Tuesday 13' November 2018

How to decide how much data is enough?

Stat sig ≠ Pract. sig

ex New drug for Hypertension

Person	Before	After
1		
2		
⋮		
n		

$\text{mean } (\bar{y}) = -1 \text{ mmHg}$
$\text{SD } (s) = 10 \text{ mmHg}$ } OF DIFF (A − B)

Practically significant? NO.

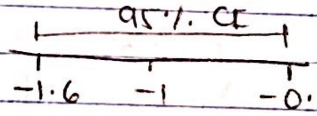
Stat sig?

Devil's advocate: Drug no good ($\bar{y} = 0$)
↳ results due to unlucky rand. sampling

$\bar{y} \pm t^{0.95}_{999} \frac{s}{\sqrt{n}}$ (here $t = z$)

$-1 \pm 1.96 \frac{10}{\sqrt{1000}}$ SE = 0.32

→ 95% CI
-1 ± 0.6 }



{ 0 (devil's advocate's position) not on 95% CI ∴ differente is stat sig.

· maybe CI is narrow ∴ doesn't include 0

Q3 Why stat. sig isn't pract. sig?
SE tiny because of big sample (1000)

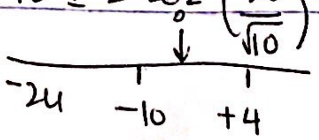
D = A − B

[ ] n = 10 Is pract. sig

mean = −10 mmHg
s = 20 mmHg

$\bar{y} \pm \left(t^{0.95}_{9}\right) \frac{s}{\sqrt{n}}$

$-10 \pm 2.262 \left(\frac{20}{\sqrt{10}}\right) = -10 \pm 14 \text{ mmHg}$



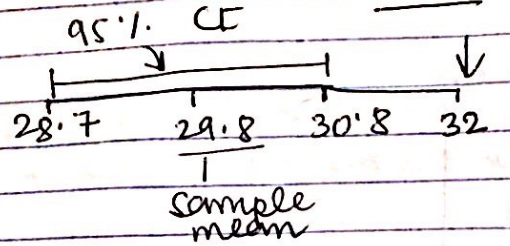
D in 95% CI
not stat sig.

WHY
Pract sig but not stat sig
*not enough data

Zar case study SAMPLE SIZE DETERMINATION

Sea Water Calcium conc. 32 mmole/Kg of H_2O

n = 13 - why 13?



$\mu = 32$

Data not agreeing w/ theory

Why 13?

μ = Pop mean

Null Hyp = $\mu = 32 = \mu_0$ (Theory 1)
H_0

alt H_A : $\mu = 31.5 = \mu_A$ (Theory 2)

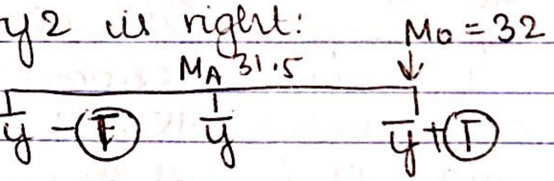
How big should n be for reliability in discrimination between these 2 theories?

Plan: take ⓝ obs and build 95% CI $\underbrace{\left(\bar{y} \pm t^{0.95}_{n-1} \frac{s}{\sqrt{n}}\right)}_{Ⓣ}$

95% CI = 100(1−α) % (α = 0.05)

From past experience ⇒ SD(s) = 1.8

If theory 2 is right:



anytime μ_0 is outside the CI (95%) → difference stat. sig.

$$n = \frac{\left(t^{(1-\alpha)(2)}_{n-1}\right)^2 s^2}{(\mu_0 - \mu_A)^2}$$

noise ↑ we need more data (n↑)
(s)

$\mu_0 - \mu_A$ ↑ n↓

s = 1.8

$|\mu_0 - \mu_A| = |32 - 31.5| = 0.5$

① $n = \frac{(1.96)^2 (1.8)^2}{(0.5)^2} = 49.8 = 50$

② try n = 50

$t^{0.95(2)}_{49} = 2.010$ n = 53

③ try n = 53 $t^{0.95(2)}_{(52)} = 2.007$

n = <u>53</u>

Scanned by CamScanner

② Significance / hypothesis testing

$H_0 : M = M_0$ (theory) $\mu_0 = 32$
null

H_A $\begin{cases} M \neq M_0 \text{ (2 sided alt) (2 tailed test)} \\ \left\{ \begin{matrix} M > M_0 \\ \mu < M_0 \end{matrix} \right\} \text{ (1 sided alt) (1 tailed test)} \end{cases}$
alt

