Analysis of Psychological Data

Lab 8. Welcome to the 'T' World: Independent/Related-Sample T-Test

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Some announcements

Syllabus has been updated (see CatCourses)

No class on April 28

Extra credit assignments on April 21 & April 28

Use this opportunity to boost your GPA!!!

Homework 5

Will be available tomorrow $\Longrightarrow$ Get my help!

What are we going to do?

Recap to give you a big picture

Independent-sample t-test

Related-sample t-test

Do it together

Statistical inference

Estimation

Let's make a best guess about the population parameter

Point estimate and interval estimate

Hypothesis testing

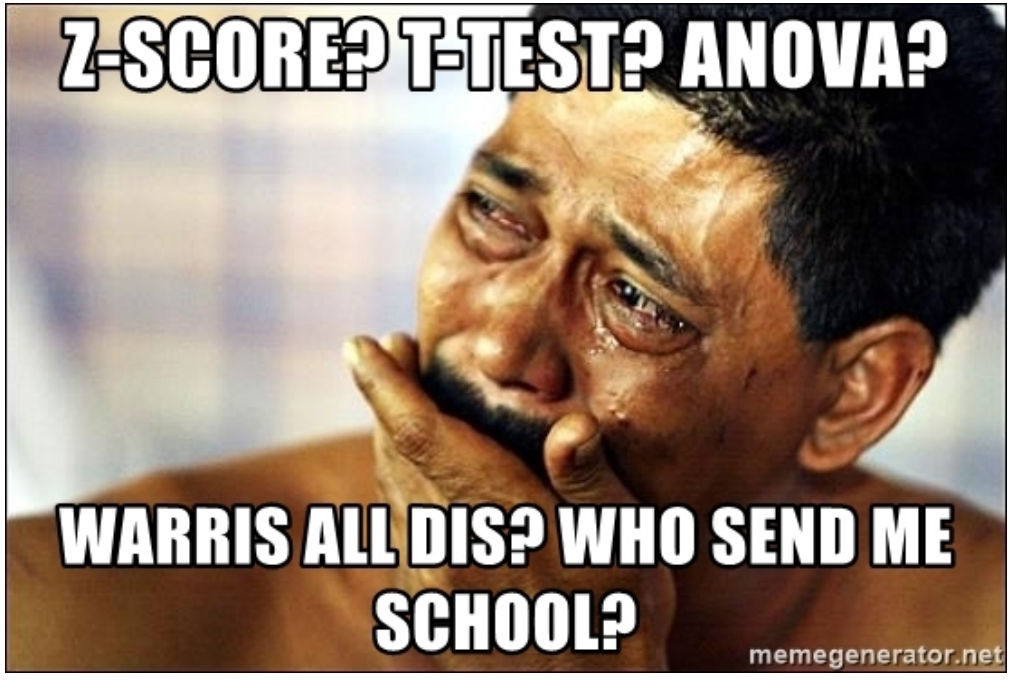
Let's test if our guess is really the case or not

Reject the null hypothesis when
p-value $< \alpha$-level $\iff |z_{obt}| > |z_{crit}| \iff |t_{obt}| > |t_{crit}|$

Are you ready?

z-test, t-test, ANOVA, ANCOVA, MANOVA, MANCOVA, RM-ANCOVA... WHAT?!

Playing the game of statistical inference about population 'means'



