



Analysis of Psychological Data

Lab 9. Hey Means, Don't Be Mean To Us: One-Way ANOVA

Ihnwhi Heo (iheo2@ucmerced.edu)

Quantitative Methods, Measurement, and Statistics

Website: <https://ihnwhiheo.github.io>

Office: <https://ucmerced.zoom.us/j/2093557522> (Thursday 3:30 - 5:30 pm)



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

Due April 19



What are we going to do?

Recap to give you a big picture

One-Way ANOVA

Do it together



Statistical inference

Estimation

Let's make a best guess about the population parameter

Hypothesis testing

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

Reject the null hypothesis when
 $p\text{-value} < \alpha\text{-level}$

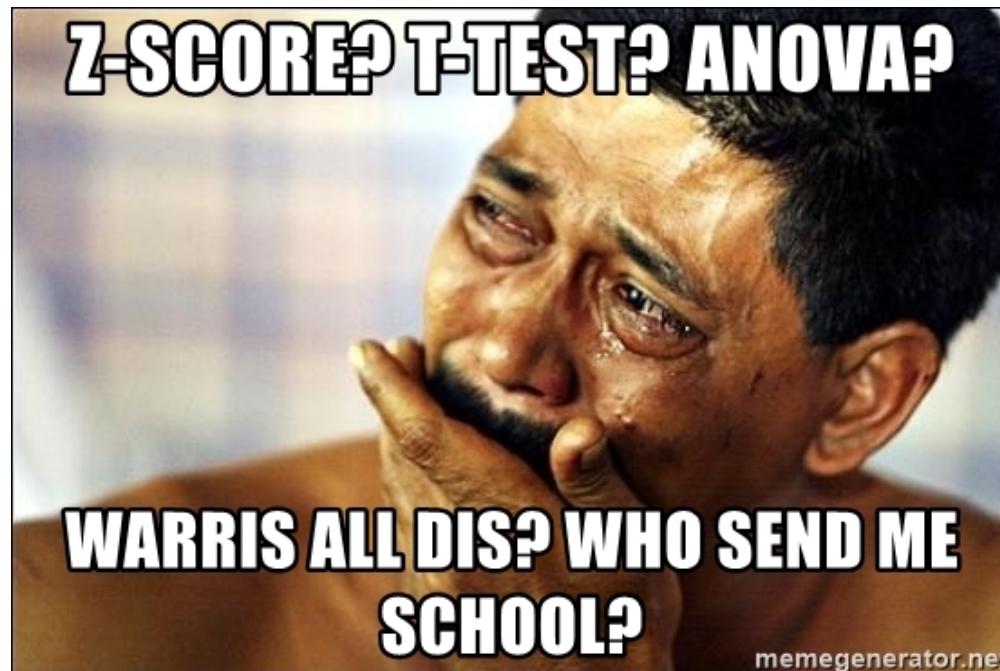
$$\iff |z_{obt}| > |z_{crit}| \iff |t_{obt}| > |t_{crit}| \iff F_{obt} > F_{crit}$$



Are you ready?

