Lecture 5

Last time

We learned many different ways to take a RANDOM sample: SRS, Stratified Random Sample, Multistage sample, systematic sample.

Why do we want a random sample? Why can't I just choose people I know?

Also, what are some problems that come with sampling?

Samples and Populations

In addition to deciding how to choose our sample, we have to decide what type of study we will use to test our ideas:

An **observational study** observes individuals/experimental units and measures variables of interest but does not attempt to influence the process. Experimental units are monitored in their natural habitat.

Example: A survey of mothers across the country is taken. They are asked what their stress level is (on a scale of 1-10) and the number of children that they have. A positive correlation is found to exist between the number of children and stress level.

Is there a problem here?

A **designed experiment** deliberately impose some treatment on individuals/experimental units in order to observe their responses. This is the only way to prove that the treatment actually causes the response.

Example: The stress level of a large group of adults is rated on a scale. To determine the effect of a prescription stress relieving drug, half of the group takes the drug daily, and the other half takes a placebo daily. After six weeks of taking pills, all participants rank their stress levels again.

There are many types of designed experiments, today we will go over some basic designs used accurately find association and cause between variables.

Designing Experiments

Here are some basic vocabulary used in experiment design:

Experimental units are subjects in the study; they can be humans, rats, cakes, paper, fields,...

Response variable is characteristic/variable measured from the subject; it can be human blood pressure, rat body temperature, cake thickness, paper strength, lettuce fertility in field,...
Explanatory variable what we use to explain changes in the response variable - usually these are the "factors":

Factor (treatment) is the condition applied to the experimental units
Levels are the different values of a factor that are used in the experiment

Example:
In a cake baking experiment where cake thickness is the response variable, possible factors (explanatory variables) and levels are:

Oven Temperature (350 F, 400 F, 450 F, 500 F)
Amount of Tartaric Acid (0 oz, 3 oz, 6 oz)
Bake Time (60 minutes, 75 minutes, 90 minutes)

Example:
A photo developing lab wants to test what combination of light levels and chemical bath make the most vibrant colors in pictures. They have 3 lamp settings to test and 2 different chemical mixtures. A color meter measures the vibrancy on a 1 to 10 scale (with 10 being the most vibrant) after the picture is developed. They used the same film and paper to process the photos in every treatment.

What are the explanatory and response variables?

How many factors are there? How many levels for each factor?

How many treatment combinations are there? List them.

ADVANTAGES OF AN EXPERIMENT:

1. Study effects of a specific treatment
2. Hold constant factors not of interest that could affect results(use same paper and film)
3. Study combined effects of 2 factors (light and chemical mixture)

DISADVANTAGES OF AN EXPERIMENT:

1. Must control environment of units so that they are all exposed to same conditions, except for the treatments.

2. Lab results can be unrealistic because the environment is contrived. Lurking variables pop up many times in real world.

More vocab:

A **control** is a factor level that represents "usual" or default status of factor. (NOTE: a control does not always exist)

A **placebo** is a highly-used control treatment in experiments with humans.

A **block** is group of experimental units known to be similar in some way that will affect the response.

Blocking is a technique used to reduce variability by grouping units by some factor that is known to be different (like men and women) and unimportant to our analysis(like different runs of a machine); within each block units are randomly assigned to a treatment.

Example:

Twenty patients with migraines agree to be part of a study to test a new pain medication. They are split into 2 groups of 10 each: one group gets the drug and the other group gets a placebo (looks exactly the same but does nothing). Neither doctors, administrators or patients know which is which. All patients are instructed on how and when to take the drug and asked to record the percentage of pain relief that the pill gave them.

What are the explanatory and response variables?

How many factors are there? How many levels for each factor?

How many treatments are there? List them.

What could have happened if all the patients had been given the real drug?

What methods were used to maintain a similar set of conditions for each subject (addressing Disadvantage #1)?

Draw a diagram of the experiment design.

NOTE: To reduce the Disadvantages in #2 the experiment should be carried out both in a lab setting and in the field (real life) whenever possible.

We selected our sample randomly but are we done with the idea of randomness when designing the experiment? NO!!

We must ensure that there is no bias in assigning the treatment/factors to the experimental units. **Randomization** is a process by which experimental units are assigned to a treatment with equal likelihood of being assigned to any treatment. This random process ensures that groups formed do not depend on the judgment of the researcher so as to not introduce bias.

When experimental units are assigned randomly to *all* treatments, this is called a completely randomized design.