Recap: z-test

Idea

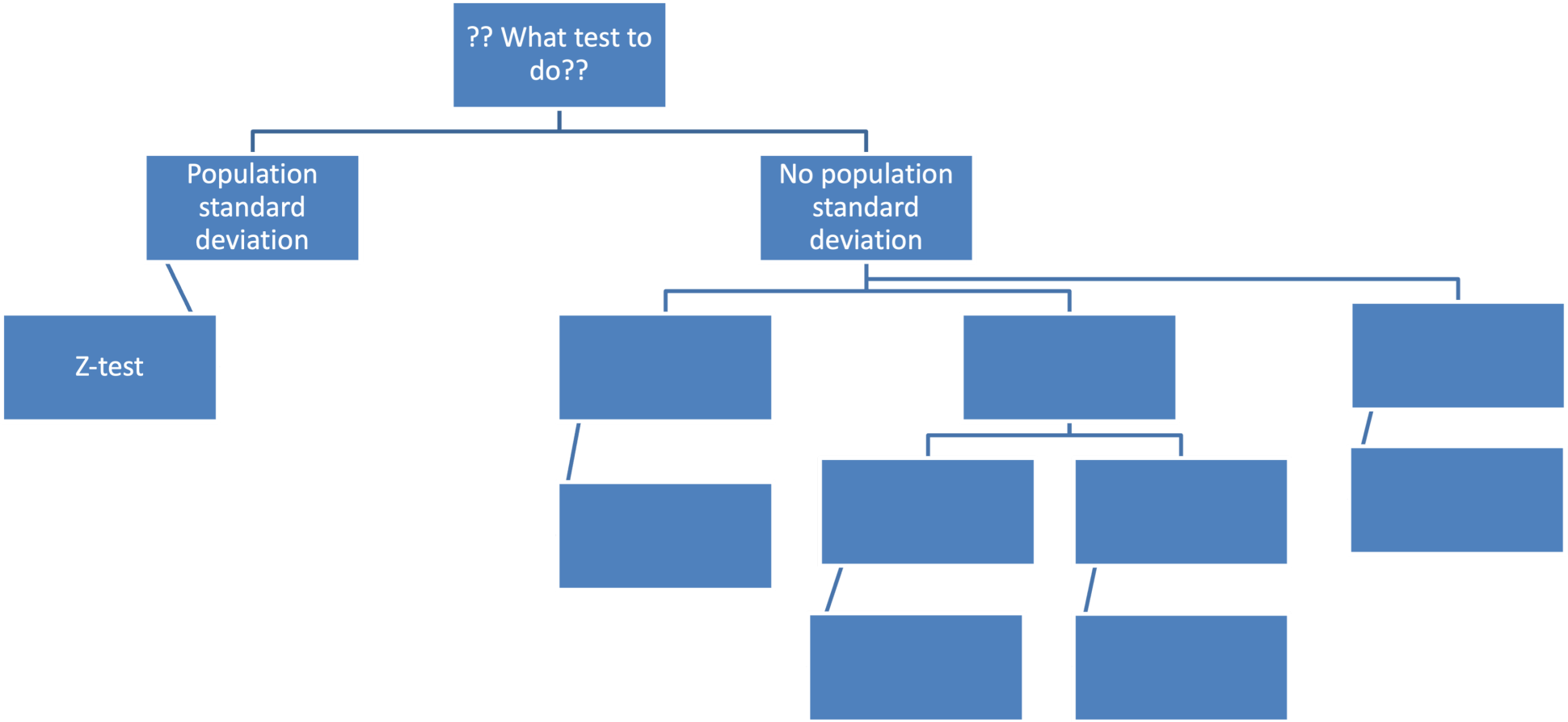
We have a sample mean (estimation)

When we know the population mean and standard deviation, we test if the likelihood of observing our sample mean or more extreme is significantly low (hypothesis testing)

Test-statistic

$$z_{obt} = \frac{\overline{X} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

Big picture


?? What test to do??
Population standard deviation
No population standard deviation
Z-test

