A (Very) Brief Intro to Stats

Sabrina Sghirripa

What type of variable do I have?

- Nominal or categorical
  - No particular relationship between options
  - Can't take an average, no real order
  - Examples
    - Gender
    - Eye colour

- Ordinal
  - Meaningful order, but that's where it ends
  - Can't take an average
  - Examples
    - The person who won the race came first, which means they ran faster than second place, but we don't know how much
    - Measuring attitudes/beliefs

- Interval
  - Order is meaningful
  - Addition and subtraction makes sense, but multiplication and division don't
  - Examples
    - Temperature in degrees C
    - Year someone started uni

- Ratio
  - Order is meaningful and there's a zero value
  - Multiplication and division make sense now
  - Examples
    - Response time

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  Continuous Variables

- Ratio
  - Order is meaningful and there's a zero value
  - Multiplication and division make sense now
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Continuous vs Discrete Variables

- Continuous → for any two values, it's possible to have a value in between
- Discrete → um, not continuous…
  - Nominal/categorical and ordinal variables are ALWAYS discrete
  - E.g. There's no eye colour between brown and blue (categorical)
  - E.g. There's no placing between first and second (ordinal)

Response time example:

→ B was 0.8s slower than A, which is 3.1 / 2.3 = 1.35 times as slow

- Participant A: 3.1 seconds
- Participant B: 2.3 seconds
- Participant C can fall between A and B, therefore, it's continuous

What about Likert Scales?

Nicki Minaj ✓
@NICKIMINAJ
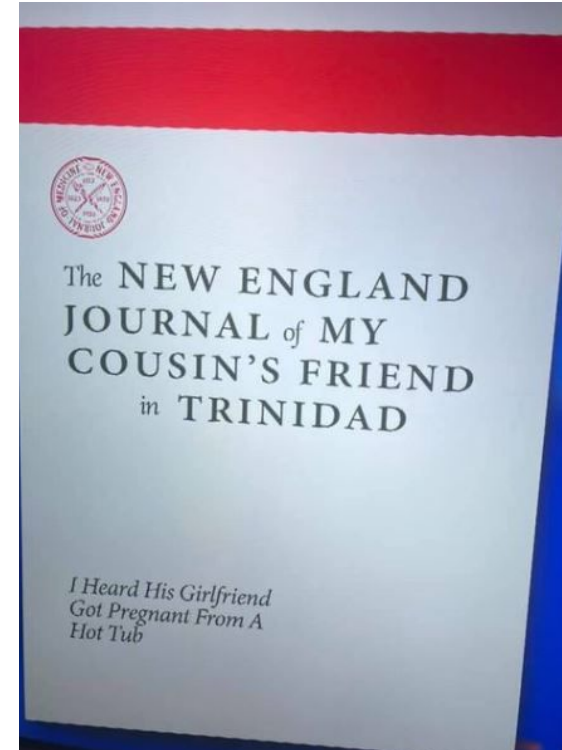
My cousin in Trinidad won't get the vaccine cuz his friend got it & became impotent. His testicles became swollen. His friend was weeks away from getting married, now the girl called off the wedding. So just pray on it & make sure you're comfortable with ur decision, not bullied

7:44 AM · Sep 14, 2021 · Twitter for iPhone

The Curious Case of Nicki Minaj's Cousin's Friend in Trinidad

- Research Hypothesis: 'Covid vaccines lead to impotence' - Dr Nicki Minaj
  - Experiment: testing whether men with the covid vax are more likely to experience impotence than anti-vaxxers (measured via self report)
- Statistical hypothesis:
  - If the vaccine does NOT cause impotence, and all other things are matched, then the two groups of men have an equal chance of reporting impotence (**vax = antivax**)
  - If the vaccine does cause impotence, then those vaxxed should report impotence more often than those without (**vax > antivax**)
  - If the covid vax actually protects against impotence, then anti vaxxers should report a higher impotence incidence **(vax < antivax)**
  - If I don't know if the vaccine leads to impotence, I might just say that the two groups will differ in some way (**vax =/= antivax**)

The NEW ENGLAND JOURNAL of MY COUSIN'S FRIEND in TRINIDAD

I Heard His Girlfriend Got Pregnant From A Hot Tub

Null and Alternative Hypotheses

- In the Curious Case of Nicki Minaj's Cousin's Friend in Trinidad
  - NULL HYPOTHESIS → vax = no vax (i.e. there will be NO difference -Nicki's cousin's friend in Trinidad was bullshitting)
  - ALTERNATIVE HYPOTHESIS → vax =/= no vax (i.e. there *will* be a difference- Nicki's cousin's friend in Trinidad was indeed not bullshitting)
- Statistical tests aim to prove that the null hypothesis is *false*
- 'Trial of the null hypothesis'
  - The null hypothesis is believed to be true unless the researcher proves that the null is false
  - Design your experiment in a way that maximises the chance of you reaching a conviction
  - However, the statistical test sets a range of rules you need to follow… If the null is true, the chances of a false conviction need to be low

