Sample Methods Reference Sheet – Observational Studies

Population: entire group of individuals about which we want information.
Sample: the part of the population from which we actually collect information.
Polling is an example of sampling from the population in order to get a better idea of the characteristics of a population. The sample must be **representative** of the population being studied.

Type of sampling	Example	Advantage	Disadvantage
Convenience Sampling	In order to get an idea of how students think of the new school policy, the principal stands outside the library and asks a few students their opinions.	Easy and Cheap	Not representative of the population
Voluntary Response Sample	After the State of the Union speech, ABC tells its audience to call a 1-900-555-1234 if they thought the speech was good and 1-900-555-7890 if they thought the speech was bad (there is a $0.50 charge for the call).	Easy	Biased toward people with strong opinions.
Systematic Random Sampling	HP Selects every 200th computer off the assembly line and inspects it for quality control.	Every member has an equal probability of being selected.	Not every sample of size n is possible.

Randomization Methods: Dice, draw from a hat, random number table, technology

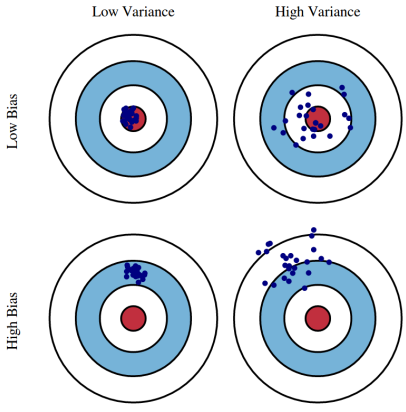
Sampling Methods:

The Simple Random Sample (SRS)
This consists of n individuals from the population chosen in such a way that every set of n individuals has an equal chance of being the sample actually selected. This is often the best and most appropriate way to collect data for a sample. Easiest method: use the hat.

Stratified random sampling
Divide the population into groups of similar individuals (strata) then select an SRS within each strata. Combine the SRSs from each strata to form your full sample. ***Each strata is different, but the subjects in the strata are similar.***

Cluster Sampling (Multi-stage sampling)
Divide the population into sections (clusters) then randomly choose a few of those clusters, and select every member or an SRS of the clusters chosen. ***Each clusters is similar, but the subjects within the clusters are different from one another.***

	Simple Example Population: 10 Men, 10 Women	Pros	Cons
Simple Random Sample	Place the names of all 20 people in a hat, shake it up and randomly draw out 8 names without replacement	We have an unbiased SRS. If the sample is size is large enough, stratification is unnecessary.	The SRS of size 8 could be result in one gender being over-represented and the sample may be biased toward that gender.
Stratified Random Sample	Strata 1 = men Strata 2 = women Place the names of the 10 men in hat and the names of the 10 women in a second hat. Randomly select 4 men from the first hat without replacement and 4 women from the second hat without replacement.	We have an unbiased and representative SRS.	If the population is large and spread-out, it may be difficult to contact the subjects for data collection.
Cluster Sampling	Step 1: Randomly select 4 high schools from the county high schools to be clusters A, B, C, and D. Step 2: Place the names of all students from school A in a hat, shake it up and randomly select 25 students without replacement to be surveyed. Repeat this process for school B, C, and D.	We have an unbiased SRS that is likely to be representative of the population AND the data can be collected in a reasonable manner.	If each cluster is not representative of the population then we could end up the data that does not reflect the population. If all schools selected are suburban and no urban school is selected, then the sample is biased.



Samples are ***biased*** if they are systematically not representative of the desired population.

Sampling errors occur in when the method of selecting subjects is flawed. Examples: random sampling error, under-coverage.

Non-sampling errors occur when there are flaws in the collection process or analysis of the data. Examples: Non-response, Lies, Ignorance, Lack of Memory, Timing of the survey, Question Phrasing

Goals:
High Sample Size that is randomly drawn from the population. Ideal = SRS.
High Quality Questions to gain accurate data and low variance.