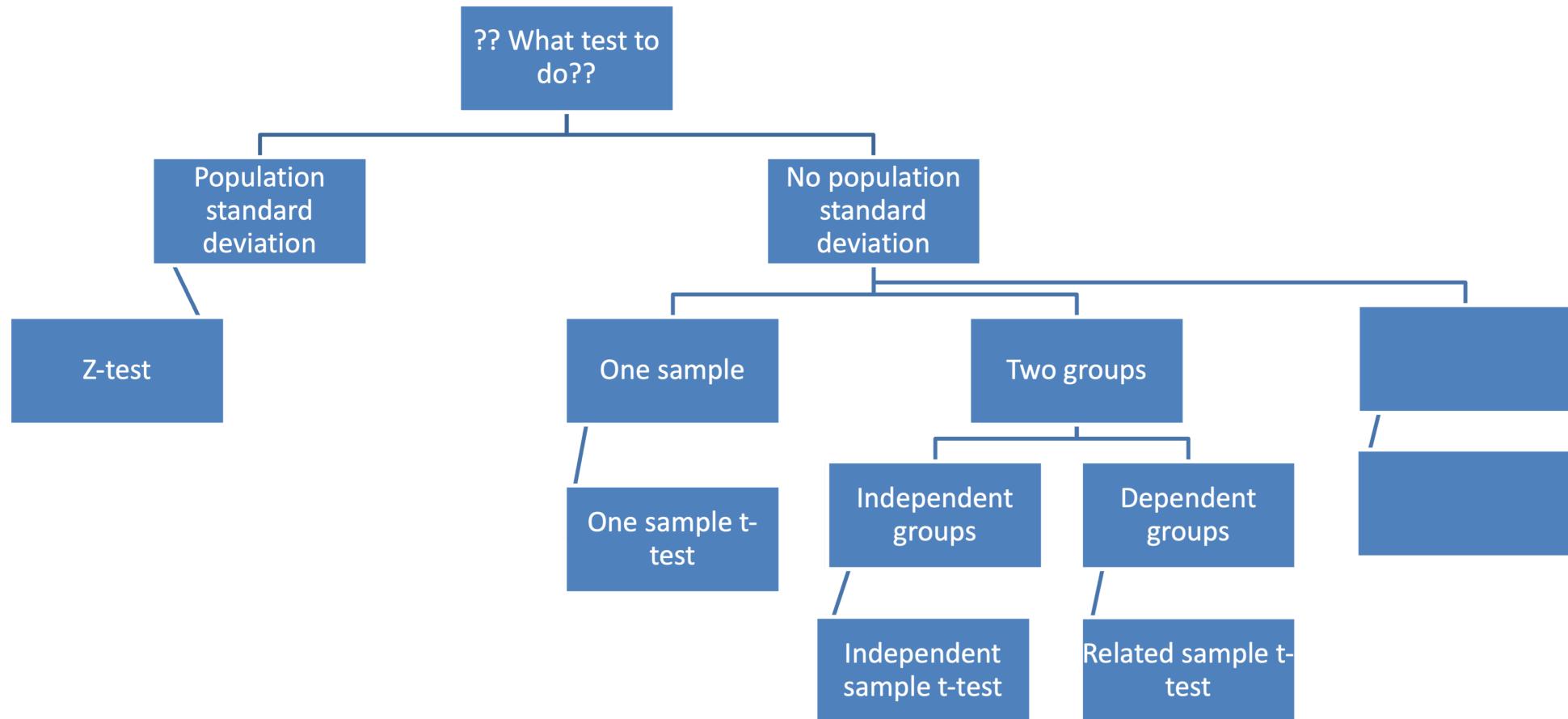
z-test, t-test, ANOVA, ANCOVA, MANOVA, MANCOVA, RM-ANCOVA... WHAT?!

Playing the game of statistical inference about population 'means'





Big picture





A gentle introduction to ANOVA

So far, we've only compared one group or two groups

z-test, one-sample t-test, independent-sample t-test, related-sample t-test

What if we have three groups?
(e.g., Merced College, UC Merced, Merced High School)

ANOVA (= Analysis of Variance)



A gentle introduction to ANOVA

Variables

So far, we think of our variables as different groups

For ANOVA, think of our variables as multiple levels of the same variable

That is,

Instead of comparing Merced College vs. UC Merced vs. Merced High School

We have 'school type' as the independent variable (*aka.* factor in ANOVA context)

