Comparing Two Means

Please read the attached lesson on Hypothesis Testing for two independent population means. We are trying to find out if there is a difference between the mean of one sample to another second sample. For Confidence intervals you follow PANIC and for hypothesis testing you follow PHANTOMS. If after reading the lesson below with example, you still cannot figure out how to do the 3 problems, please read Section 10.2 in the textbook.

Reminders:

HW tonight: HW #46 (NO Data Exploration) Please bring or have cell phone ready for Case Study #9 and #10 for Friday.

HW Due Tuesday: HW #43 & HW #47 (Practice Tests in book)

Thursday February 16th: Significant Testing and Confidence Intervals form Chapters 9&10.

On my website under Inference: **"Significant Test Practice Multiple Choice"** and **"Hypothesis Testing in a Nutshell"** are two good practice or resources for the test.

Comparing Two Means

We have examined and performed test with the null hypothesis *Hₒ*: $\mu = \mu_o$ against some alternative. Those were one-sample t-tests 9section 9.3). But it is possible to do two-sample t-tests as well (like we did 2-sample z –test for proportions in section 10.1 on Monday)—to compare one set of data to another.

So, when we have a two-sample design, the requirements are these:

- We have two random samples from 2 distinct populations. The samples are independent.
- To find the Confidence Interval for $\mu_1 - \mu_2$, use the formula: $(\bar{x}_1 - \bar{x}_2) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ for degrees of freedom of the smaller of $n_1 - 1$ and $n_2 - 1$.
- The same conditions apply as one-sample but you have to check for both samples (*for stats, check Central Limit Theorem; for Data plot 2 NPP's and check 2 modified boxplots for outliers*).
- To use a hypothesis test, it is very similar to one-sample except starred steps are different:
  *1) Parameter of interest is the difference between the two population means $\mu_1 - \mu_2$
  2) Hypotheses: H_o: $\mu_1 = \mu_2$ or H_o: $\mu_1 - \mu_2 = 0$ and H_a: $\mu_1 \neq,>,< \mu_2$ or H_o: $\mu_1 - \mu_2 \neq,>,< 0$
  *3) Check conditions for BOTH Populations
  *4) Name: 2-samplt t-test for independent samples
  5) Test statistic: $t = \frac{(\bar{x}_1-\bar{x}_2)-0}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$ for df: $n_1 - 1$ and $n_2 - 1$. (or use Calculator's DF)
  6) Find you p-value on calculator : 2-SampTTest and compare it to alpha and shade normal curve.
  7) Reject or not reject null and state whether there is evidence or no evidence.

Example: Back in 2014 football season, New England patriots QB and the organization were accused of using footballs that were deflated (or below the expected Psi for an NFL football). Below is the comparison between Brady's footballs and the Colts when measured after the game. Is there evidence that the mean PSI in the Patriots footballs was lower than the mean Psi in the Colts' footballs?

Table 2. Pressure measurements of the footballs as recorded on Game Day.

Team	Ball	Tested by Clete Blakeman	Tested by Dyrol Prioleau
Patriots	1	11.50	11.80
	2	10.85	11.20
	3	11.15	11.50
	4	10.70	11.00
	5	11.10	11.45
	6	11.60	11.95
	7	11.85	12.30
	8	11.10	11.55
	9	10.95	11.35
	10	10.50	10.90
	11	10.90	11.35
Patriots Average		*11.11*	*11.49*
Colts	1	12.70	12.35
	2	12.75	12.30
	3	12.50	12.95
	4	12.55	12.15
Colts Average		*12.63*	*12.44*

P: Find evidence that the mean PSI in the Patriots footballs were lower than that of the Colts' footballs.
H: H_o: $\mu_P - \mu_C = 0$ or $\mu_P = \mu_C$ H_a: $\mu_P - \mu_C < 0$ or $\mu_P < \mu_C$ where μ_P mean Psi of Patriots and μ_C mean Psi of Colts
A: Not random samples but the balls were randomly given to the game
n = 11 and 4 are less than 10% of all footballs by NFL
Check NPP for both data and modified boxplots.
N: 2-sample t-test for independent samples
T: $t = \frac{(\bar{x}_1-\bar{x}_2)-0}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}} = t = \frac{(11.11-12.63)-0}{\sqrt{\frac{s0.403_1^2}{11}+\frac{.119_2^2}{4}}} = -11.218$ from T!=84 Calculator (say no to pool)
df=12.9 p-value = 0.0000000252
O; Alpha level .01 make a normal curve with shade
M: Since p-value is way lower than alpha level (0.01), we reject the null hypothesis.
S: There is a lot of evidence that the mean Psi in the New England Patriots footballs were way lower than the mean Psi in the Colts' footballs. Brady cheated!!!!!