Recap: one-sample test

Idea

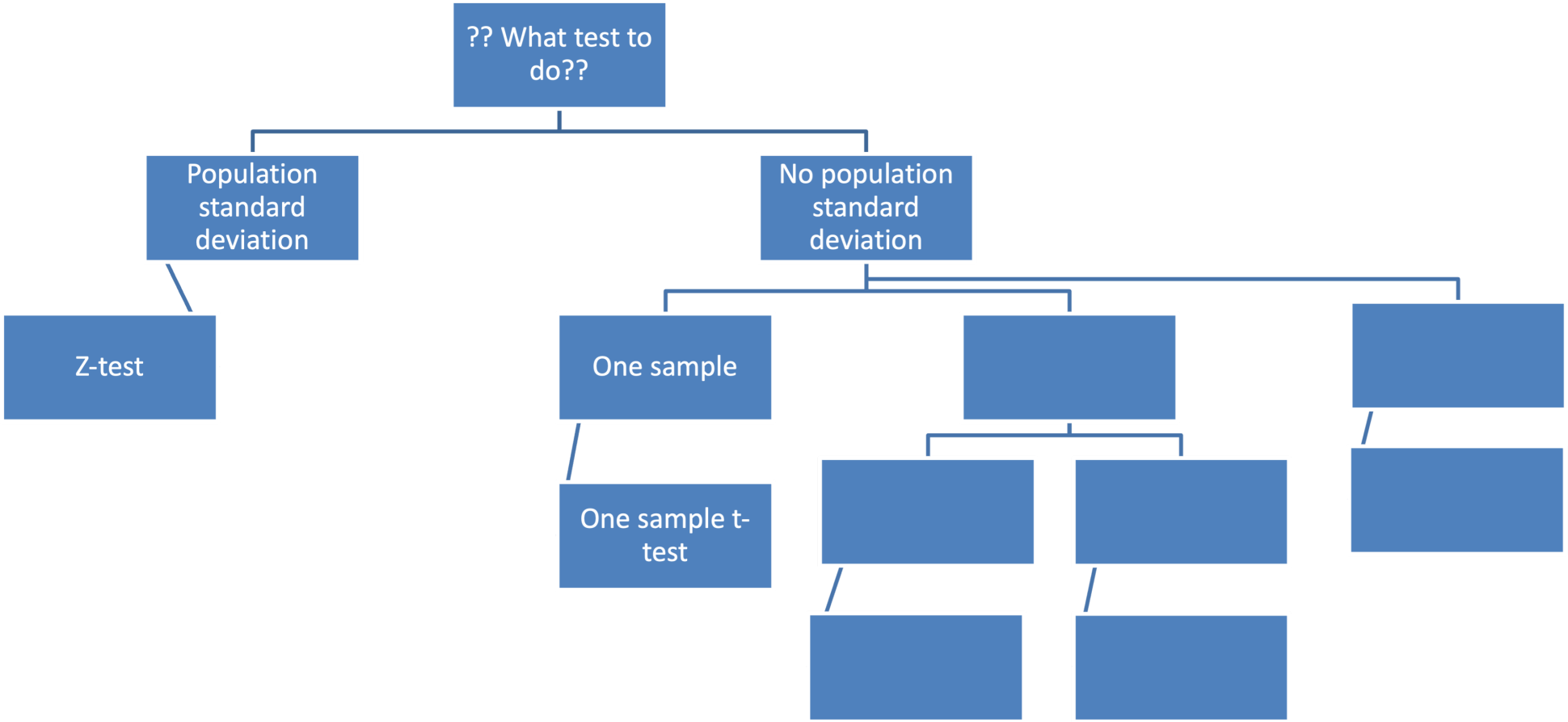
We have one sample mean (estimation)

When we only know the population mean, we test if the likelihood of observing our sample mean or more extreme is significantly low using sample standard deviation (hypothesis testing)

Test-statistic

$$t_{obt} = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}}$$

Big picture


?? What test to do??
Population standard deviation
No population standard deviation
Z-test
One sample
One sample t-test

Independent-sample t-test

"Independent-sample"...

What is it?

Independent-sample t-test

What does it test?