Errors

	ACCEPT Null	REJECT Null
Null is TRUE (no difference)	Correct	Type 1 error
Null is FALSE (difference)	Type 2 error	Correct

Punishing the innocent is worse than letting the guilty walk free… A statistical test needs to control for the possibility of type 1 errors by setting a *significance level*

Errors

	ACCEPT Null	REJECT Null
Null is TRUE (no difference)	1-α Correct (probability of correct retention)	α (Type 1 error) FALSE POSITIVE
Null is FALSE (difference)	β (Type 2 error) FALSE NEGATIVE	1-β (power of the test)

- We need to keep the probability of a type 1 error low by setting a significance level: 0.05, 0.01, 0.001…
- Power: probability with which we reject a null when it is actually false

p-values

- The *p*-value is the smallest Type 1 error rate you are willing to tolerate if you want to reject the null hypothesis
  - P = 0.05 → 5% chance that if we reject the null, that it is a false positive
- In other words...
  - The *p*-value is the probability of obtaining results at least as extreme as the observed results of a statistical hypothesis test, if the null hypothesis is correct
  - Or, if there truly is no difference (the null is correct), then we'd only see a value this extreme 5% of the time

Effect Sizes

	Big Effect Size	Small Effect Size
Significant Result ($p<0.05$)	Difference is real and we should (probably) care	Difference is real, but honestly, who cares?
Non-Significant Result ($p>0.05$)	No effect observed	No effect observed

A quick word on power

- Obviously, we don't want to accept the null when there actually is a difference (i.e. false negative)
- We minimise the Type 2 error rate by maximising the statistical power of the test
- How?
  - Increase your effect size by designing an experiment that isn't shit (unfortunately I haven't worked out how to do this yet…)
  - Increase your sample size

Picking a Test: Choose Your Own Adventure

1. Is your outcome variable DISCRETE or CONTINUOUS?

If you chose 'continuous'...
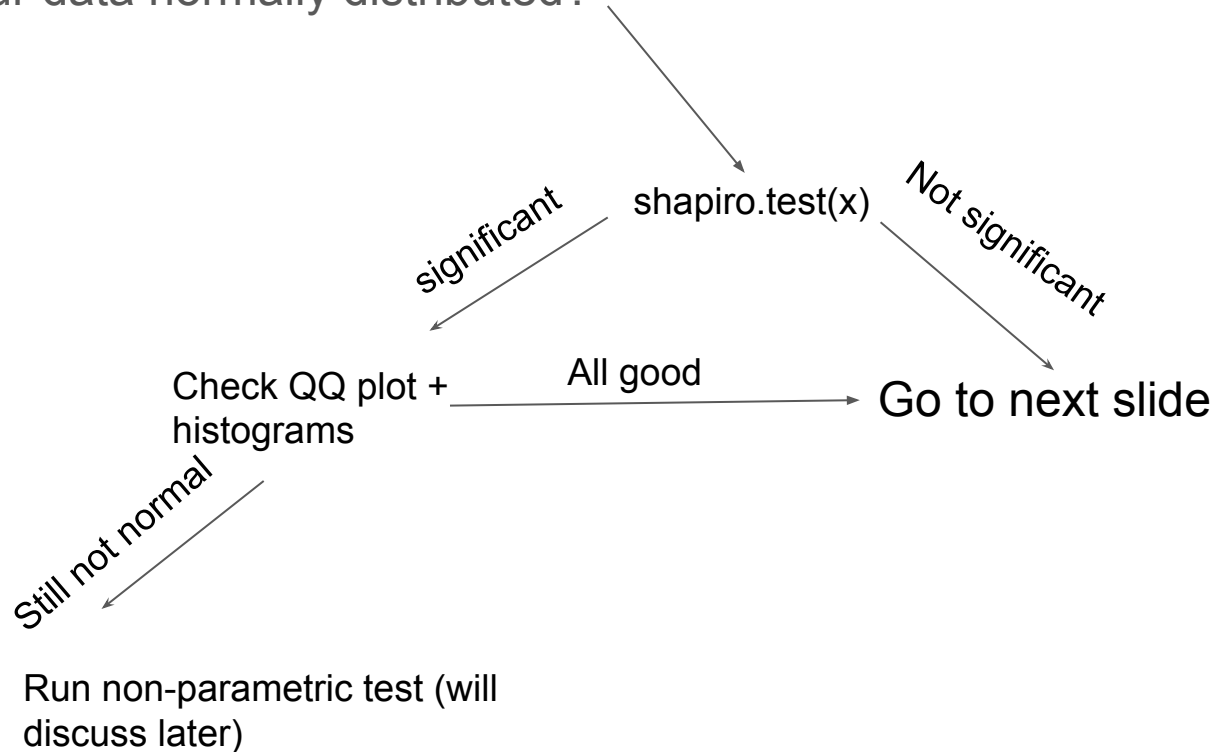
2. What are you trying to do?

A.   Compare group means on
      an outcome variable

B. Examine a relationship
between two or more variables

If you chose A...

