Scaling and Dimensional Analysis
2019 ICPSR Summer Program
Daily, 1:00–3:00 p.m.

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Course Description

This course is aimed at aiding social scientists in better measuring the phenomena they are interested in. Though scientists of all stripes recognize measurement as a fundamental and crucial step of the scientific process, the topic is rarely given formal attention in core graduate courses beyond a cursory treatment of the concepts of reliability and validity.

We will begin by discussing a theory of data that can be used to aid researchers in determining the most appropriate and useful scaling methodologies to apply to their data. From here, we will engage psychometric philosophies of measurement, which will eventually introduce participants to basic unidimensional scaling models. The assessment, and ultimate reduction, of dimensionality via principal components, factor, and latent class analysis will round out the second core section of the course. Finally, we will consider a host of methodologies useful for representing substantively interesting characteristics of data in multiple dimensions, and, in particular, providing spatial, or geometric, visualizations of those characteristics. These methodologies include classical multidimensional scaling, weighted multidimensional scaling, multidimensional unfolding, and multidimensional preference scaling.

NB: A great deal of credit is owed to Bill Jacoby, whose long-running course of the same name inspired much of the structure and content of this iteration of the course. Many thanks are also owed to Dave Armstrong, who provided a wealth of materials upon which some lectures and assignments are heavily based.

Course Prerequisites & Software Considerations

Participants should be familiar, and comfortable, with basic descriptive statistics and linear models (i.e., OLS regression). Familiarity with matrix algebra and maximum likelihood estimation will serve participants well, but is not required for participation or necessary for participants to understand course material.
Most software programs include routines for executing most of the techniques we will discuss in class, though none is perfect. In an effort to keep the focus of course on the substantive material, code to execute most methodologies in the R statistical computing environment will be made available to participants. I am happy to work with students who are most familiar with Stata or SPSS outside of class.

Course Materials

There is no required textbook for this course. This is partially because much of the material we will be exploring can be learned from more accessible (i.e., free!) journal articles. The class schedule below provides a lengthy list of such articles, organized by topic. The lack of a textbook is at least equally due to the fact that there really is no single text that addresses all of the topics we will be considering, at least not in the way we will be covering them.

Those caveats aside, there are a few excellent textbooks that cover several of the topics we will be addressing. In order of utility to this course, by my estimation, starting with most useful:


Some less comprehensive texts that pop up over the course of at least a couple of topics are:


Texts that may help in conducting analyses in R:


**Course Requirements**

Though the ICPSR Summer Program is most concerned with providing participants with the practical tools necessary to aid their own research, formal evaluations of course performance will be made at the end of the session. Depending on how the course unfolds, 4-5 assignments designed to provide participants an opportunity to apply the methodologies discussed in class will be administered.

Participants who are required to obtain, or are otherwise expecting, a formal letter grade must complete all assignments and alert the teaching assistant that they are requesting a letter grade. Other participants are encouraged to complete and submit the assignments, though no letter grade will be administered upon completion of the course. Assignments will be graded primarily for effort and completion.

**Class Schedule**

**Basics of Data and Measurement**

I. Data Theory & “Scaling”


II. Dimensionality

III. Measurement


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**Measurement Theory & Unidimensional Scaling**

I. Classical Test Theory & Reliability


II. The Summated Rating Model


- Applications:


  Most papers that have “scales” or “indexes”...
III. Guttman and Mokken Scaling


- Applications:


IV. Item Response Theory


- Applications:


V. The Unfolding Model


- Applications:


Assessing (and Reducing) Dimensionality

I. Singular Value Decomposition and the Biplot


- Applications:


II. Principal Components Analysis


- Applications:


**III. (Common) Factor Analysis**


- Applications:


IV. Multiple Correspondence Analysis & Nonlinear PCA


• Applications:


V. Latent Class Analysis (will discuss only briefly)


• Applications:


  Bakker, Ryan, Christopher Hare, Robert N. Lupton, and Keith T. Poole. “Crowded Coalitions: Internal Party Divisions in the American Mass Public”
Multidimensional Scaling

I. Classical Multidimensional Scaling


Armstrong II et al. 2014. Pages 103-128.


• Applications:


II. Weighted Multidimensional Scaling


Armstrong II et al. 2014. Pages 132-143.

• Applications:


III. Multidimensional Unfolding

Armstrong II et al. (2014), Chapter 5.

Borg and Groenen (2005), Chapter 14.

- Applications:

  [https://voteview.com/](https://voteview.com/)


IV. The Vector Model of Unfolding


Lattin et al. 2003. Pages 244-252.


- Applications:

