Outline of the course

- Some review of Statistics I   plus Chapter 15 on design considerations
- Single-factor studies; completely randomized design (Ch. 16)
- Follow-up analysis of factor level means in single-factor studies (Ch. 17)
- Diagnostics for one-way ANOVA; Section 18.1
- Balanced two-way factorial experiments; two-factor studies; Ch. 19
- Randomized blocks experiment and analysis; Ch. 21
- Analysis of covariance; Ch. 22 (if possible)
- Two-factor studies with unequal sample size (unbalanced); Ch. 23

REVIEW OF STATISTICS I

We will consider some topics from Stats I that are especially important building blocks for regression and Anova.

Three main topics or units of study in Statistics I (2023, 3032, 4321/4322): Data description, Probability, Inference

List of key Statistics I topics

- Features of designs: control, randomization
- Data description: histogram, mean, standard deviation, scatterplot, correlation
- Probability: random variable (r.v.) and its expected value, variance and standard deviation (SD); expected value, variance and SD of a linear combination of r.v.'s; normal distribution; t distribution
- Inference: concepts of confidence interval and hypothesis test; t procedures for two samples; F tests

Let's begin the review of Statistics I by considering the types of studies covered in that course.

Settings for Inference (Statistics I Review)

1. one sample, inference about the mean μ

2. one sample, inference about the proportion p

3. two independent groups, inference about the difference of two means
   mu_T = popul. mean no. colds if given Vit C, mu_C = popul mean no of colds if given Placebo, interested in mu_T - mu_C
4. two independent groups, inference about the difference of two proportions

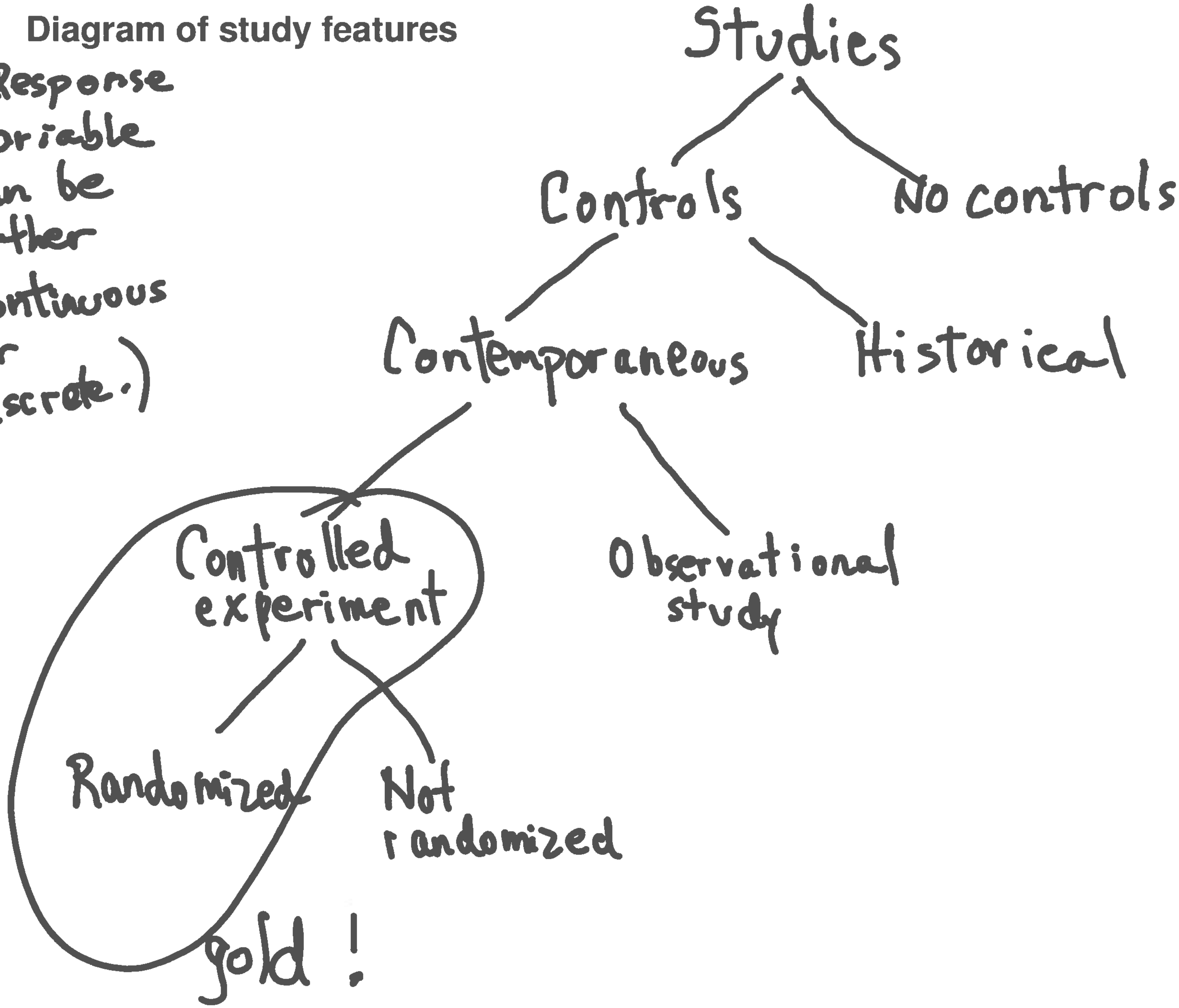
5. inference about the mean of paired differences

