Homework assignment

L2: Reliability and measurement error

Assignment date:	**08.10.2019**
Deadline:	**14.10.2019 23:59**
Slides:	http://www.cs.cas.cz/martinkova/NMST570
Note:	Send answers and `R` script to hladka@cs.cas.cz
Name:	

1 Calculation of reliability

Ex. 1.1 Assume that true score $T \sim \mathcal{N}(5, 1)$ and error term $e \sim \mathcal{N}(0, 1)$ 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. [0.5pt]

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. 1.2 Follow assignment of Exercise 1.1. and create `R` script with 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`.
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()`.

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

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

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

where $m = \frac{\text{number of items in new data}}{\text{number of items in original data}}$, 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. [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.

2 R code

Ex. 2.1 Download data available at

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

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. [0.25pt]

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)		
Revelle's β		

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

3 Reading

Ex. 3.1 Read following article and respond to questions:

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

1. What negative consequences of low reliability are mentioned in the paper? [0.5pt]

2. What strategies can be used to increase reliability? [0.5pt]

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? [0.5pt]

4 Provide feedback

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