

Homework assignment

L2: Reliability and measurement error

Assignment date: 9.10.2018
Deadline: 15.10.2018 23:59
Slides: <http://www.cs.cas.cz/martinkova/NMST570>
Note: Send answers and R script to drabinova@cs.cas.cz
Name:

1 Calculation of reliability

Ex. 1.1 Assume that true score $T \sim \mathcal{N}(5, 1)$ and error term $e \sim \mathcal{N}(0, 1)$ and T and e are independent. Observed score Y is defined as $Y = T + e$.

1. Calculate reliability using formula $\text{rel}(Y) = \text{corr}(Y, T)^2$. Provide whole calculation. [1.25pt]
2. Calculate reliability using formula $\text{rel}(Y) = \frac{\text{var}(T)}{\text{var}(Y)}$. Provide whole calculation. [0.75pt]
3. How does reliability change when $\text{var}(e) = 0.1$ and distribution of T remains unchanged? [0.25pt]
4. How does reliability change when $\text{var}(T) = 2$ and distribution of e remains the same? [0.25pt]

Ex. 1.2 Using R and following assignment of Exercise 1.1 create script to generate $T \sim \mathcal{N}(5, 1)$ and $e \sim \mathcal{N}(0, 1)$ of sample size 100. Use `set.seed(123)` for reproducibility and comment results. [0.75pt]

1. Calculate Y and estimate its reliability using both formulas, compare with theoretical results. [1pt]
2. How do results change when you increase sample size to 1,000? [0.25pt]

HINT: for generating from normal distribution use `rnorm()` function, see `?rnorm`.

Ex. 1.3 Test consists of 5 items and has reliability 0.7. Use Spearman-Brown formula

$$\text{rel}(X^*) = \frac{m \cdot \text{rel}(X)}{1 + (m - 1) \cdot \text{rel}(X)}$$

and answer following questions.

1. What would be the reliability if we use 10 items (equally precise, measuring the same construct)? Provide whole calculation. [0.5pt]
2. How many items (equally precise, measuring the same construct) would be necessary to increase reliability to 0.9? Provide whole calculation. [1.25pt]
3. Include calculation into R script. You may use `psychometric` package and its functions `SBrel()` and `SBlength()`. [0.5pt]

2 Reading

Ex. 2.1 Read following article and respond to questions:

http://www.statpol.cz/cs/wp-content/uploads/IB_4_2014.pdf

1. What negative consequences of low reliability are mentioned in the paper? [0.25pt]
2. What strategies can be used to increase reliability? [0.25pt]
3. What type of reliability can be described by Cronbach's alpha? [0.25pt]
4. Which cases of violation of assumptions are described in the paper? Which alternative approaches can be used in such cases? [0.25pt]

3 R code

Ex. 3.1 Download data available at

http://www.cs.cas.cz/drabinova/documents/HCI_test_retest.RData

and download following R script:

http://www.cs.cas.cz/drabinova/documents/NMST570_HW2.pdf

Run and if necessary modify R script and answer following questions. Some of the analyses can be run with **ShinyItemAnalysis**.

1. What is the value of Pearson correlation coefficient in test-retest analysis for HCI_test_retest data? Include also confidence interval. [0.5pt]
2. What are the estimates of reliability obtained by half-split methods on HCI data? Report also confidence intervals. [1.5pt]

Method	Estimate	Confidence interval
First-last		
Odd-even		
Random		
Revelle's β		
Average (10,000)		
Average (all)		

3. Calculate Cronbach's alpha. Include also confidence interval. [0.25pt]

4 Provide feedback

Here you can provide feedback on lecture, lab session and/or materials (slides, HW assignment, ShinyItemAnalysis manual) [1pt bonus] :)