To compare two samples whether they are different from each other

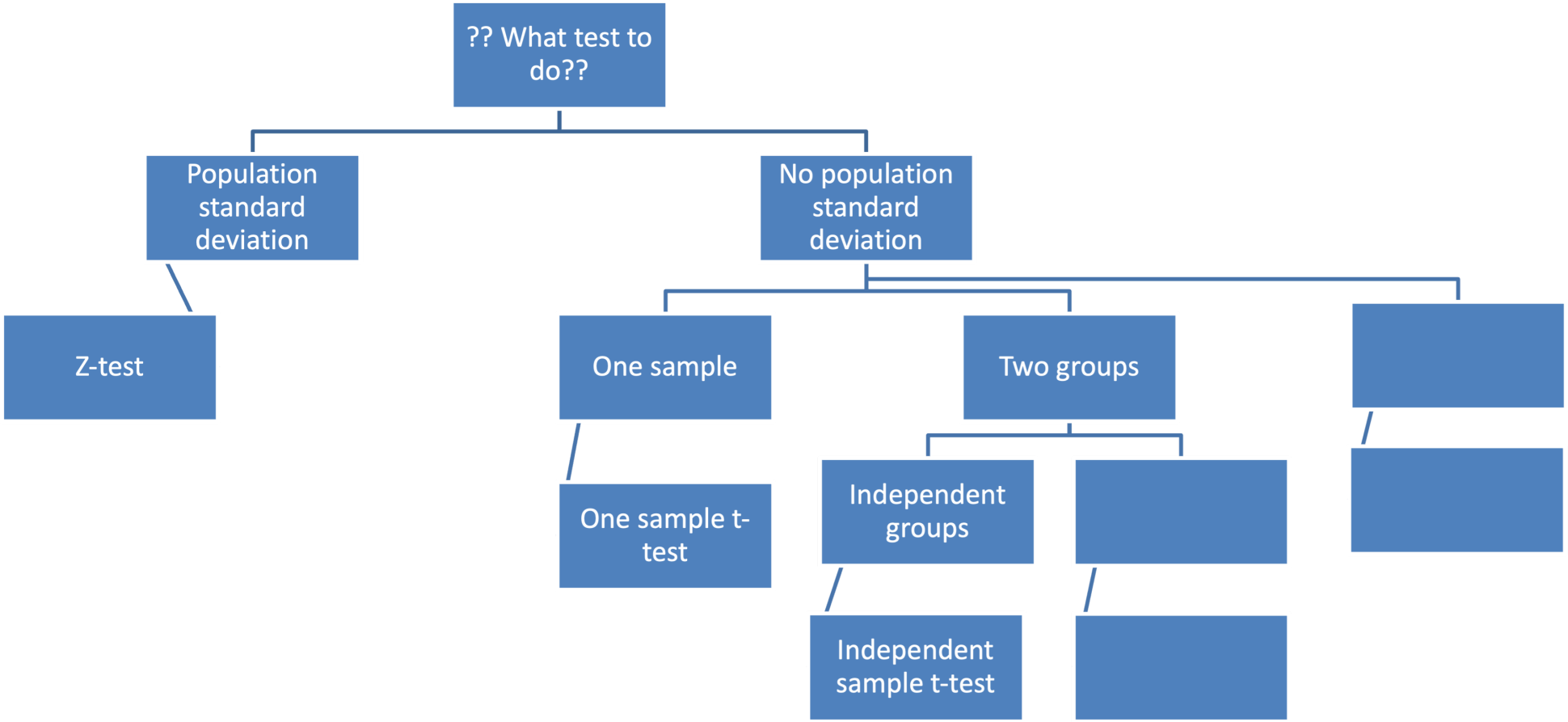
Note

We use the t-distribution based on df of $n_1 + n_2 - 2$

But, when?

We know the population mean but not the population standard deviation

Big picture


?? What test to do??
Population standard deviation
No population standard deviation
Z-test
One sample
Two groups
One sample t-test
Independent groups
Independent sample t-test

Do it together

Rosimary, a chief school psychologist at Harvard University, conducts an experiment to study the effect of a newly invented study program on academic achievement. She assigns participants into two groups: experimental and control. In each group, there are 50 people. In the population, it is known that the means of academic achievement are the same between the two groups. After the program, it is observed that the means of academic achievement are 80 for the experimental group and 50 for the control group. Use the α-level of .05.

Which statistical technique should we use? Why?

