

Homework assignment

L2: Reliability and measurement error

Assignment date: 13.10.2020
Deadline: 19.10.2020 23:59
Slides: <http://www.cs.cas.cz/martinkova/NMST570>
Note: Send answers and R script to hladka@cs.cas.cz and martinkova@cs.cas.cz (in CC)
Include NMST570 in subject of your e-mails
Name:

Lecture presentation

Watch lecture presentation (online Zoom, or video shared on course webpage) and provide answer(s) to question(s) posed in the presentation. Note that the question slide is not included in the PDF file shared on course webpage.

Reading with Perusall (alternative)

It is possible to skip up to 4 HW assignments and to provide satisfactory feedback (10 relevant annotations, each may gain up to 1 point) to readings instead (Chapter 3 and relevant R code this week).

1 Reading with Perusall

Provide 1 annotation in Czech or in English to assigned reading (Chapter 3 and relevant R code this week) [1pt].

2 Calculation of reliability

Ex. 2.1 Assume that true score $T \sim \mathcal{N}(5, 1)$ and error term $e \sim \mathcal{N}(0, 1)$ where T and e are independent. Observed score X is defined as $X = T + e$.

1. Calculate reliability using formula $\text{rel}(X) = \frac{\text{var}(T)}{\text{var}(X)}$. Provide whole calculation. [0.75pt]
HINT: Note that $\mathcal{N}(5, 1)$ is normal distribution with expectation of 5 and variance equalled to 1.
2. How does reliability change when $\text{var}(e) = 0.1$ and distribution of T remains unchanged? [0.5pt]
3. How does reliability change when $\text{var}(T) = 2$ and distribution of e remains the same? [0.5pt]

Ex. 2.2 Follow assignment of Exercise 3.1. and create an R script with the following parts. Use `set.seed(1)` for reproducibility.

1. Generate true score $T \sim \mathcal{N}(5, 1)$ and error term $e \sim \mathcal{N}(0, 1)$ of sample size 100. [0.75pt]
HINT: for generating from normal distribution use `rnorm()` function, see `?rnorm` for its help page.
2. Calculate observed score X and estimate its reliability using both formulas $\text{rel}(X) = \frac{\text{var}(T)}{\text{var}(X)}$ and $\text{rel}(X) = \text{cor}(X, T)^2$, compare with theoretical results and comment. [1.25pt]
HINT: use functions `var()` and `cor()` to compute variance and correlation.

3. How do results change when you increase sample size to 1,000 and 10,000? Why? [0.25pt]

Ex. 2.3 Test consists of 5 items and has reliability 0.7. Use Spearman-Brown formula

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

where $m = \frac{\text{number of items in new data}}{\text{number of items in original data}}$, and answer the following questions.

1. What would be the reliability if we use 10 items (equally precise, measuring the same construct)? Provide whole calculation. [0.75pt]
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. [0.5pt]
HINT: You may use `psychometric` package and its functions `SBrel()` and `SBlength()`. See Spearman-Brown formula tab of Reliability section in `ShinyItemAnalysis` for sample R code.

3 R code

Ex. 3.1 Download data available at

https://github.com/patriciamar/psychometrics_intro/blob/master/datasets/HCI/HCI_test_retest.rda

and download R script:

http://www.cs.cas.cz/hladka/documents/NMST570_HW2.R

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

1. What is the value of Pearson correlation coefficient between total scores form test and retest datasets? Include also confidence interval. [0.5pt]
2. What are the estimates of reliability obtained by half-split methods for test and retest datasets? [1.5pt]

Method	Test	Retest
First-last		
Odd-even		
Random		
Average (10,000)		
Average (all)		
Worst		

3. Calculate Cronbach's alpha for test and retest datasets. Include also confidence intervals. [0.5pt]

4 Provide feedback

Here you can provide feedback on lecture, lab session and/or materials (slides, video presentation, HW assignment, `ShinyItemAnalysis` application, etc.) [1pt bonus] :)