Lecture 2: 3 Principles

Experiment

* Manipulation of a factor(s) to create treatments.
* Assignment of treatments to experimental units.

Three Principles

* Control.
* Replication.
* Randomization.

Control

* Control of outside variables.
* Control/Comparison group.

Replication

* Replication within an experiment.
* Replication of an entire experiment.

Randomization

* Random assignment of treatments to experimental units.
* Random selection of experimental units.

Control of Outside Variables

* Outside variables are variables that may have an effect on the response.
* Controlling outside variables means not letting them change.
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Example
- Outside variables that may affect blood pressure.
  - Age
  - Gender
  - Exercise
  - Stress
  - Heredity

Control of Outside Variables
- Same age – 50 years.
- Same gender – women.
- Same exercise – 30 minutes a day three days a week.
- Hard to control stress and heredity.

Purpose of Control
- The purpose of control of outside variables is to isolate the effect of the treatments, i.e. the manipulated variable.

Problem with Control
- By controlling outside variables it is hard to make broad generalizations.
- Can only generalize to experimental units like the ones used in the experiment.

Control/Comparison Group
- A group of experimental units used to see if the factor of interest has any effect at all.

Control/Comparison Group
- Placebo Group
- Standard Treatment Group
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**Placebo Group**

* A placebo is not an active treatment, e.g. a treatment with no active “ingredient”.
* In the sodium and blood pressure experiment the placebo would be a diet with no sodium.

**Placebo Group**

* If other treatments are different from the placebo, we know that the factor of interest has an effect at some level.

**Standard Treatment Group**

* In an experiment looking at the effect of drill speed (rpm) on the surface roughness of drilled holes the standard treatment would be the drill speed that is currently being used.

**Comparison Group**

* Can then evaluate how changing the speed affects the surface roughness and make a recommendation to improve the process.

**Replication**

* Replication within an experiment requires assignment of each treatment to several (more than one) experimental units.

**Purpose of Replication**

* Experimental units receiving the same treatment are treated the same. Replication allows us to quantify the natural variation in units treated the same.
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Purpose of Replication

*The quantification of natural variation in units treated the same provides a means for determining if differences between treatments are statistically significant.

Purpose of Replication

*Can the difference between observed treatment means be explained by natural variation or could it be due to the treatment?

Replication

*Without replication within an experiment it is difficult to determine statistically significant differences.

Replication

*Replication of the entire experiment means doing the experiment again with different experimental units.

Replication

*Replication of an entire experiment allows us to see if the effect of treatment can be repeated (replicated).

Replication

*Replication of the entire experiment with different experimental units (e.g. men instead of women) allows us to see if the effect of treatment is the same for both genders.