(α) Type 1 error : False rejection of null (when null is true)
(β) Type 2 error False acceptance of null (when null is false)

$P(\text{reject } H_0 \mid H_0 \text{ true}) = P$ type 1 error $= \alpha$
↑ (want this small)

$P(\text{don't reject } H_0 \mid H_0 \text{ false}) = P(\text{type II error}) = \beta$ (Beta)
↑ want this small

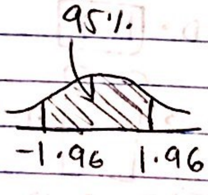
if β is small, $\underbrace{1-\beta}$ is huge
↳ POWER OF THE TEST

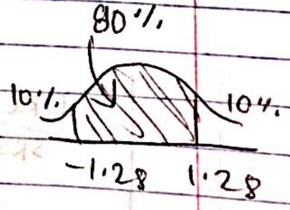
$$n = \frac{\left(t_{n-1}^{(1-\alpha)(2)} + t_{n-1}^{(1-\beta)(2)}\right) s^2}{(\mu_0 - \mu_A)^2}$$

(1) for 1 tailed test
(2) for 2 tailed test

ex calcium $s = 1.8$ $|\mu_0 - \mu_A| = 0.5$ ① Start w/ z
2 tailed test $\alpha = 0.05$

$(1-\beta) = 0.9$ so $\beta = 0.1$

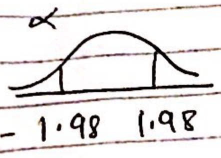


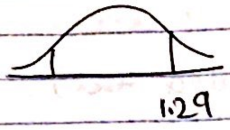


t for β is alway 1 tailed

$$n = \frac{(1.96 + 1.28)^2 (1.8)^2}{(0.5)^2} = 136$$

② $t_{135} = ?$





$$n = \frac{(1.98 + 1.29)^2 (1.8^2)}{0.5^2} = 139$$

③ n=139 so stop

2 Sample inferential problems

How does you compare 2 samples
①Paired comparisons
② ~~Any~~ Analysis of 2 independent samples

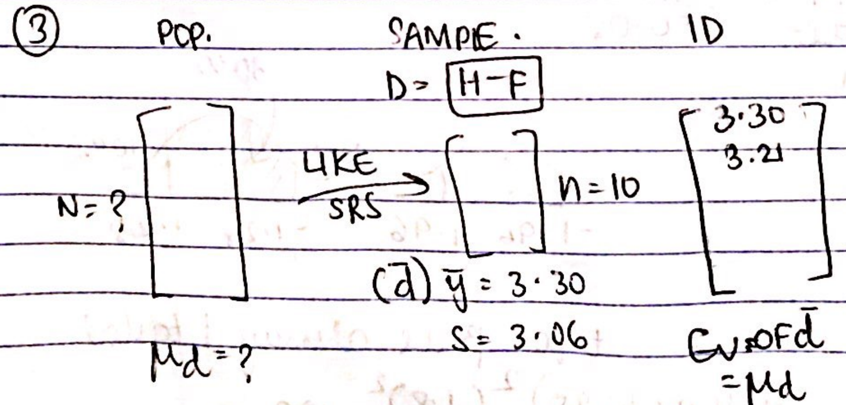
2 sample problem ⟶ 1 sample problem
(Paired comparison)↓

① Ⓣ v/s Ⓒ $\boxed{\text{TAKE DIFFERENCE}}$

② Repeated Measures (2 readings @ different times)
example: Before V/S After on same person

D = After - Before → to judge stat sig
After and Before → for pract sig

③



Ev of d̄ = μd

unknown φ of interest	μ_d = pop mean diff (H −F)
ESTIMATE	$\bar{d}$ = 33cm
Give or take for $\bar{d}$ as estimate	~~$\bar{d} \pm 2.262$~~ $\hat{SE}(\bar{d}) = 0.97$ cm ~~± 1.11, 5.49~~
95% CI for Md	$\bar{d} \pm$ ~~2.62~~ 2.262 $\hat{SE}(d)$ = (1.11, 5.49)

$\text{SE of } \bar{d} = \hat{SE}_{IID}(\bar{d}) = \hat{SE}_{IID}(\bar{y})$

SE of $\bar{d}$ = 0.97

$= \frac{s_d}{\sqrt{n}} = 0.97$ cm → 95% CI = 1.11 —— 5.49
so diff is stat sig.