Biostatistics: ANOVA and Design

PubH 7406
4 credits, A/F or S/N
Spring 2006 – SYLLABUS

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Course Objectives

Statistics is the art and science of obtaining, analyzing, and interpreting data and has application in almost every field of study. The emphasis of this course is on learning the basics of experimental design and the appropriate application and interpretation of statistical analysis of variance techniques. Topics include two-sample t-tests, ANOVAs with fixed and/or random factors, multiple comparison procedures, diagnostics, sample size calculations, and some non-parametric approaches, all within the context of specific types of experimental designs. Computing is done in this course primarily using SAS, with some attention on R (or S-Plus).

Class Meetings

Class meetings will be a mixture of lecture and discussion. Much useful information will be available for download from the course web page (see Miscellaneous Notes below). We will meet Mondays and Wednesdays 10:10 am – 12:05 pm in Mayo A-110.

Prerequisites

Statistics at the level of PubH 7405 and Stat 5101; and SAS and R (or S-Plus) programming experience; and familiarity with matrix notation; or permission of instructor. Co-requisite: enrollment in Stat 5102.

Guidelines

Students should be familiar with the basic notions of random variables, statistical inference, multiple linear regression, and matrix algebra. We will make some use of matrix notation. The focus of this course is on both the underlying statistical theory and applications.

Required Materials

One course packet of handouts by the instructor, and one textbook: Kuehl (2000). Design of Experiments: Statistical Principles of Research Design and Analysis, Second Edition. Pacific Grove, CA: Duxbury Press. ISBN 0-534-36834-4. Both are available at the Coffman Union Bookstore.

Computing

All registered students can request access to the Biostatistics computer UNIX network, which has SAS, R, and S-Plus. Students with access to software elsewhere are free to use whichever system is most convenient. SAS Version 9 or higher will be needed. Graphing of data can be done in the student's package of choice.

Work Expectations

Students are expected to attend class, participate in class discussions, and complete all assigned homework, projects, and exams. Students are also expected to complete assigned reading from the required materials.

Homework

There will be **six homework assignments** during the semester. We encourage you to work together in computing and discussing the problems. However, each student is expected to independently write up the submitted assignment using her or his own computing and giving explanations in her or his own words. All assignments will involve computing; please attach only relevant computer output to what you turn in. Some assignments may also include reading and writing about a related journal article.

You will get two weeks to work on each homework assignment. The homework will be graded on a scale of 0 to 25 points, for a maximum of 150 points possible over the semester. **Late homework will lose four points per day**, unless arrangements for an extension have been made with the instructor PRIOR to the due date.

Exam

There will be two in class exams. Each exam is worth 50 points. A hand calculator with the *ln* and *e* functions will be needed.

Project

There will be a final project towards the end of the semester instead of a final exam. The project is worth 50 points. The project could take one of two structures:

(1) Obtain a data set for analysis; using relevant background information, determine several scientific questions to be answered by the data. Carry out a full analysis which addresses these scientific questions using any appropriate modeling strategies covered in class and discuss the results. A written report is required.

(2) Carry out a simulation to demonstrate or explore a concept we covered during the course, or an extension of the concepts we covered. A written report is required.

More details will be handed out in April. Each student must write a <1 page project proposal (by e-mail is fine) and get approval from the instructor. We will have a few data sets available for option (1) and a few ideas available for option (2) if you do not already have something you would like to work on.

Grading

A letter grade will be determined from the percentage of (300 possible) points each student receives as follows:

		B+	87-89%	C+	77-79%	D+	67-69%
A	93-100%	B	83-86%	C	73-76%	D	63-66%
A-	90-92%	B-	80-82%	C-	70-72%	F	0-62%

For those enrolled S/N, a letter grade of C- or better must be achieved to receive an S. The University Senate has established a uniform grading policy for all letter grades: `www1.umn.edu/usenate/policies/gradingpolicy.html`. If you would like to switch grading options (e.g., A/F to S/N), it must be done within the first two weeks of the semester.

Class Time

Lectures and the reading are meant to complement each other, not to repeat each other. **Please complete the assigned reading from the required text BEFORE coming to class.**

Outline

- Introduction
  - Course administration
  - Course motivation
- Basic Principles of Experimental Design (Chapter 1)
  - Experimental units and experimental factors
  - Sources of errors
  - Replication and randomization
  - Principles of analysis
- Completely Randomized Designs: One Factor (Chapters 2-5)
  - Review of two-sample t-tests
  - Review of Type I and II error, power, and sample size calculations
  - One-way ANOVA to compare means
  - The ANOVA-regression connection
  - Contrasts and multiple comparisons
  - Diagnostics and remedial measures
  - Sample size calculations
  - One-way ANOVA to compare variances
- Completely Randomized Designs: Factorials (Chapter 6)
  - Two-way ANOVA for crossed factors
  - Interactions and contrasts
  - Sample size calculations
  - Three-way and higher ANOVAs for crossed factors
  - Unbalanced ANOVAs
  - Completely randomized designs without replication
- Variations on Factorial Designs (Chapter 7)
  - Nested and crossed factor designs
  - Fully nested designs
- Randomized Block Designs (Chapters 8, 17)
  - Two-way and higher ANOVAs with blocking factors
  - ANCOVA as an alternative to blocking
- Other Designs (Chapters 14-16)
  - Split plot designs
  - Repeated measures designs
  - Crossover designs

Time permitting, we will also cover Incomplete Block Designs (Chapter 9).

