STA 4211 Design and Analysis of Experiments

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This is STA 4211 Design and Analysis of Experiments, the section for non-statistics majors. Introduce myself.
Day 1: 1. Some key features of the course, 2. Main thing today: Introduction; Review of Stats I, 3. Syllabus details
1. Key features. Second course in applied statistics sequence. Required for statistics majors. There is a stress on understanding and communication of statistical analysis and results, for non-majors and majors alike.
Describe format of class.
State what the use of Canvas will be: 1. Student submission of assignments 2. Grading of assignments, recording of grades
Course web site: `www.stat.ufl.edu/~burrdoss/Courses/4211`; username 4211; password milerun
`R`: We will use the free statistical computing language `R`; download it in the first week of the semester from `http://www.r-project.org`. You are expected to be familiar with `R` usage for linear models from the prerequisite course, STA 4210. We will use R on several regular homeworks and on two projects.

What is STA 4211 about?

Design of experiments is an important topic.

We will study:

- Key features common to many designs, and
- Specific, common experimental designs that illustrate these features

Important Questions Can we infer causation from a given design? If yes, how and to what degree can we infer causation?

Let's consider an example.

I have a car that gets 35 miles per gallon. I want to know if switching to high octane gas will give me better mileage. So I wait until my tank is nearly empty, and fill up with high octane. At the same time, I notice that my tires are not inflated enough, so I inflate them to the recommended level. Then I drive for a couple of weeks, and calculate my MPG. I notice that I got 38 MPG. What can I conclude? Answer: Nothing. I changed two things at once, and it is impossible to attribute the improvement to the high octane gas.

In this course, we learn how to study the two factors together in an experiment, but in such a way that their effects are **not** confounded.

What is STA 4211 about? (con.)

Note: We will consider situations with continuous, or at least quantitative, response variable Y.

Two major topics:

- Design
- Analysis
  - "By hand" when possible; for balanced designs (as seen in Statistics I)
  - Via the linear model (as in STA 4210 Regression Analysis); with categorical predictors
  - Using R. Why use of code is important.

Additional comments:

- We start with two building block designs and cover them thoroughly.
- Standard inference, plus multiple comparisons.

Most examples are controlled, designed experiments.
To move on to next slide: Let's consider an example of a real study in order to illustrate the most crucial distinction between types of studies.

Ch. 15 Example Effect of Vitamin C on Number of Colds

In the 1970s there was much interest in effect of vitamin supplements on health. In particular, it was believed that taking vitamin C could help prevent colds.

Questions: Does taking vitamin C reduce number of colds, and if so, by how many? Get data to find out.

Method 1: Select 400 individuals from the set of people who take vitamin C every day, and select 400 individuals from set of people who don't. Count the number of colds for each of the 800 people, and compare the numbers of colds in each group.

Let Y_i = number of colds the ith person gets in the study period

Method 2: Take a sample of 800 volunteers. Half, selected randomly, are to take vitamin C for the study period, the other half a placebo. At the end of the study, count the number of colds for each of the 800 people, and compare the numbers of colds in each group.

Method 1 This is an *observational study* because the experimenter does not assign the treatment (Vitamin C or no Vitamin C); the subject decides whether to take Vit. C or not.

Example. Experiment on Vitamin C and Colds

Experiment conducted in 1976, with 868 children participating. Half of them were randomly selected for the experimental group; these 434 children received a 1000-mg tablet of vitamin C daily for the test period. The remaining 434 children, the control group, received an identical tablet containing no vitamin C every day.

Results:

Mean no. of colds

Group	Mean	n
Vitamin C	.38	434
Placebo	.37	434

The difference between the two groups ($.01$ colds per child) was not statistically significant.

The difference is not practically significant either.

Consider the following aspects of design:

- Control
- Randomization
- Blinding (single, double)

Subject does not know whether he/she got Vit C or Placebo.

Features of experiments

Ex. Vitamin C and Colds

1. This is a *controlled experiment* because the experimenter decides who gets the treatment, and who gets the placebo.
2. It is also *randomized*, because those who receive Vit C are selected at random from the whole group.
3. It is *blinded*, because a placebo pill is given. Thus the subjects don't know if they received Vitamin C or not. Important in experiments with human subjects where there may be a psychological effect of the treatment; blinding eliminates this bias.
4. The experiment might have been double-blinded. We aren't given enough information to tell for sure. We'd have to know the protocol for diagnosing the colds. If the subjects themselves report how many colds they had during the study period (self-report), then since the subjects are blinded already, this means the study is double-blinded.

We will discuss *statistical significance* later.