

Chapter 4.2 Lecture Notes and Examples Part 3

Section 4.2 (Part 3) pp. 246 - 251

1. Block and Randomized Block Design

If our experimental units (subjects) differ in some characteristic that may affect the results of our experiment, we should separate the groups into **blocks** based on that characteristic and then randomly assign the subjects *within* each block. (Sounds like stratified sampling doesn't it?)

- We use blocks to *reduce variability* so that we can see the effects of the treatments.
- The blocks themselves are **not treatments**.
- Blocks are another form of *control*.
- They control the effects of some outside variables by bringing those variables into the experiment to form the blocks

Definition:

A **block** is a group of experimental units that are known before the experiment to be similar in some way that is expected to affect the response to the treatments.

In a **randomized block design**, the random assignment of experimental units to treatments is carried out separately within each block.

- The idea of blocking is an important additional principle in experimental design.
- A wise experimenter will form blocks based on the most important unavoidable sources of variability (confounding variables) among the experimental units.
- Randomization will then average out the effects of the remaining unknown variables.
- Our goal is to be able to assess cause and effect relationship between the treatment imposed and the response variable. Blocking reduces variability so that the differences we see can be attributed to the treatment we imposed.

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Control what you can

Block on what you cannot control

Randomize to create comparable groups

Example. A cell phone company is considering two different keyboard designs (A and B) for its new line of cell phones. Researchers would like to conduct an experiment using subjects who are frequent texters and subjects who are not frequent texters. The subjects will be asked to text several different messages in 5 minutes. The response variable will be the number of correctly typed words.

a. Explain why a randomized block design might be preferable to a completely randomized design for this experiment.

b. Outline a randomized block experiment using 100 frequent texters and 200 novice testers.

2. Matched Pairs Design - Matched pairs design is a common form of block design for comparing two treatments.

- The idea is to create blocks by matching pairs of similar experimental units.
- Then we use chance to decide which member of the pair gets the first treatment. The other subject gets the other treatment.
- Just like other forms of blocking, matching helps reduce the effect of variation among the experimental units.

Example: Marathon runners are matched by weight, physical build, and running times. They are asked to test the durability of a new model of running shoe and compare it to the manufacturer's old shoe design. A coin is tossed to determine which runner in each pair will wear the new design. After the marathon, the difference in wear pattern is then measured and recorded.

Sometimes each "pair" in a matched pairs design consists of just one experimental unit that gets both treatments one after the other. In this case, each experimental unit serves as its own control. The *order* of the treatments can influence the response, so we randomize the order for each experimental unit.

Example: A researcher believes that students are able to concentrate better while listening to classical music. To test the theory, she plans to record the time it takes a student to complete a puzzle maze while listening to classical music and the time it takes to complete another puzzle of the same difficulty in a quiet room. Because there is so much variability in problem-solving abilities among students, a matched pairs design will be used to reduce variability so that any difference recorded can be attributed to the conditions under which the student completed the puzzle.

Each student will complete a puzzle under each of the conditions. A coin will be flipped to determine whether they will first complete the puzzle in the quiet room or while listening to music. The difference in time it takes to complete the puzzles is then recorded for each student.