons1
sensitivity2 <- sensitivity(matrix(
                c(1,7,1,9,8, 1/7,1,1/6,7,9, 1,6,1,9,9, 1/9,1/7,1/9,1,5,
                1/8,1/9,1/9,1/5,1), nrow=5, byrow=TRUE))
sensitivity2
```

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