

GESIS Summer School in Survey Methodology 2022

Syllabus for the course: “Sampling and Weighting in Survey Statistics”

Lecturer: Dr. Anne Konrad

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Date: 22-23 August 2022

Time: 09:00-12:00 | 13:30-16:30

Venue: Online via Zoom

About the Lecturer:

Anne Konrad is a postdoc at Trier University. She is involved in a research project with the Federal Statistical Office of Germany. Her research interests include samplings designs, weighting procedures, calibration estimators, household surveys, variance estimation, and rotational surveys. She taught the lecture “Weighting and calibration” at the University Trier.

Selected Publications:

- Konrad, A., Burgard, J. P., and Münnich, R. (2021): A Two-level GREG Estimator for Consistent Estimation in Household Surveys. *International Statistical Review*, 89(3), pp. 635-656.

Course Description:

Methods to analyze data taught in introductory statistics and econometric courses often rely on the assumption that the data are collected in a simple random sampling process. However, in practice rather complex sampling techniques are often used, such as stratification or clustering. In these cases, a weight has to be assigned to the sampled units to account for the sampling design. The course will cover methods to select random samples and weight the sampled units to infer from the single sample to the population. We will discuss the several steps in a weighting process including 1) obtaining the design weights to account for the random sample selection, 2) adjusting the design weights to compensate for nonresponse, and 3) adjusting the weights such that the sample estimates agree with known population totals. The focus of the course is on the intuition of the underlying theory and the statistical methods so that the participants can assess the appropriateness of the methods in their application by themselves. For the course, no prior knowledge on survey statistics is required, but the participants are expected to be comfortable with statistics and to have some experience with data analysis. We will do exercises in R that apply the techniques learned in the lecture. Participants will get the most out of the class if they have prior experience with R.

Keywords:

Sampling, Weighting, Estimation, Nonresponse, Calibration

Course Prerequisites:

- Introductory course in statistics. No prior knowledge of sampling theory is assumed.
- Prior knowledge of R is required.
- Basic understanding of survey methodology and how to handle survey data is helpful but not necessary.

Target Group:

Participants will find the course useful if:

- you have experience conducting surveys and/or analyzing survey data but have no experience with survey sampling and weighting.
- you plan your own survey and have to weight the collected data, or you are analyzing survey data.

Course and Learning Objectives:

By the end of the course participants will:

- know the most commonly used sampling designs including element sampling and multistage sampling (simple random sampling, stratified sampling, sampling proportional-to-size, cluster sampling, and related designs).
- know to compute design weights, how to compensate for nonresponse, and utilize external auxiliary information into the weighting process.
- understand how the sampling design affects the analysis of survey data.
- be able to assess the advantages and disadvantages of the different sampling designs and weighting methods.
- know how to apply the discussed methods in R.

Organizational Structure of the Course:

The course is organized as a mixture of lectures and exercises. Several examples will be given during the lecture to underpin the introduced theory. At the end of each topic, you will work on practical exercises to apply the discussed methods on your own. An in-depth solution for each exercise is provided and discussed afterwards.

Software and Hardware Requirements:

R and RStudio should be installed on participants' computers.

Day-to-day Schedule and Literature:

Day	Topic(s)
1	<p>Basic concepts in survey statistics</p> <ul style="list-style-type: none"> - Sampling process and sampling designs (simple random sampling, stratified sampling, sampling proportional-to-size, systematic sampling, cluster sampling, multistage sampling) - Estimation process (inclusion probabilities, approaches for statistical inference, Horvitz-Thompson estimator) - Quality measures <p>Importance of weights in survey sampling and statistical analysis</p> <ul style="list-style-type: none"> - Motivation of weighting - Weighting procedure <p><u>Suggested reading:</u></p> <ul style="list-style-type: none"> ▪ Chapter 2, 3, 5 and 6 in Lohr, S. L. (2009): Sampling: Design and Analysis. 2nd edition. Cengage. ▪ Lavallée, P. & Beaumont, J.-F. (2015): Why We Should Put Some Weight on Weights. <i>Survey Insights: Methods from the Field, Weighting: Practical Issues and 'How to' Approach, Invited article</i>, Retrieved from https://surveyinsights.org/?p=6255.
2	<p>GREG estimators</p> <ul style="list-style-type: none"> - Auxiliary variables - Motivation by assisting models <p>Calibration estimators</p> <ul style="list-style-type: none"> - Post-stratification

	<ul style="list-style-type: none"> - Raking estimator <p>Weight modification</p> <ul style="list-style-type: none"> - Calibration with bounds - Trimming <p>Nonresponse adjustment</p> <ul style="list-style-type: none"> - Nonresponse propensity weighting - Nonresponse adjustment via calibration
	<p><u>Suggested reading:</u></p> <ul style="list-style-type: none"> ▪ Chapter 13 and 14 in: Valliant, R., Dever, J. A., & Kreuter, F. (2013): Practical Tools for Designing and Weighting Survey Samples. Statistics for Social and Behavioral Sciences: Springer. ▪ Haziza, D. and Beaumont, J.-F. (2017): Construction of weights in surveys: A review. Statistical Science, 32(2):206–226.

Preparatory Reading:

Any introductory sampling text covering hypothesis testing, standard errors, confidence intervals.

Additional Recommended Literature:

- Kalton, G. and I. Flores-Cervantes (2003): Weighting Methods. Journal of Official Statistics 19(2): 81-97.
- Särndal, C.-E. (2007): The calibration approach in survey theory and practice. Survey Methodology, 33(2):99–119.
- Särndal, C.-E., Swensson, B., and Wretman, J. (1992): Model assisted survey sampling. Springer Science & Business Media.
- Deville, J.-C. and Särndal, C.-E. (1992): Calibration estimators in survey sampling. Journal of the American Statistical Association, 87(418):376–382.