More Designs
Section 4.2B
Block

A group of experimental units or subjects that are known before the experiment to be similar in some way that is expected to systematically affect the response to the treatments.

*Similar to stratified samples in surveys.*
Randomized Block Design

• The random assignment of experimental units to treatments is carried out **separately** within each block.

• We block to **reduce variation**.

• You cannot randomize a block!

• You can block on a pre-existing condition.

• Allows you to draw separate conclusions about each block.
Example: Laundry

- Suppose you want to test a new hand wash detergent for clothes to see if it works better in warm or cold water.

- The response variable is a cleanliness rating from 0 (very dirty) to 10 (very clean).

- **Possible lurking variable**: There might be a lot of variability in cleanliness ratings in both groups due to the color of the clothing which would make it difficult to detect a difference in the effects of the treatments!

- Possible Solution: Separate laundry into 2 piles – one for lighter colors and one for darker colors. The same person should do the washing as a form of control. **This design could reduce the variation due to color of clothing!**
Randomized Block Design – Laundry Example

Assignment to blocks is *not* random

Many pieces of dirty laundry

Light-colored clothing → Random assignment → Cold water

Dark-colored clothing → Random assignment → Hot water

Cold water → Compare cleanliness

Hot water → Compare cleanliness

Treatments
Example

• We want to monitor the progress of a type of cancer that differs in women and men.

• We want to test 3 therapies for this cancer – thus we block for gender.

• Let’s take a look.
Subjects

Men → Random assignment

Women → Random assignment

Group 1 → Therapy 1

Group 2 → Therapy 2

Group 3 → Therapy 3

Compare survival
Form blocks on the most important unavoidable sources of variability among the experimental units.

*Control what you can, block what you can’t control, and randomized the rest.*

Block into Homogenous Groups.

Made up of the same kind of people of things.
Example

• Women and men respond differently to advertising. We want to design an experiment to compare the effectiveness of 3 ads for the same product.

• Why is a randomized block design better to use than a completely randomized design?

A completely randomized design would ignore the differences between men and women, which would result in much variability in responses to the ads in all three groups!
Advertising Block Design – Use 300 volunteers (180 men and 120 women)
Matched Pairs Design

- *Compares just two treatments*

- Subjects are matched in pairs

- There’s still randomization – *which treatment they get*

- Can use the same subject for both treatments.

  Sometimes, a “pair” in a matched-pairs design consists of a single unit that receives both treatments. Since the order of the treatments can influence the response, chance is used to determine with treatment is applied first for each unit.
Matched Pairs Design

• Twins are used a lot for matched pairs testing because they have the same genetic make up and could be considered as “one.”

• Medication Testing – Men react differently to women.

• Brakes Testing – I want to test brakes on a car. Better to test each tire at same time with same driver.

• Runners testing a “wonder drug.” - Slow runners vs. fast runners.
Example – Cell Phone and Driving Experiment

All subjects drove both with and without using the cell phone. Researchers compared each individual’s reaction times with and without the phone.
If all subjects drove 1\textsuperscript{st} with the phone and then without it – the effect of talking on the cell phone would be confounded with the fact that it was the first run in the simulator.

Thus we randomize the order.
Let’s Review 2 designs with an Activity:

• Are standing pulse rates generally higher than sitting pulse rates?

• In this Activity, you will design 2 experiments to answer this question.

• Design an experiment using a) a completely randomized design and b) a matched pairs design.
Pulse Rates: Completely Randomized Design

• Randomly assign half the students in your class to stand and the other half to sit. You can use the hat method, Table D, or technology to carry out the random assignment.

• Once the two treatment groups have been formed, students should stand or sit as required.

• Then they should measure their pulses for one minute.
Pulse Rates: Matched Pairs Design

• Each student should receive both treatments in a random order.

• Since you already sat or stood in Step 1, you just need to do the opposite now. As before, everyone should measure their pulses for one minute after completing the treatment (that is, once they are standing or sitting).

• Have all the subject record their data in a chart.
Don’t forget to be very specific when describing how you randomize!
Classwork

- Blocking Worksheet
Homework

• Worksheet