Sample Methods Reference Sheet – Experiments

Experimental Units: The things on which the experiment is done. **Subjects**: When the experimental units are human beings
Treatment: A specific experimental condition applied to the units. These are the explanatory variables in an experiment. Sometimes, these are called the "factors"
Level: The specific value of the treatment to be administered
Observational study: Observes individuals and measures variables of interest but does not attempt to influence the responses.
Experiment: Deliberately imposes some treatment on individuals to measure their responses.
Lurking Variable: A variable that is not among the explanatory or response variables in a study but that may influence the response variable.
Confounding: Confounding is when two variables are associated in such a way that their effects on a response variable cannot be distinguished from each other. We cannot state the effect of the explanatory variable on the response variable because there is another variable that could also have affected the response variable. When a lurking variable is not addressed in the design of the experiment, then the results are confounded.
Control Group: A Control Group is treated identically in all respects to the group receiving the treatment except that the members of the control group do not receive the treatment.
Placebo: An inactive treatment. There is a proven phenomenon called the placebo effect. Patients receiving Placebo tablets which have no active drug ingredient (e.g. a sugar tablet) may experience a certain beneficial effect.
Robust: When the link between the treatment and result holds despite controlling for lurking variables and can be replicated, the finding is called Robust.
Blinding: It is usually best if the subject does not know whether they are receiving the treatment or not. This practice is called Blinding. Sometimes it is also best if the experimenter does not know which subject is receiving the treatment and which is not. This will remove any potential bias in the way the experimenter reports his findings. Experiments in which both the subject and the administrator of the experiment do not know who receives the treatment are called **Double Blind**.
Statistically Significant: An observed effect is so large that it would rarely occur by chance is called statistically significant. The typical standard in statistics is that a result become statistically significant if the chance of the result occurring by chance is less than 5%.

Three critical elements of experiment design:

Control
Assign a placebo to control group so that you know if the treatment actually caused the effect.
Plan to control for possible lurking variables using blocking, matched pairs, etc.
By showing that the other variables are NOT changing the effect, the evidence that the treatment caused the effect strengthens.

Randomization
Randomly draw the sample from the population (SRS is ideal). If subjects are not drawn from the target population, then the results cannot be generalized to the population and are limited to the subjects in the study (No volunteers).
Randomly assign the treatments to the subjects.
An experiment that randomly assigns treatments to subjects selected randomly from the population is called a Completely Randomized Design.

Replication
Use a large sample size so the experiment is repeated many times.
Ideally, studies are repeated in multiple settings by different research teams. When a study is published with a surprising or profound finding, it is often replicated by researchers that are independent of the original team to see if the effect holds.

Inference

We must randomly draw from the population in order to generalize to the population. (The sample reflects the larger group)
We must have a well-designed experiment with a control group and random assignment of treatment in order to reach a cause-effect relationship.

Block Designs

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. ***The purpose of blocking is to reduce variation for the response variable.***

Randomized block design:

1. Decide what variable will cause variation in the results (example: gender for average height)
2. Split the subjects according to this variable (example: separate men and women)
3. Perform the experiment on the blocks separately (example: this experiment blocked based on gender)

Matched Pair Experiment

Matched pair is an experimental design in which either the same individual or two matched individuals are assigned to receive the treatment and the control. In the case where an individual receives both the treatment and the control, the order in which this happens should be random. And the experiment should be conducted as a Double Blind experiment. ***The purpose of a matched pair design is that the control and treatment are both used in identical environments***

Matched Pair Design:

1. Decide what variable will cause variation in the results (example: IQ when comparing teaching methods).
2. Pair the subjects according to the variable so that they are as similar as possible for that variable (example: put subjects with similar IQ scores together).
3. For each pair, randomly assign one to receive the placebo and one to receive the treatment.

Alternate Method: Each person is their own control. Two different examples are described below:

- Each person can receive the placebo and control at the same time (example: if an ointment effectively treats poison ivy)
- Randomly assign each person to receive the placebo then the treatment OR the treatment then the placebo (example: taste test between regular sugar candy and a sugar substitute candy)