An Introduction to Psychometric Theory with Applications in R
A short course

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Abstract

Psychometrics is that area of psychology that specializes in how to measure what we talk and think about. It is how to assign numbers to observations in a way that best allows us to summarize our observations in order to advance our knowledge. Although in particular it is the study of how to measure psychological constructs, the techniques of psychometrics are applicable to most problems in measurement. The measurement of intelligence, extraversion, severity of crimes, or even batting averages in baseball are all grist for the psychometric mill. Any set of observations that are not perfect exemplars of the construct of interest is open to questions of reliability and validity and to psychometric analysis.

Although it is possible to make the study of psychometrics seem dauntingly difficult, in fact the basic concepts are straightforward. This "short course" is an attempt to introduce the fundamental concepts in psychometric theory so that the reader will be able to understand how to apply them to real data sets of interest. It is not meant to make one an expert, but merely to instill confidence and an understanding of the fundamentals of measurement so that the reader can better understand and contribute to the research enterprise.

The links throughout this syllabus are to a) chapters in a draft text text book (Revelle, in prep) as well as a set of slides.

A longer version of this syllabus is here.

1 Introduction to Psychometrics and to R

An overview of psychometrics and this course.

1.1 Theory of Data, Issues in Scaling

Theory of Data and issues in scaling.

1.2 R functions used

- `read.clipboard`
- `describe`
- Package vignettes

2 More than you ever wanted to know about correlation

2.1 Lecture notes

Correlation and Regression.
A review of linear algebra.

2.2 R functions used

- `cor`
- `scale`
- `lm`
- `lowerCor`
- `corr.test`
- `cor.plot`
- `mat.regress`
- `polychoric`

3 Dimension reduction through factor analysis, principal components analyze and cluster analysis

3.1 Lecture notes

EFA/PCA.

3.2 R functions used

- `fa`
- `principal`
- `fa.diagram`
- `fa.parallel`
- `vss`
- `fa.congruence`
- `fa.extend`
- `iclust`

4 Classical Test Theory and Item Response Theory

4.1 Lecture notes

Classical theory and Item response theory.

4.2 R functions used

- `alpha`
- `scoreItems`
- `omega`
- `irt.fa`

5 Structural Equation Modeling and applied scale construction

5.1 Lecture notes

Structural Equation Modeling.

5.2 R functions used

- *lavaan*
- *sem*

6 Putting it all together

The notes from the last session have been expanded to give a demonstration of how to analyze two sets of items, This includes describing the data, estimating the number of factors to extract using parallel analysis as well as Very Simple Structure, and then factoring the data using the raw data or using polychoric/tetrachoric correlation matrices. Scores for the subjects are found using conventional scoring algorithms, as well as item response based scoring.

6.1 Lecture notes

Applied scale construction.

6.2 R functions used

- `describe`
- `fa.parallel`
- `fa.parellel.poly`
- `alpha`
- `scoreItems`
- `omega`
- `irt.fa`