Randomization

How do we randomly assign the experimental units or subjects to the different treatment groups.

Idea: "draw names out of a hat"

In practice,

1. Use a random number tables.
2. Use statistical software.

A **table of random digits** is a list of the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, that has the following properties:

1. The digit in any position in the list has the same chance of being any one of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.
2. The digits in different positions are independent in the sense that the value of one has no influence on the value of the other.

As a result,

- Any *pair* of random digits has the same chance of being any of the 100 pairs: 00, 01, 02, …, 98, 99.
- Any *triple* of random digits has the same chance of being any of the 1000 triples: 000, 001, 002, …, 998, 999.
- Any so on…

Using a **table of random digit** (Table B):

1) Assign every experimental unit a numerical label starting with 1 (or 01 or 001, etc...). Use shortest possible labels. All the labels should have the same number of digits.

2) Let k be the number of digits in a label and N the number of experimental units available.

3) Suppose we want to assign m experimental units to one group. Start at any row in the table and read across k digits at a time. Record the first m unique values between 1 and N that appear.
- Skip any values not in the range 1 to N.
- Skip any value that has already been chosen.
- Continue on to the next row until the desired sample of size m is selected.
- Assign the individual in the sample corresponding to the numbers selected to the group.

Suppose that a newspaper is interested in convincing its advertisers to buy larger add spaces. The newspaper has 20 local companies (see below) that regularly place small adds in in the paper . The newspaper decides to do an experiment in which 5 companies are selected and get free upgrades to a large add. All of the companies are asked to report their revenue in the weeks before and after the experiment is performed.

A-1 plumbing	Computer Answers	Photo Arts
Accent Printing	Darlene's Dolls	River City Books
Balloons Inc.	Hernandez Electronics	Riverside Tavern
Bailey Trucking	Johnson commodities	Rustic Boutique
Bennett Hardware	JL Records	Satellite Services
Best Camera Shop	Liu's Chinese Restaurant	Von's Video Store
Classic Flowers	Magic Tan	

Which 5 businesses should be select to get the large adds? We need to select five businesses at random.

First: Label the businesses 01 to 20.

01 A-1 plumbing	08 Computer Answers	15 Photo Arts
02 Accent Printing	09 Darlene's Dolls	16 River City Books
03 Balloons Inc.	10 Hernandez Electronics	17 Riverside Tavern
04 Bailey Trucking	11 Johnson commodities	18 Rustic Boutique
05 Bennett Hardware	12 JL Records	19 Satellite Services
06 Best Camera Shop	13 Liu's Chinese Restaurant	20 Von's Video Store
07 Classic Flowers	14 Magic Tan	

Step 2: Choose a line in Table B to start – we'll use line 128 (and 129 if necessary).

128 15689 14227 06565 14374 13352 49367 81982 87209
129 36759 58984 68288 22913 18638 54303 00795 08727

Step 3: Read the digits in groups of 2 (since our labels have 2 digits). If we read off a number that is one of our labels, include the business with that label in the sample. Continue going through the row until 5 businesses are in the sample

15 68 91 42 27 06 56 51 43 74 13 35 24 93 67 81 98 28 72 09
36 75 95 89 84 68 28 82 29 13 18 63 85 43 03 00 79 50 87 27

15 68 91 42 27 **06** 56 51 43 74 **13** 35 24 93 67 81 98 28 72 **09**
36 75 95 89 84 68 28 82 29 **13** **18** 63 85 43 03 00 79 50 87 27

The first five labels we read that correspond to the labels of are experimental units are: 15, 06, 13, 09, 18

So our sample is:

Best Camera Shop, Darlene's Dolls, Liu's Chinese Restaurant, Photo Arts, and Rustic Boutique

Using MINITAB instead of a table to select 5 businesses:

1. If all of the experimental units are in a column of a dataset, then select **Calc - Random Data - Sample from Columns…**
   (want to select *without replacement*)

2. If the experimental units are not in a column of a dataset, then select **Calc - Random Data - Integer…**
   This function basically gives you a table of random numbers as large as you want. It will give replicates so choose a larger number of random numbers than you need.

Matched Pairs Designs

In **matched pairs designs** experimental units are matched as closely as possible. The matched individuals form blocks of size two and each unit in a block is assigned one treatment.

Why? Using a matched pairs design, we can produce more precise results because the variability between subjects is distributed between the different treatment groups.

Sometimes blocks in match pairs designs consist of only one individual.

- The subject gets one treatment after another. (Order can matter so randomize.)
- The subject gets both treatments at once if they can be administered simultaneously without interfering with each other.

Example (matched pairs design): A manufacturer of children's shoes wants to test whether a new brand of shoe laces is more durable. They perform an experiment that measures how long the regular laces and the new laces last on a group of 6 year old boys. Each boy wears one regular shoe lace on one shoe and one of the new laces on the other shoe. To control for a "foot effect," the new laces are randomly worn on either the right shoe or the left shoe.

Block Designs

- Matched pairs designs are an example of **block designs**.
- A **block** is a group of experimental units or subjects that are known before the experiment to be similar in some way that is expected to affect the response to the treatments. In a **block design**, the random assignment of units to treatments is carried out separately within each block.
- Blocks are another form of *control*. They control the effects of *lurking variables* by bringing those variables into the experiment to form blocks.

Example (block design): A drug company performs an experiment to find the most effective dosage of a new medication. Since there is concern that the appropriate dosage may depend of the sex of the user, separate randomized comparative experiments are performed on the female subjects and the male subjects.