Examples of studies Subjects; goal

1. Sample UF students. Estimate mean time on Internet.
2. Sample UF students. Estimate proportion who have had covid.
3. 60 volunteers. 30 get individual tutoring, 30 get classroom instruction only. Does tutoring improve math test scores?
4. Sample UF male and female students. Estimate difference in proportions of male and female UF students who have had covid.
5. Five pairs of college students, matched on math scores. Randomly assign one member of pair to tutoring, other member to no tutoring. Does tutoring improve math test scores?

Diagram of study features

(Response variable can be either continuous or discrete.)



Studies: Controls or No Controls One-sample studies do not have controls. Controls: Contemporaneous or Historical. Pause for a moment to consider this distinction.

So in this course, we focus on studies that do have a comparison or control group. Further, our preferred studies always have a contemporaneous control group, not a historical one.

Further, with contemporaneous controls, we distinguish between:: Controlled experiment, or Observational study (Vitamin C Method 2, Vitamin C Method 1).

Notes: 1. Both the controlled experiment, and the observational study have a control group. 2. In the controlled experiment, the experimenter decides ("controls") which group gets treatment, which gets placebo. In the observational study, the experimenter merely observes which subjects got the treatment and which did not get the treatment.

The final feature of experiments we have discussed is randomization. For this to be a feature, we must have a controlled experiment, which can be either Randomized or Not Randomized

A study may have no comparison or control group at all, for example, if you are interested in the percent of the population who have been infected with covid-19, this is a *one-sample* problem and doesn't involve a control group.

Role of statistical significance $\bar{Y}_T - \bar{Y}_C$

In a controlled, randomized experiment, if the observed difference is found to be statistically significant (1), then we can conclude that the difference is real, and that the treatment caused the difference. (2)

Reason:

$\mu_T - \mu_C \neq 0$

(2) because of randomization

Advantage of Randomization

Randomization makes the two groups similar with respect to all factors (other than that one gets the new treatment and the other gets the old treatment). This includes factors we might have predicted would affect the response *and* factors we had not ever even thought about. Thus the two groups differ only in that one got the new treatment and the other got the old.

In brief: **Randomization eliminates confounding**

Definition. Confounding means a difference between the treatment and control groups–other than the treatment—which affects the responses being studied. A *confounder* is a third variable, associated with exposure and with disease.

treatment or control   response, r

Eg. Health status is a likely confounder in the Vit C study, Method 1.

Role of statistical significance in conclusion of randomized, controlled experiment

If the P-value of our two-sample t test (or other appropriate procedure) is very small, this eliminates the possibility that the observed difference is due to chance, and proves the "alternative hypothesis," which says that the observed difference is "real." In a randomized, controlled experiment, there is no other possible explanation. So, if we get a small P-value, we've proved that the treatment causes the improvement.

the only possible explanation for the difference is that one group got treatment, & the other group didn't.