



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Metodi per le Indagini Campionarie M

2021-1-F8204B007

Learning objectives

This course aims at providing the students with all the necessary notions to face statistical inference for finite populations. In the first part of the course, the teacher will introduce the most important sampling schemes for finite populations and he will define different kinds of estimators for means/totals. In the last part of the course some important applications will be discussed, with a special focus on the most recent techniques to privatize a dataset.

Contents

The first part of the course aims at providing the students with a solid theoretical background to face statistical inference for finite populations. More precisely the most important sampling schemes will be analyzed: simple random sampling, stratified, systematic, cluster sampling, multi-stage design, etc. Besides different kinds of estimators for means, totals and proportions will be defined and studied, among them we consider the ratio and regression estimators. In the second part of the course, some applications will be analyzed, among which the randomized response technique, disclosure risk assessment and differential privacy. _____

Detailed program

1. INTRODUCTION AND BASIC NOTIONS

Historical background, the difference between a sample survey and a census. The notion of population, sample, variable. The underlying probability space in a sample survey and the notion of sampling design. Non-probabilistic sampling schemes.

2. SIMPLE RANDOM SAMPLING WITHOUT REPLACEMENT

The Horvitz-Thompson estimator for the total for simple random sampling without replacement. Evaluation of the variance and the unbiased estimator. Hájek theorem (without proof) and the construction of asymptotic confidence

intervals. Estimators for means and proportions. The problem of sample size in simple random sampling.

3. SIMPLE RANDOM SAMPLING WITH REPLACEMENT

The Hansen-Hurwitz estimator: derivation in the general case. Analysis of the estimator for simple random sampling with replacement. The notion of design effect.

4. VARYING PROBABILITY SAMPLING

The variance of the Hansen-Hurwitz and the Horvitz-Thompson estimator. The notion of auxiliary variable. Different sampling schemes with varying probabilities.

5. STRATIFIED SAMPLING

The definition of the sampling scheme. Estimators for mean, total in the stratified sampling scheme. Optimum and proportional allocation. Poststratification.

6. RATIO ESTIMATOR

The use of auxiliary variables for defining different and more efficient estimators. The ratio estimator: definition, the method of linearization to estimate the variance, comparison with simple random sampling.

Ratio estimator for stratified random sampling.

Regression estimator: definition, variance.

8. CLUSTER AND MULTISTAGE SAMPLING

Cluster sampling: basic properties. The unbiased estimator and the ratio estimator in cluster sampling. The analysis of variance: variability within and across clusters, total variability of the population, the index of homogeneity within clusters.

Multistage design: definition, estimator of the total and evaluation of the variance.

9. APPLICATIONS

Disclosure risk assessment. Randomized response techniques. Differential Privacy.

10. NON-SAMPLING ERRORS

The notion of non-sampling errors.

The randomized response technique: Warner's and Simmons's methods.

Prerequisites

It is recommended the knowledge of the arguments of Mathematical Analysis and Statistics, taught during the bachelor degree.

Teaching methods

Traditional lessons and class exercises.

During the emergency Covid-19 the lessons will be live via Webex.

Assessment methods

The exam is divided in two parts: written and oral examination. In the written examination the student is asked to solve exercises. If the student passes the written exam, then she/he is admitted to the oral examination. The oral

exam will focus on a discussion of the written test, and on questions of the theory developed during the course. In the period of Covid emergency, the written and oral examination will be held via Webex and Esamionline.

Textbooks and Reading Materials

As for the first part, the following books are recommended:

- 1) S. Thompson. Sampling. Wiley, 2012.
- 2) G. Cicchitelli, A. Herzel, G.E. Montanari. Il campionamento statistico. Il Mulino, 1997.

As for the second part (disclosure risk assessment and differential privacy):

- 1) Dwork, C., Roth A. The Algorithmic foundations of Differential Privacy. 2014.
- 2) Papers suggested during the course.

Semester

Spring semester.

Teaching language

The lessons will be held in Italian.