Resources

Several books on background material and further references on the material we will cover are on reserve in the Bio-Medical Library in Diehl Hall at the Reserve Desk:

(1) The required text.
(2) Oehlert (2000). *A First Course in Design and Analysis of Experiments*.
(3) Yandell (1997). *Practical Data Analysis for Designed Experiments*.
(4) Neter, Kutner, Nachtsheim, and Wasserman (1996). *Applied Linear Statistical Models*, 3rd Edition. For review of matrix algebra and regression in matrix notation, see Chapter 5. ANOVA and experimental design are covered in Chapters 16-31.
(5) Hocking (1996). *Methods and Applications of Linear Models*.
(6) Box, Hunter, and Hunter (1978). *Statistics for Experimenters*.
(7) Dunn and Clark (1987). *Applied Statistics*, 2nd Edition.

In addition, the Biostatistics Reading Room (Mayo A-460) has full documentation for SAS Version 8, books on graphing in SAS, S-Plus documentation, introductory books for learning S-Plus and UNIX, and many other books on experimental design. The computer manuals cannot be checked out except to make copies, but can be browsed in the Reading Room.

Miscellaneous Notes

Clarifications from class, changes in homework assignments, or course announcements will be distributed by e-mail. We are required to send e-mail only to your University x.500 account. Also, we will be maintaining a course web page at

`http://www.biostat.umn.edu/~lynn/ph7406.html`

Lecture notes, homework solutions, past exams, some computing code, data sets, and office hours will be available there. You will be asked to evaluate the course at the end of the semester. Please take this opportunity seriously and give feedback on how the course might be improved.

The following policies are common to all courses in the School of Public Health and are mandated by the School's Educational Policies document.

Grading Option Policy

If applicable, students may change grading options during the initial registration period or during the first two weeks of the term. **The grading option may not be changed after the second week of the term.**

An incomplete grade is permitted only in cases of extraordinary circumstances and following consultation with the instructor. In such cases, an "I" grade will require a specific written agreement between the instructor and the student specifying the time and manner in which the student will complete the course requirements. Extension for completion of the work will not exceed one year.

Scholastic Dishonesty

Students are responsible for knowing the University of Minnesota Board of Regents' policy on student conduct and scholastic dishonesty: `www1.umn.edu/regents/policies/academic/StudentConductC`

ode.pdf. Scholastic dishonesty as defined in the policy will be reported to the Office of Student Judicial Affairs: www.sja.umn.edu and will result in a grade of "F" or "N" for the entire course.

Plagiarism is an important element of this policy. It is defined as the presentation of another's writing or ideas as your own. Serious, intentional plagiarism will result in a grade of "F" or "N" for the entire course. For more information on this policy and for a helpful discussion of preventing plagiarism, please consult University policies and procedures regarding academic integrity: writing.umn.edu/tww/plagiarism/.

Students are urged to be careful that they properly attribute and cite others' work in their own writing. For guidelines for correctly citing sources, go to tutorial.lib.umn.edu and click on "Citing Sources."

In addition, original work is required in this course. It is unacceptable to hand in assignments for this course for which you receive credit in another course unless by prior agreement with the instructor. Building on a line of work begun in another course or leading to a thesis, dissertation, or final project is acceptable.

If you have any questions, consult the instructor.

Withdrawal Policy

School of Public Health students may withdraw from a course **through the second week** of the semester without permission. No "W" will appear on the transcript. **After the second week,** students are required to do the following:

1) The student must contact and notify their advisor and course instructor informing them of the decision to withdraw from the course.
2) The student must send an e-mail to the SPH Student Services Center (SSC) at sph-ssc@umn.edu. The email must provide the student name, ID#, course number, section number, semester, and year with instructions to withdraw the student from the course, and acknowledgement that the instructor and advisor have been contacted.
3) The advisor and instructor must e-mail the SSC acknowledging the student is canceling the course. All parties must be notified of the student's intent.
4) The SSC will complete the process by withdrawing the student from the course after receiving all e-mails (student, advisor, and instructor). A "W" will be placed and remain on the student transcript for the course.
5) After discussion with their advisor and notification to the instructor, students may withdraw up until the eighth week of the semester. There is no appeal process.

It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have a documented disability (e.g., physical, learning, psychiatric, vision, hearing, or systemic) that may affect their ability to participate in course activities or to meet course requirements. Students with disabilities are encouraged to contact Disability Services to have a confidential discussion of their individual needs for accommodation. Disability Services is located in Suite 180 McNamara Alumni Center, 200 Oak Street. Staff can be reached by calling (612) 626-1333 (V/TTY).
