AP Statistics
Unit 07 – Day 05 Notes
Significance Tests: 2-Sample Means

Name Key
Period______

Two-sample t-Test for the difference between means

The conditions for the two-sample t-test for the difference between the means of two independent groups are the same as for the two-sample t-interval. We test the hypothesis:

$$H_0: \mu_1 - \mu_2 = \Delta_0 \text{ (delta naught)} \qquad \text{or} \qquad H_0: \mu_1 = \mu_2$$

where the hypothesized difference is almost always 0, using the statistic

$$\boxed{t = \frac{(\bar{x}_1 - \bar{x}_2) - \Delta_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}}$$

When the conditions are met and the null hypothesis is true, this statistic can be closely modeled by a Student's t-model with a number of degrees of freedom given by a special formula. We use that model to obtain a P-value.

we use the calculator

Pooled T-Test for Means

The conditions for the pooled t-test for the difference between the means of two independent groups are the same as for the two-sample t-test with the **additional assumption that the variances of the two groups are the same**. We test the hypothesis:

$$H_0: \mu_1 - \mu_2 = \Delta_0 \qquad \text{or} \qquad H_0: \mu_1 = \mu_2$$

where the hypothesized difference Δ_0, is almost always 0, using the statistic

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - \Delta_0}{\sqrt{\frac{s_{pooled}^2}{n_1} + \frac{s_{pooled}^2}{n_2}}}$$

where the pooled variance is

$$s_{pooled}^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)}$$

need to know in case you have a MC question about it

When the conditions are met and the null hypothesis is true, we can model this statistic's sampling distribution with a t-model with $(n_1 - 1) + (n_2 - 1)$ degrees of freedom. We use that model to obtain a P-value for a test. **We only use a pooled t test IF we don't have technology to calculate our DF & the variances are equal. The population variances are rarely exactly equal in real life. The only other reason we would use a pooled t test is if we are told we must.**

CALCULATOR:

1. STATS → TESTS → 2-SampTTest
2. Fill in values or choose data
3. Click CALCULATE

	prop	means
CI	no	no
ST	yes	no

unless we're told to!

Example 1:

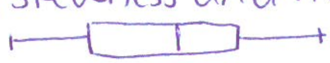
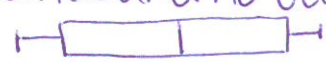
A researcher wants to determine if there is a difference in the price people would offer a friend rather than a stranger when selling personal items. The researcher randomly divided subjects into two groups and gave each group descriptions of items they might want to buy. The data below represents two independent groups:

Price Offered For a Used Camera ($)	
Buying from a FRIEND	Buying from a STRANGER
275	140
300	250
260	175
300	130
255	190
275	225
290	240
315	

State: μ_1 = the true mean price of a used camera offered to a friend.
μ_2 = the true mean price of a used camera offered to a stranger.

$H_0: \mu_1 = \mu_2$ $\bar{x}_1 = \$283.75$
$H_A: \mu_1 \neq \mu_2$ $\bar{x}_2 = \$192.86$ $\alpha = 0.05$

Plan: Random: subjects randomly divided into 2 independent groups ✓
10% condition: $n_1 = 8$ 80 < all times a used camera has been sold to a friend ✓
$n_2 = 7$ 70 < all times a used camera has been sold to a stranger ✓

Normal/Large: $n_1 = 8 < 30$ but a rough sketch of the data shows no strong skewness and no outliers: 
$n_2 = 7 < 30$ but a rough sketch of the data shows no strong skewness and no outliers: 

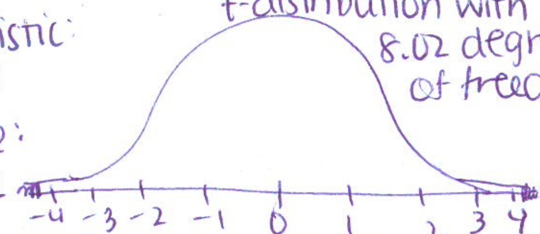
Because our conditions are met, we will perform a 2-sample t-test for the difference of 2 means $\mu_1 - \mu_2$.

DO: 2-SampTTest
$\bar{x}_1$: 283.75 $\bar{x}_2$: 192.86 $\mu_1 \neq \mu_2$
Sx_1: 21.00 Sx_2: 47.60 pooled: no
n_1: 8 n_2: 7 df: 8.02

test statistic: 4.67

p-value: 0.001592

t-distribution with 8.02 degrees of freedom:



Conclude: Because our p-value = 0.001592 is less than our significance level $\alpha = 0.05$, we reject the null. There is convincing evidence that there is a difference in the true mean prices offered to strangers and friends for a used camera.

Example 2:

Many office "coffee stations" collect voluntary payments for the food consumed. Researchers at the University of Newcastle upon Tyne performed an experiment to see whether the image of eyes watching would change employee behavior. They alternated pictures of eyes looking at the view with pictures of flowers each week on the cupboard behind the "honesty box," randomly choosing which went first. They measured the consumption of milk to approximate the amount of food consumed and recorded the contributions in pounds each week per liter of milk. The graphs of the data sets show no strong skewnes ... heir results:

replace or edit this problem. it sucks!

		Flowers
n (# weeks)		5
$\bar{x} = mean$		0.151
$S_x = standard\ deviation$		0.067

Do these results provide evidence ... y even when its only photographs of eyes that are "wc ...

State: μ_1 = the true m ... per liter of milk consumed eac ... g" the honesty box

μ_2 = the true m ... ls' per liter of milk consumed eac ... wers next to the honesty box.

$H_0: \mu_1 = \mu_2$ $\bar{x}_1 = 0.417$ pounds/liter

$H_A: \mu_1 \neq \mu_2$ $\bar{x}_2 = 0.151$ pounds/liter $\alpha = 0.05$

Plan: random: independent weekly contributions and randomly assigned photos above the honesty box. ✓

10% condition: $n_1 = 5$ 50 < all weeks where "eyes watching" could ✓ be placed over the honesty box and voluntary payments are collected

$n_2 = 5$ 50 < all weeks where flower photos could ✓ be placed over the honesty box and voluntary payments are collected.

Normal/Large:

$n_1 = 5 < 30$ and $n_2 = 5 < 30$

but a graph of the data sets show no strong skewness and no outliers

Because our conditions are met, we will perform a 2-sample t-test for difference of 2 means $\mu_1 - \mu_2$.

DO: 2-SampTTest

$\bar{x}_1$: 0.417 pooled: no

Sx_1: 0.1811 test statistic: 3.0803

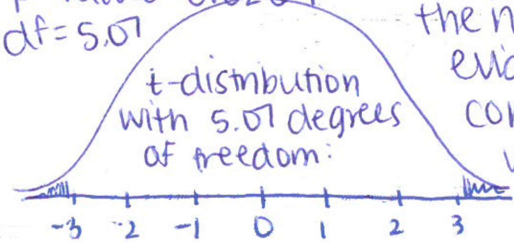
n_1: 5 p-value: 0.0269

$\bar{x}_2$: 0.151 df = 5.07

Sx_2: 0.067

n_2: 5

$\mu_1 \neq \mu_2$



Conclude: Because our p-value = 0.0269 is less than our significance level $\alpha = 0.05$, we reject the null hypothesis. There is convincing evidence that the true mean contribution (pounds/milk liters) differs when "eyes are watching" from when flower photos are up.