Do it together

Step 1. State the null hypothesis and alternative hypothesis

$$H_0 : \mu_1 = \mu_2$$

$$H_1 : \mu_1 \neq \mu_2$$

Do it together

Step 2. Set the level of significance

$\alpha =$

Do it together

Step 3. Compute the test-statistic (in this case, t-statistic)

$$t_{obt} = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_{\bar{X}_1 - \bar{X}_2}} =$$

where

$$s_{\bar{X}_1 - \bar{X}_2} = \sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}} =$$

where

$$s_p^2 = \frac{s_1^2(df_1) + s_2^2(df_2)}{n_1 + n_2 - 2} = \frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2} = \frac{SS_1 + SS_2}{n_1 + n_2 - 2} =$$

Do it together

Step 4. Make a statistical decision

Reject H_0 if p-value $< \alpha$
$\iff |t_{obt}| > |t_{crit}|$

We need to see the t-table

What is the degrees of freedom for the independent-sample t-test?

$n_1 + n_2 - 2$

Do it together

Step 4. Make a statistical decision

Find a correct critical t-value

https://catcourses.ucmerced.edu/courses/23514/files/4944724?module_item_id=297542

See if $|t_{obt}| > |t_{crit}|$

What is our decision?

Do it together

Additional steps

Calculate the effect size (meaningful if significant)

Calculate the confidence interval

Do it together

Additional step 1. Effect size

$$d = \frac{\bar{X}_1 - \bar{X}_2}{s_p} =$$

How to interpret?

Our sample mean is ~~~ standard deviation units above/below the population mean difference

Small (0.2)? Medium (0.5)? Large (0.8)?

Do it together

Additional step 2. Confidence interval

Lower limit: $(\bar{X}_1 - \bar{X}_2) - s_{\bar{X}_1 - \bar{X}_2} \times t_{crit}$

Upper limit: $(\bar{X}_1 - \bar{X}_2) + s_{\bar{X}_1 - \bar{X}_2} \times t_{crit}$

Does the confidence interval contain the population mean difference?

What does this confidence interval mean?

Related-sample t-test

"Related-sample"...

What is it?

Related-sample t-test

What does it test?