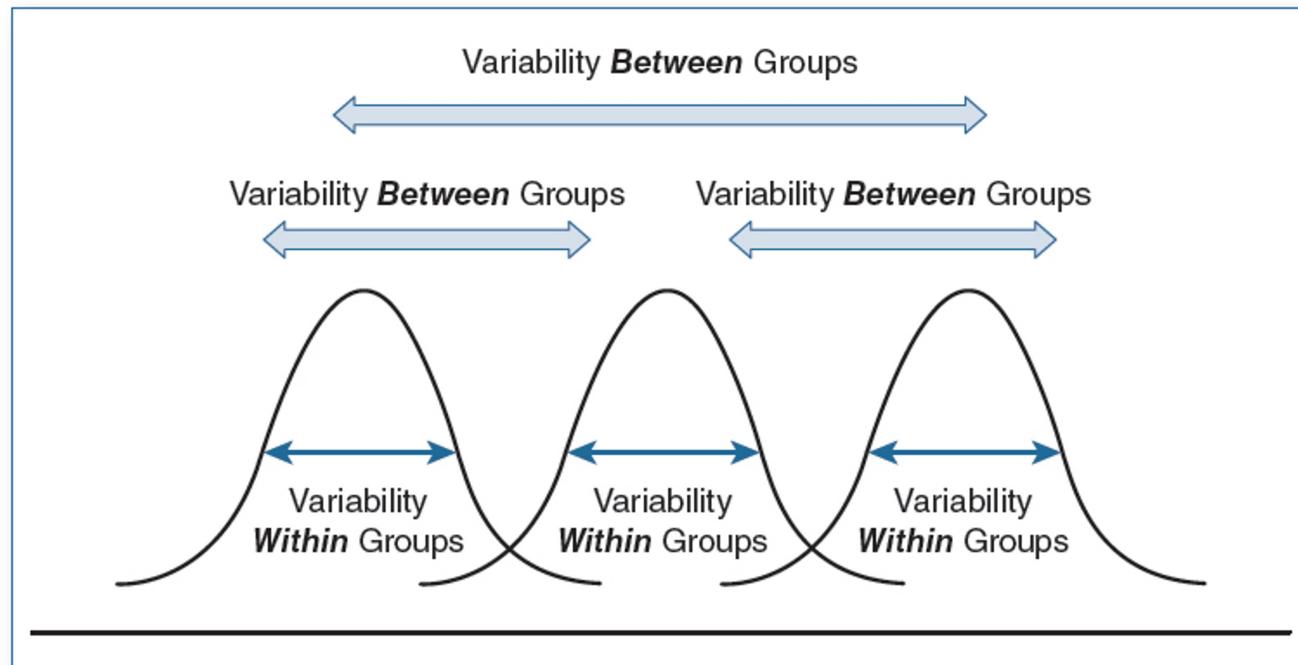
The 'school type' has 3 levels: Merced College, UC Merced, and Merced High School



One-way ANOVA

'N-Way': N = the number of IV (or factor)

One-way ANOVA: ANOVA using one IV; factorial ANOVA: 2 or more IV





One-way ANOVA

Hypotheses in ANOVA

Assuming there are three groups (Merced College, UC Merced, Merced High School)

Null hypothesis (H_0)

$$\mu_{MC} = \mu_{UCM} = \mu_{MHS} \iff \sigma_\mu^2 = 0$$

Alternative hypothesis (H_1)

At least one pair has a different mean $\iff \sigma_\mu^2 > 0$



One-way ANOVA

F-ratio

Test-statistic for ANOVA

The ratio between the between group-variability and within-group variability

Larger F-ratio → larger portion of between-group variability compared to within-group variability

$$F_{obt} = \frac{\frac{SS_{between}}{df_{between}}}{\frac{SS_{within}}{df_{within}}} = \frac{MS_{between}}{MS_{within}}$$



One-way ANOVA

'Variance' is the key, and do you remember that SS plays a role in variance?

Population variance and sample variance

$$\sigma^2 = \frac{\sum_{i=1}^N (X_i - \mu_X)^2}{N} \text{ and } s^2 = \frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1}$$

Can you find SS and df?



One-way ANOVA

We 'separate' the between-group variance and within-group variance

In terms of SS

$$SS_{total} = SS_{between} + SS_{within}$$

In terms of df

$$df_{total} = df_{between} + df_{within}$$
$$N - 1 = (k - 1) + (N - k)$$



One-way ANOVA

Mean squares → What does it look like?!?!

