Selected topics in psychometrics

NMST570 (1/1 C+Ex, 3 credits)

Instructor:	Patrícia Martinková, Ph.D.
Lectures:	Tuesday, 3:40 – 4:30pm, room K9, Sokolovská 83, Praha 2
Lab sessions:	Tuesday, 4:30 – 5:10pm, room K9, Sokolovská 83, Praha 2
Online:	Link for ZOOM sessions will be sent to registered students via e-mail
Course webpage:	www.cs.cas.cz/martinkova/NMST570.html
Last update:	October 11, 2022

Course description

Psychometrics uses statistical models for analysis of educational, psychological, or patient-reported measurements. This course covers computational aspects of main topics in psychometrics, including reliability and validity of measurement, traditional item analysis, use of regression models for item description, item response theory (IRT) models, differential item functioning (DIF), computerized adaptive testing (CAT), and an overview of further topics. Methods are demonstrated using data of behavioral measurements from different areas. Exercises are prepared in freely available statistical software R, other psychometric software is also introduced.

Tentative outline

- Introduction, measurement data
- Validity
- Reliability and measurement error
- Traditional item analysis
- Regression models for item description
- Item response theory models
- Differential item functioning
- Factor analytic approach to measurement data
- Computerized adaptive testing
- Further topics in psychometrics.

Course goals

After taking this course you should be able to:

1. Name and discuss the main topics studied in psychometrics, understand the underlying statistical models.
2. Describe and apply strategies to find proofs about validity of assessment instrument. Explain how different statistical tests can be utilised in validation studies.
3. Describe and apply strategies to find proofs about reliability of assessment instrument. Understand the differences between different computational methods for estimation of variance components.
4. Describe and apply traditional methods to describe item functioning (difficulty, discrimination, distractor analysis).
5. Explain how different regression models may be used to describe item properties, apply regression models on real data and interpret results.
6. Describe how exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) can be used on measurement data, explain connections with IRT models.
7. Formulate IRT models for binary, polytomous and nominal items (Rasch model, 1-4 parameter IRT model, graded response model, generalized partial credit model, rating scale model, nominal response model), apply these models on real data and interpret results.
8. Explain concept of differential item functioning, describe and apply some DIF detection methods (Mantel-Haenszel test, logistic regression, IRT-based Lord's test, Raju's test etc.).
9. Explain process of computerized adaptive testing, prepare your own adaptive test.
10. Describe process of assessment development and validation and apply its steps in real situations.

Course texts

- Martinková, P. & Hladká, A. Computational aspects of psychometric methods. With R. (Book in preparation)
- Rao, C. R. & Sinharay S. (2006). Handbook of statistics. Volume 26: Psychometrics. Amsterdam, NL: Elsevier.
- van der Linden, W. J. (2016). Handbook of item response theory: Models, statistical tools, and applications (Vols.1-3). Boca Raton, FL: Chapman & Hall/CRC.

Grading policy

Each week, students are expected to be actively present in lecture (45 minutes), and lab session (45 minutes). Lecture may take form of a Zoom meeting and/or video presentation and/or individual work on assignment. Lab session provides hints and solutions for homework assignments which will involve calculations, software implementation, and reading. Part of the assignments will ask students to annotate readings using perusall.com.

Course credit requirements
The credit for the exercise class will be awarded to the student who hands in satisfactory solutions to homework assignments by the prescribed deadline. Homework will be assigned during lab sessions and will be due by the end of the week.

Exam/Grade
Final project will be assigned during the course. Students can work in teams of size 2 or 3, multidisciplinary teams are preferred. Teams are welcome and encouraged to use their own data for the project in lieu of the data assigned to the class. In such a case, teams are expected to prepare written project proposal and submit it to the lecturer during the first month of the course. Final grade will be assigned during oral examination, which will take into account submitted project report (40%), homework assignments (40%, one HW with lowest grade is being dropped), and answers to follow-up question(s) (20%). Project report needs to be submitted at least 2 days before oral exam, one feedback is provided to projects sent to the instructor at least two weeks before the oral exam.