Example 1 (output after Example 3)

Do pregnant women who use cocaine have babies with lower birth weight than women who do not use cocaine? Pregnant women were tested for cocaine/crack, and the birth weights of babies (in grams) were recorded and averaged for women who tested positive and those who tested negative separately.

coc use		n	$\bar{x}$	s
NOT USE	Negative Test	5974	3118	672
USE	Positive Test	134	2733	599

① Type of problem   mean or proportion ?
One group / 2 indep groups / matched pairs ?
$\boxed{\text{2 indep means}}$

② Assumptions, • SRS of pregnant women who use / do not use cocaine. Truly random? Probably NOT.
Representative? ~~Pos~~ Possibly.
• $n \geq 30$ per group ✓

→ 95% CI for $\mu_1 - \mu_2$: estimator ± (t or z)* std. error

$$\bar{X}_1 - \bar{X}_2 \pm 1.96 \times \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} = (281.262, 488.738)$$

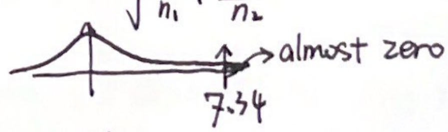
* means: t table w/ df very large, so can use $z_{0.025}$

• Interpretation: We are 95% confident that mothers who DO NOT use cocaine have babies that weigh between 281.262 and 488.738 grams more than mothers who USE cocaine.

→ Sig Test: $H_0: \mu_1 - \mu_2 = 0$ $H_a: \mu_1 - \mu_2 > 0$ (Why?)

$$TS: t = \frac{\text{est} - \#H_0}{\text{std.error}} = \frac{\bar{X}_1 - \bar{X}_2 - 0}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} = 7.34$$

p-val ≈ 0.000 (< 0.01)



Desicion: Reject H_0

Conclusion: We have very strong evidence to prove that pregnant women who USE cocaine have babies with lower birth weight than women who do not use cocaine.

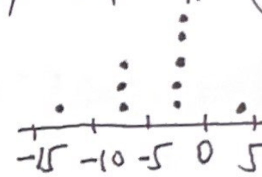
Example 2

Many children are diagnosed each year with asthma. In an effort to educate these children about their condition, an educational video was developed. To test the effectiveness of this video, ten randomly selected children, of elementary school age, who had been recently diagnosed, were chosen to participate in a study. A nurse asked the children a series of questions about asthma, then showed them the video and asked the questions again. The children's scores were as follows:

$\bar{X}_d$ mean $\sqrt{\frac{\sum(X_d-\bar{X}_d)^2}{n-1}}$ std.

	Child	1	2	3	4	5	6	7	8	9	10		
1	Before	61	60	52	74	64	75	42	63	53	56		
2	After	67	62	54	83	60	89	44	67	62	57		
	Diff	−6	−2	−2	−9	4	−14	−2	−4	−9	−1	−4.5	5.13

① Type of problem: ~~two~~ matched pairs mean



② Assumptions: ~~n≥30~~ OR original distribution is Normal

No outliers (data could have come from Normal population)

→ 95% CI: est $\bar{X}_d \pm (t \text{ or } z) * s.e.$

$$= \bar{X}_d \pm t_{9,0.025} \cdot \frac{std}{\sqrt{n}} = -4.5 \pm 2.262 \times \frac{5.13}{\sqrt{10}} = (-8.17, -0.83)$$

Interpretation: 95% confident that scores after video will be higher in population between 0.83 and 8.17 on average.

somewhere

→ Sig Test: $H_0: \mu_d = 0$ $H_a: \mu_d < 0$

$$TS: t = \frac{est - \#H_0}{std/\sqrt{n}} = \frac{-4.5-0}{5.13/\sqrt{10}} = -2.73$$

p-val: $P(t_{n-1} \le -2.73) = 0.011$ < 0.05, > 0.01 Desicion: Rej.

conclusion. We have pretty strong evidence to say video works

Example 3

The College Alcohol Study at the Harvard School of Public Health interviews samples of students at 119 colleges periodically and asks questions about their drinking habits and behavior. One of the questions asked was whether they had ever engaged in unplanned sexual activities because of drinking alcohol. In 1993, 2440 out of 12708 students surveyed answered yes to this question, while in 2001, 1871 out of 8783 answered yes. Has there been a significant increase?

① Type of problem: Yes/No – proportions Two groups

1993: $\hat{p}_1 = \frac{2440}{12708} = .192$ (19.2%)

2001: $\hat{p}_2 = \frac{1871}{8783} = .213$ (21.3%)

② Assumptions: • SRS of college students in 1993 + 2001

Random? Probably NOT. Representative? Likely. (119 ~~colleges~~ colleges)

• enough succ + fail per group (≥ 15) ✓

→ 95% CI for $p_1 - p_2$: $\hat{p}_1 - \hat{p}_2 \pm 1.96 \cdot \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}} = (-.032, -.010)$

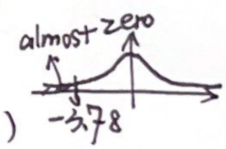
Interpretation: We are 95% confident that the proportion increase of college students who say "yes" to the question was between 1% and 3.2%.

→ Sig Test: $H_0: p_1 - p_2 = 0$ $H_a: p_1 - p_2 < 0$ (Why?)

TS: $\frac{\hat{p}_1 - \hat{p}_2 - 0}{\sqrt{\hat{p}(1-\hat{p})(\frac{1}{n_1} + \frac{1}{n_2})}} = -3.78$

where $\hat{p} = \frac{2440 + 1871}{12708 + 8783} = 0.201$.

p-val $= P(Z < -3.78 \mid Z \sim N(0,1)) \approx 0$ (< 0.01)



Desicion: Reject H_0

Conclusion: We have very strong evidence to say there was a significant increase in population.

Sidenote: Statistical significance – Diff in population based on results from sample

v.s.

Practical significance: Are the numbers "big"?

Design of Experiments (Ch. 4 in textbook)

Design of Experiments

- **Response variable**: What we want to draw conclusions about
- **Explanatory (predictor) variables**: Do these variables influence the response? Can we use them to predict response?
- **Treatments**: the conditions "applied" to the experimental units
- **Experimental units**: people/objects/animals on which the study is conducted
- **Replications**: # of people per treatment

Types of Studies

- **Experiments** assign participants to trt, control for all extraneous variables so we can prove cause / effect.
- **Observational Studies** observe + record

  Association is NOT causation
- **Surveys** opinions

Motivating Example: Which diet is best for losing weight?

- **Pick diets** you want to compare: low CARB, low FAT, low CAL
- **Find subjects**: Hard We assign them to diets/trts
- **Real experiment**: Make sure they all follow diets to the letter really hard.

  Even if we find one diet works best in a controlled environment, it does NOT mean it would work best in real life.

In our example we have:

- **Response variable:** (Quant.) wt loss

- **Explanatory variable:** (Categorical) diet

- **Treatments:** 3 diets

- **Experimental units:** people (the more the better)

- **Replications:** # ppl per trt. $\frac{N}{3}$ (if balanced)

To analyze data: Compare average weight loss with those diets.
ANOVA (Analysis of Variance) compares the means of 3 or more treatments.

What if:

- We added 2 more diets?

- We wanted to compare the effectiveness of the diets for males and females?