To compare two samples whether they are different from each other

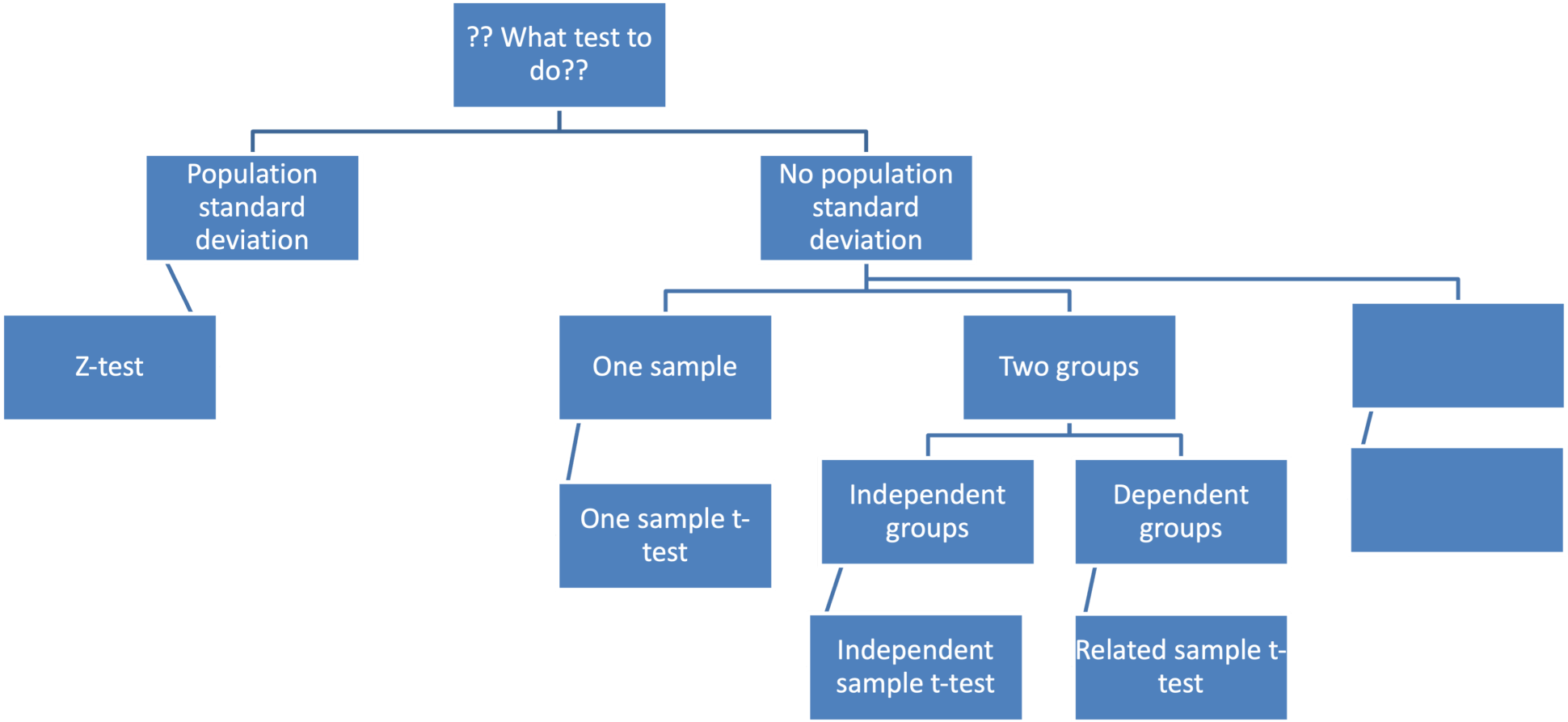
Note

We use the t-distribution based on df of $n - 1$

But, when?

We know the population mean but not the population standard deviation

Big picture


?? What test to do??
Population standard deviation
No population standard deviation
Z-test
One sample
Two groups
One sample t-test
Independent groups
Dependent groups
Independent sample t-test
Related sample t-test

Do it together

Mireya, a biological scientist at Stanford University, conducts an experiment to study if the level of happiness has changed between February and April. From 100 participants, she repeatedly measured the level of happiness in February and April. In the population, it is known that the mean level of happiness is the same between two months. In her sample, it is observed that the mean happiness in February is 50 and that in April is 80. Use the α-level of .05.

Which statistical technique should we use? Why?

Do it together

Step 1. State the null hypothesis and alternative hypothesis

$$H_0 : \mu_1 = \mu_2$$

$$H_1 : \mu_1 \neq \mu_2$$

Do it together

Step 2. Set the level of significance

$\alpha =$

Do it together

Step 3. Compute the test-statistic (in this case, t-statistic)

$$t_{obt} = \frac{\bar{D}_{obt} - \mu_D}{\frac{s_D}{\sqrt{n}}}$$

Do it together

Step 4. Make a statistical decision

Reject H_0 if p-value $< \alpha$
$\iff |t_{obt}| > |t_{crit}|$

We need to see the t-table

What is the degrees of freedom for the independent-sample t-test?

$n - 1$

Do it together

Step 4. Make a statistical decision

Find a correct critical t-value

https://catcourses.ucmerced.edu/courses/23514/files/4944724?module_item_id=297542

See if $|t_{obt}| > |t_{crit}|$

What is our decision?

Do it together

Additional steps

Calculate the effect size (meaningful if significant)

Calculate the confidence interval

Do it together

Additional step 1. Effect size

$$d = \frac{\bar{D}_{obt}}{s_D} =$$

How to interpret?

Our sample mean is ~~~ standard deviation units above/below the population difference score

Small (0.2)? Medium (0.5)? Large (0.8)?

Do it together

Additional step 2. Confidence interval

Lower limit: $\bar{D}_{obt} - s_{\bar{D}} \times t_{crit}$

Upper limit: $\bar{D}_{obt} + s_{\bar{D}} \times t_{crit}$

Does the confidence interval contain the population difference score?

What does this confidence interval mean?

Before you go home...

Lab materials are available at

https://github.com/lhnwhiHeo/PSY010

Any questions or comments?

Office hours or my email

Thanks! Have a good one!