3. Are your data normally distributed?

shapiro.test(x)

significant

Not significant

Check QQ plot + histograms

All good

Go to next slide

Still not normal

Run non-parametric test (will discuss later)

How many groups are there?

One group compared to a theoretical mean

Two groups defined by a predictor variable

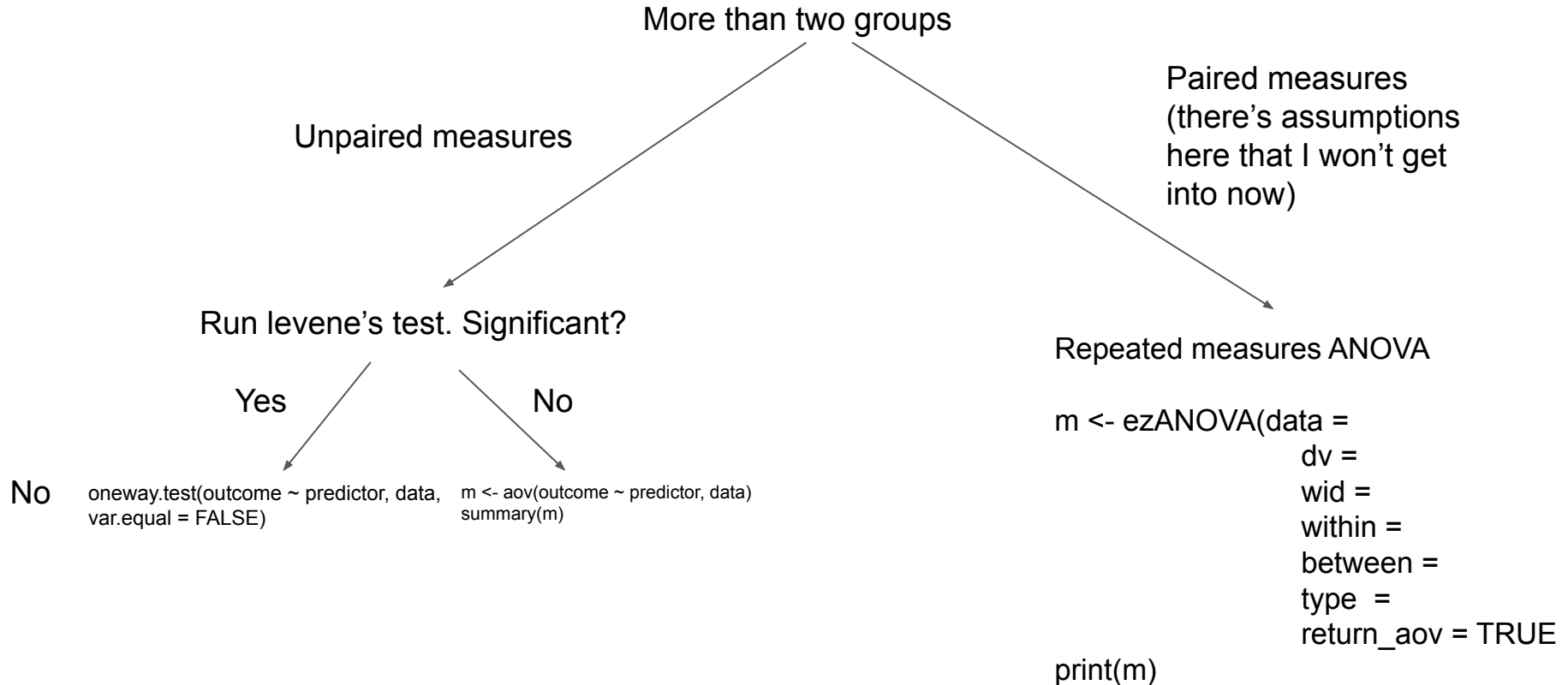One-sample t-test
t.test(y, mu)

Are the variables paired?

Yes

t.test(outcome ~ predictor, data, paired = TRUE)
pairedSamplesTTest(~outcome + predictor, data)

t.test(outcome ~ predictor, data)

How many groups are there?

More than two groups

Unpaired measures

Paired measures (there's assumptions here that I won't get into now)

Run levene's test. Significant?

Yes

No

Repeated measures ANOVA

No

oneway.test(outcome ~ predictor, data, var.equal = FALSE)

m <- aov(outcome ~ predictor, data)
summary(m)

```
m <- ezANOVA(data =
             dv =
             wid =
             within =
             between =
             type  =
             return_aov = TRUE
print(m)
```

If you chose B...

Finding the relationship between two outcome variables

cor.test(data$x, data$y)

Finding the relationship between two or more outcome variables

m <- lm(outcome ~ predictor1, predictor2 ... , data
summary(m)

If you chose 'categorical'…

What are you trying to do?

Compare one variable x against a theoretical comparison p

Compare two variables x and y against each other

Chi-squared goodness of fit test
chisq.test(x, p)

Chi-squared goodness test of association
chisq.test(x, y)