METHODS OF RANDOMIZATION:

Double-blind - an experiment where both the experimenter and subject are unaware of which treatment has been given to a subject

Single-Blind - when either the experimenter or subject is unaware which treatment a subject has been given

Zero-Blind - when experimenter and subject know which treatment a subject has been given

Another type of experiment is a **matched-pair design** which is a specific blocking design where one subject (or very similar subjects) is a member of each block; matching experimental units into pairs with random assignment of treatment.

Example:

A psychology graduate student selects subjects with reserved personalities to be in an experiment testing the value of verbal expression of emotions. Two subjects at a time are taken into an examining room. A cardboard barrier is placed between them but both can see a TV set. A segment of film shows a situation where a character is forced to make an ethically uncomfortable decision. They rank their discomfort from 1 to 10 on a written form. Then, one subject is randomly selected to verbally express his/her attitude towards the film while the other listens. The same film is shown again and they rank their discomfort from 1 to 10 on a written form. The grad student hopes to show that the second ranking is lower than the first for the student who verbally expressed his/her discomfort.

FINAL NOTE ON EXPERIMENTS: Designed experiments are better than observational studies when trying to establish a cause-and-effect relationship, however designs that rely on human participation often require volunteer samples and may not be representative of the intended population.

Welcome to the real world

What kind of studies are these?

The first example shows that decaffeinated coffee may be harmful to the heart.

> Decaffeinated coffee may have a harmful effect on the heart by increasing the levels of a specific cholesterol in the blood, researchers say. Their explanation is that caffeine-free coffee is often made from a type of bean with a higher fat content.
>
> Robert Superko, at the Piedmont-Mercer Center for Health and Learning in Atlanta, Georgia, US, and colleagues looked at the effects of coffee on 187 people. The group was split into three similar-sized groups for the three-month study: one group drank three to six cups of caffeinated coffee per day; one drank three to six cups of decaffeinated coffee per day; and a control group drank no coffee. US coffee drinkers drink an average 3.1 cups of coffee per day.
>
> The researchers analysed blood samples from the groups before and after the study to determine the levels of cholesterol and non-esterified fatty acids (NEFAs) in the blood key indicators of heart disease risk.
>
> To their surprise, the researchers found the decaffeinated group had experienced an 18% rise in NEFAs in the blood and an 8% rise in apolipoprotein B a protein associated with a cholesterol linked to cardiovascular disease. This was not seen in the other two groups.

From http://www.newscientist.com/article.ns?id=dn8328

Remember the VIOXX scare last year. Here's some information on the study that broke the news:

> BACKGROUND: Although cyclooxygenase-2 inhibitors (coxibs) were developed to cause less gastrointestinal hemorrhage than nonselective nonsteroidal antiinflammatory drugs (NSAIDs), there has been concern about their cardiovascular safety. We studied the relative risk of acute myocardial infarction (AMI) among users of celecoxib, rofecoxib, and NSAIDs in Medicare beneficiaries with a comprehensive drug benefit. METHODS AND RESULTS: We conducted a matched case-control study of 54 475 patients 65 years of age or older who received their medications through 2 state-sponsored pharmaceutical benefits programs in the United States. All health-care use encounters were examined to identify hospitalizations for AMI. Each of the 10 895 cases of AMI was matched to 4 controls on the basis of age, gender, and the month of index date...

From Circulation. 2004 May 4;109(17):2068-73. Epub 2004 Apr 19. Found at http://www.ncbi.nlm.nih.gov.

Here's another example of a study that found that men get more pleasure in getting revenge.

> A lust for vengeance may be hardwired into the male brain. Scans of brain activity suggest that men experience greater satisfaction than women in seeing cheaters get their comeuppance at least when the punishment is physical.
>
> Tania Singer of University College London, UK, and colleagues used a functional magnetic resonance imaging (fMRI) machine to analyse the brain activity of 32 volunteers after their participation in a simple game, called the Prisoner's Dilemma.
>
> The game allows players to cooperate or double-cross one another, and so fosters camaraderie or enmity between players. Following the game, participants were placed inside an fMRI machine and then saw their fellow players zapped with electricity. The activity in their brain was recorded as they watched. NS Forum Is the feeling of delight at revenge just a man thing? Discuss this story ¿¿
>
> The scans revealed changes in activity as players who had cooperated got zapped, compared with those who had double-crossed them in the game. The results suggest that men get a much bigger kick than women from seeing revenge physically exacted on someone perceived to have wronged them.

From http://www.newscientist.com/channel/being-human/dn8605.html