Register for AP Exams
Due Fri. Mar 10

pg. 785 1, 3-4, 7, 11, 13, 16ab, 17

13.1 Comparing Two Means

Paper Airplane Experiment (Tape Measure)

Lipitor vs. Pravachol

n = 4000 people with heart disease
Randomly assigned to two groups: L or P
① Bad cholesteral levels are tested

Is the difference statistically significant?

Comparing two means: $P(\bar{x}) = 95$ mg/dl
$L(\bar{x}) = 62$ mg/dl

② Patients who died, heart attack, or other serious condition within two years

Is the difference purely by chance?

Comparing two proportions: $P(\hat{p}) = .263$
$L(\hat{p}) = .224$

Two-sample problems - comparing two populations or two treatments

- Goal of inference is to compare the responses to two treatments or to compare the characteristics of two populations
- Separate sample from each treatment or each population.
- Responses of each group are independent of those in the other group

Example 13.1 (pg 781) Examples of two-sample studies

Matched Pairs vs. Two-Sample

Matched pairs matches samples; same size, traits, etc
Two samples do not require similarity, even in size

HW 13.2, 13.4 first (?)

Conditions for Comparing Two Means

SRS/Independence - Independent, random samples from the populations of interest or data from a randomized two-treatment experiment

Normality ① n_1 & $n_2 \geq 30$ CLT says distribution is ~N

② Graphs of sample data is ~N

③ Stated as ~N

Side-by-side w/ CI steps

Steps for two sample t-test for difference in Means

① State the hypothesis: $H_0: \mu_1 - \mu_2 = 0$

$H_a: \mu_1 - \mu_2 \ (<, >, \neq)\ 0$

② Procedure: Two sample t-test for the difference in mean __(context)__ for all __(context)

③ Check conditions: SIN

④ Computation: $t = \dfrac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)_{H_0}}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}}$ df = ___

(z = same w/o df)

p-value = ___

⑤ Conclusion: Since the p-value ___ is $<$ / $>$ α ___ I reject/fail to reject H_0 that (context). There is/is not evidence to conclude (context).

Degrees of freedom Two-Sample t stat

$$df = \frac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{1}{n_1 - 1}\left(\dfrac{s_1^2}{n_1}\right)^2 + \dfrac{1}{n_2 - 1}\left(\dfrac{s_2^2}{n_2}\right)^2}$$

Calculator: $\boxed{\text{STAT}}$ $\boxed{\text{TESTS}}$

2-SampTest

w/o technology: use smaller of $n_1 - 1$ and $n_2 - 1$

13.1 cont'd

Calculator Technology toolbox pg. 795
Significance test
Confidence Intervals

Pooling - procedure averaging (pooling) two sample variances to estimate the common population variance. Populations are assumed to have equal variances in a pooled test. Since variances are rarely equal in a two-sample test, DO NOT Pool

Steps for a two-sample t CI:

① Procedure: Two-sample t CI for $\mu_1 - \mu_2$ where $\mu_1 - \mu_2$ = the difference in mean _____ for all ____ (μ_1) and all ____ (μ_2)

② Check conditions. (same as two-sample t)

③ Computation: $(\bar{x}_1 - \bar{x}_2) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$

$t^* = \text{invT}(\text{area}, df)$

④ Conclusion: Based on these samples, I am ____ % confident that the true difference in mean _____ for all _____ and all _____ is between _____ and ____.

Example 1 Tangrams

Andy's Puzzle: $\bar{x} = 157.765$ $s = 116.762$ $n = 17$

Volcano Puzzle: $\bar{x} = 93.231$ $s = 66.708$ $n = 27$

ⓐ Do the data provide convincing evidence at the $\alpha = .05$ level, that the average number of clicks used to solve the tangram is significantly higher for Andy's Puzzle than for the Volcano puzzle.

① $H_0: \mu_A - \mu_V = 0$ $H_a: \mu_A - \mu_V \neq 0$

② Two-sample t-test for the difference in the mean number of clicks needed to complete Andy's Puzzle (μ_A) and the Erupting Volcano (μ_V) for all students who complete both puzzles.

③ We will consider the samples as independent and random. Both sample sizes (17 and 27) are > 15, so the CLT says the sampling is ~N.

④ $$t = \frac{(157.765 - 93.231) - 0}{\sqrt{\frac{116.762^2}{17} + \frac{66.708^2}{27}}} \approx 2.076$$

p-value = $P(t > 2.076)$ = .025

df = 22.663 (calc)

⑤ Since the p-value $.025 < \alpha = .05$, we reject H_0. There is evidence to conclude the average number of clicks used to solve the tangram is significantly higher for Andy's puzzle than the volcano.

13.1 Cont'd

Slide 13.1 **Example 2 Fast food**

McDonald's average service time was 188.83 seconds with a standard deviation of 17.38 sec for a random sample of 362 drive-thru visits. Burger King on a separate random sample of 318 visits resulted in a mean of 201.33 seconds and a standard deviation of 18.85 sec.

Construct and interpret a 99% CI for the difference in mean services times at McD and BK.

Procedure ① Two-sample t confidence interval for $\mu_m - \mu_B$ where $\mu_m - \mu_B$ = the difference in mean service times for all McD (μ_m) drive-thrus and all BK (μ_B) drive-thrus

Conditions ② It is stated these are independent, random samples from all McD's and BK drive thrus. Since 362 > 30 and 318 > 30, the CLT says the sampling distribution will be ~N.

Computation ③ $(\bar{x}_m - \bar{x}_B) \pm t^* \sqrt{\frac{s_m^2}{n_m} + \frac{s_B^2}{n_B}}$

Stat/Test/2SampTTest
df = 649.284
invT(.995, 649.284)

$(188.83 - 201.33) \pm 2.583 \sqrt{\frac{17.38^2}{362} + \frac{18.85^2}{318}}$

$(-16.11, -8.891)$

df = 649.284

(4) Based on these samples, I am 99% confident that the true difference in mean service time for all McD's and all BK drive-thrus (McD-BK) is between -16.11 and -8.891 seconds