Methods and Theory of Sample Design
Biostatistics 617/Survey Methodology 617/Statistics 580/Sociology 717
Winter 2016
Survey 440
Spring 2016

Monday/Wednesday, 8:30-10a, G300 Perry

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Office Hours: Friday 10:30-11:30a or by appointment

Course Description: Theory underlying sample designs and estimation procedures commonly used in survey practice.


Other reading materials as provided.

Course Goals:

Methods and Theory of Sample Design is concerned with the theory underlying the widely used practical methods of survey sampling. It covers the basic techniques of simple random sampling, stratification, systematic sampling, cluster and multi-stage sampling, and probability proportional to size sampling; methods of variance estimation for complex sample designs, including the Taylor series expansion method, balanced repeated replications, and jackknife methods; and several specialized topics, including stratification and subclasses, multi-phase or double sampling, ratio and regression estimation, selection with unequal probabilities without replacement, non-response adjustments, and dual frame sampling. The course examines the nature of the techniques, practical applications, and the theory supporting the methods.
Competencies:

1. Learn the meaning and application of conditional expectation and conditional variance in deriving expressions for sampling variance of means and proportions under a variety of finite population sampling techniques.

2. Understand the properties of various sampling techniques including simple random sampling, stratification and stratified random sampling, cluster sampling, systematic sampling, two-stage sampling, multistage sampling, probability proportionate to size sampling, stratified multistage sampling, and two-phase sampling.

3. Understand how sampling variance for means and proportions are derived for each of the sampling techniques in the course, and derive procedures for complex statistics using the Taylor series expansion.

4. Learn how sampling variance is estimated for complex sample surveys, including using such techniques as balanced repeated replication, jackknife repeated replication, and the Taylor series expansion approximation, and when to apply each in practice.

5. Understand how calibrated and model assisted estimation can be used to improve the precision of survey estimates.

Course Requirements:

The course meets twice per week, starting at 8:40 AM and ending at 10:00 AM. Class time is devoted to lecture and discussion of homework and examination problems. Questions during lecture are welcomed. The instructor will either be in the classroom in College Park (CP) approximately one week per month, and will meet the other times in Ann Arbor (AA).

Course materials are on the course web site, including lecture notes, homework problems, and online readings. Students are responsible for printing copies for their own use.

Homework assignments will be provided approximately every two weeks during the semester. Homework is to be submitted electronically via the course web site ‘Assignment tool’ as an attachment. Solutions may be handwritten or typed, but submitted in a single .pdf format file, with name and homework number at the top of the first page, and page numbers at the bottom of each page. Files must be submitted with a standard name convention: ‘Surname First-Initial HW #.pdf’ (for example, ‘Elliott M HW 1.pdf’). Assignments are due on the date indicated at the start of the class session. Without prior arrangement, homework submitted after the due date will be considered late, and 20 points deducted for each day late. Study groups are useful, and encouraged,
for preparing answers to homework exercises; however group answers are not acceptable. Each student must submit individual homework solutions.

There will be two open-book open-notes in-class examinations, a mid-term and a final. Each cover all material discussed previously in the course. Students are advised to bring a calculator to the examinations; laptops will not be allowed.

Regular attendance and participation in this class is the best way to grasp the principles and applications discussed. In the event that a class must be missed due to an illness or other compelling reason, students must notify the instructor in advance of the class. If a student is absent on days when exams are scheduled or homework due, the student must make arrangements with the instructor in advance of the class session to reschedule the exam or submit the homework later than the due date. Video recordings will be made of each class for later viewing.

Grading will be as follows:

- 30% Homework (approximately every other week)
- 30% Midterm Exam
- 40% Final Exam
- 100%

**Academic Integrity:**

The course follows ethical standards at respective campuses. The faculty and staff of the University of Michigan School of Public Health believe that the conduct of a student registered or taking courses in the School should be consistent with that of a professional person. Courtesy, honesty, and respect should be shown by students toward faculty members, guest lecturers, administrative support staff, community partners, and fellow students. Similarly, students should expect faculty to treat them fairly, showing respect for their ideas and opinions and striving to help them achieve maximum benefits from their experience in the School.

Student academic misconduct refers to behavior that may include plagiarism, cheating, fabrication, falsification of records or official documents, intentional misuse of equipment or materials (including library materials), and aiding and abetting the perpetration of such acts. The University of Maryland Honor Code (http://www.president.umd.edu/policies/iii100a.html) is administered by the Student Honor Council. The Student Honor Council statement *I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination* ordinarily should be *handwritten* and signed on the front cover of all papers, projects, or other academic assignments submitted for evaluation in this course. The instructor waives this requirement for Maryland students, but not the other provisions of the Honor Code. The student name on a document is the student’s pledge that this is theirs and theirs alone. University of Michigan students should visit http://sph.umich.edu/student-resources/mph-mhsa.html for the full Policy on student
Student Well-Being:
SPH faculty and staff believe it is important to support the physical and emotional well-being of our students. If you have a physical or mental health issue that is affecting your performance or participation in any course, and/or if you need help connecting with University services, please contact the instructor or the Office of Academic Affairs. Please visit http://sph.umich.edu/student-life/wellness.html for information on wellness resources available to you.

Student Accommodations:
Students should speak with their instructors before or during the first week of classes regarding any special needs. Students can also visit the Office of Academic Affairs for assistance in coordinating communications around accommodations. Students seeking academic accommodations should register with Services for Students with Disabilities (SSD). SSD arranges reasonable and appropriate academic accommodations for students with disabilities. Please visit https://ssd.umich.edu/topic/our-services for more information on student accommodations.

Students who expect to miss classes, examinations, or other assignments as a consequence of their religious observance shall be provided with a reasonable alternative opportunity to complete such academic responsibilities. It is the obligation of students to provide faculty with reasonable notice of the dates of religious holidays on which they will be absent. Please visit http://www.provost.umich.edu/calendar/religious_holidays.html#conflicts for the complete University policy.
Schedule
We will follow Michigan’s schedule for start and end of classes, and other breaks.

Week 1 (1/6-1/10) (Instructor in AA)
Introduction: probability and non-probability sampling, randomization inference

Week 2 (1/11-1/17) (AA)
Simple random sampling
Estimation of proportions

Week 3 (1/18-1/24) No Class Monday 1/18 (Martin Luther King Day) (CP)
Stratified sampling
Design Effects

Week 4 (1/25-1/31) (AA)
Optimal Allocation
Estimation of proportions
Poststratification
Domain estimation

Week 5 (2/1-2/7) (AA)
Equal size cluster sampling

Week 6 (2/8-2/14) (CP)
Systematic sampling

Week 7 (2/15-2/21) (AA)
Review; Midterm Exam

No Class 2/29-3/6 (Michigan Spring Break)

Week 8 (3/7-3/13) No Class TBA (ENAR Conference) (AA)
Two-stage sampling
Three-stage sampling
Optimal cluster size

Week 9 (3/14-3/20) (AA)
Ratio estimation
Regression estimation

Week 10 (3/21-3/27) (CP)
Unequal cluster size sampling
Week 11 (3/28-4/3) (AA)
Probability proportion to size (PPS) sampling
epsem designs
Stratified PPS

Week 12 (4/4-4/10) (AA)
Variance estimation via Taylor Series approximation
Variance estimation via replication: jackknife, balanced repeated replication, bootstrapping

Week 13 (4/11-4/17) (CP)
Two-phase sampling
Calibration: raking, generalized regression estimators

Week 14 (4/18) (AA)
Dual frame estimation

Final Exam, Monday, April 25, 10:30a-12:30p, location TBA