$$MS_{between} = \frac{SS_{between}}{df_{between}}$$

$$MS_{within} = \frac{SS_{within}}{df_{within}}$$

Finally, F-ratio → Compare this to the critical F-ratio

$$F_{obt}(df_{between}, df_{within}) = \frac{MS_{between}}{MS_{within}}$$



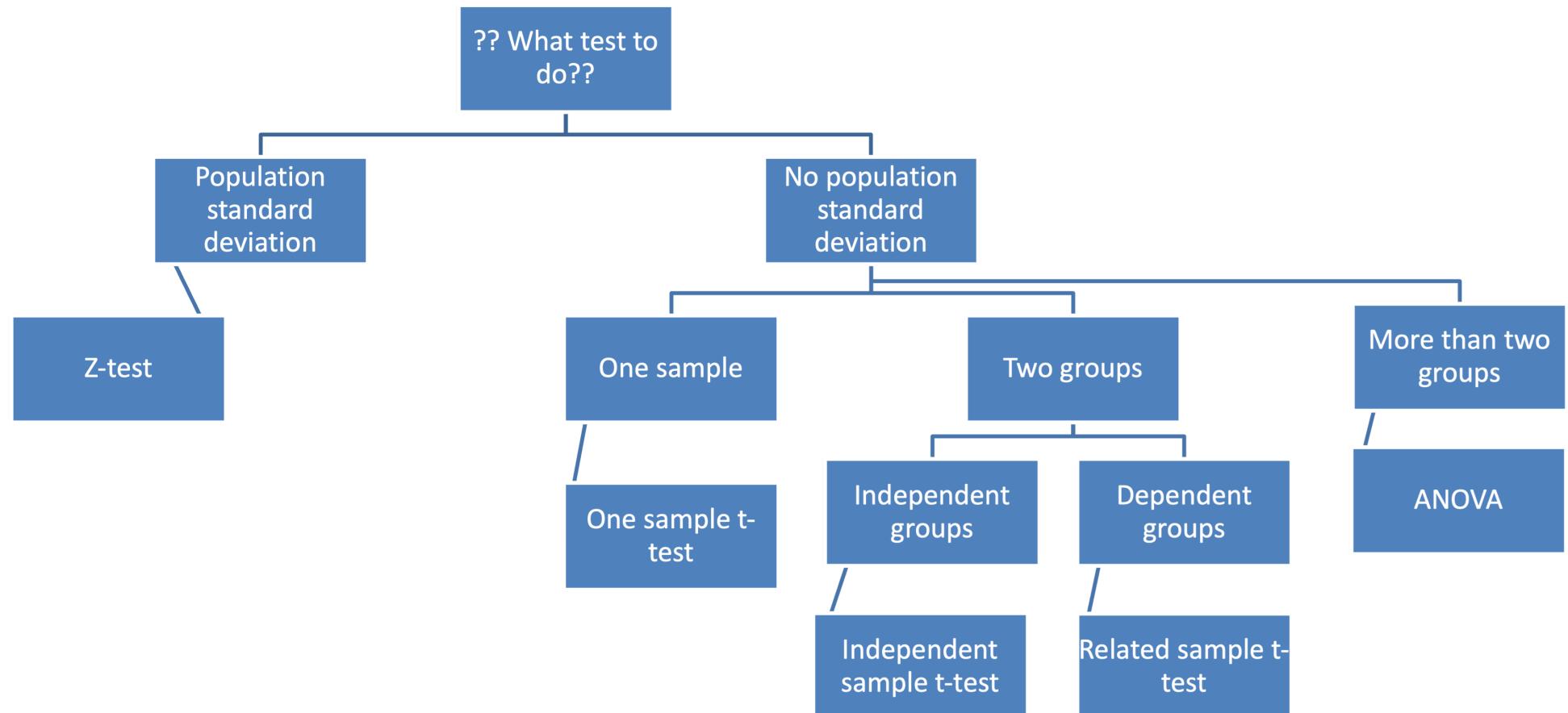
One-way ANOVA

Filling in the table

Source	SS	df	MS	F
BG				
WG				
Total				



Big picture





One-way ANOVA

Effect size (eta-squared)

$$\eta^2 = \frac{SS_{between}}{SS_{total}}$$

Magnitude of the between group effect

~% of the variance in the DV is explained by the IV

You can also use ω^2 (omega-squared)...



One-way ANOVA

Between-subjects factor → Between-subject ANOVA

Factor separates groups of **different** individuals

Each score comes from a different subject

Example?

Clinical therapy (behavioral, cognitive, control)

Place of birth (California, Oregon, Florida, Arizona)



One-way ANOVA

Within-subjects factor → Within-subject ANOVA

Factors separate multiple measures within the **same** individuals

Each subject provides scores under multiple conditions/timepoints

Example?

Time (measurements at time 1, time 2, and time 3)

Repeated measurements in general!



Do it together

Questions about homework 5?





Before you go home...

Lab materials are available at

<https://github.com/IhnwhiHeo/PSY010>

Any questions or comments?

Office hours or my email



Thanks! Have a good one!

