Principles and Techniques of Experimental Designs

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Experimentation for Comparative Studies

An Example

Does taking aspirin regularly help prevent people against heart attacks? The Physicians Health Study was a medical experiment that helped answer this question. Half of a group of 22,000 male doctors were chosen at random to take an aspirin every other day. The other half of the doctors took a placebo, a dummy pill that looked and tasted just like the aspirin but had no active ingredient. After several years, 239 of the placebo group but only 139 of the aspirin group had suffered heart attacks.

This is ***an experiment***. Note the following characteristics.

- **Objective of the study:** To study the effects of aspirin. This can be phrased formally as a hypothesis.
- **Treatments:** Aspirin and placebo, whose effects are to be compared.
- **Units:** Subjects (i.e., people) that received the treatments.
- **Randomization:** 22,000 people were randomly divided into two groups and each group received one treatment.

Reasons to Run Experiment

- to determine the principal causes of variation in a measured response.
- to find the conditions that give rise to a maximum and minimum response.
- to compare the responses achieved at different settings of controllable variables.
- to obtain a mathematical model in order to predict future responses.

Principles and Techniques

Design of Experiments

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- with optimal or near optimal power for statistical tests.
- with more statistical efficiency.
- reducing the experimental costs.

Randomization

Example: To study the effects of a diet on weight control, it is found that the group who is on the diet is 20 pounds less on average than the group receiving a placebo. Can we conclude the diet is effective?

No, if

- the diet group is all males, or
- the diet group has ages between 20 and 30 while the placebo group between 40 and 50, or
- the two groups represent two different geographic regions.

Randomization can offset the potential differences that exist and are not measured in the experiment.The purpose of randomization is to prevent systematic and personal biases from being introduced into the experiment.

A study is not a designed study without randomization.

Replication

Example: One went to Chicago one day and found the temperature to be 70 degrees. Another day he went to Indianapolis and found the temperature to be 65 degrees. Is Chicago warmer than Indianapolis?

No!

Several people of subjects (i.e., units), may be assigned to the same treatment. This is called replication. Replication is used to offset the effects of other factors or variables that are either unknown or unstudied in the experiment.

Replication differs from "repeated measures". The latter refers to measurements taken from the same unit at different time points.

Additional reading

Chapter 1 of Dean, Voss and Draguljic.