

3rd April 2023

Experimental design

AGENDA.

- p-value ✓

- α (Significance level)

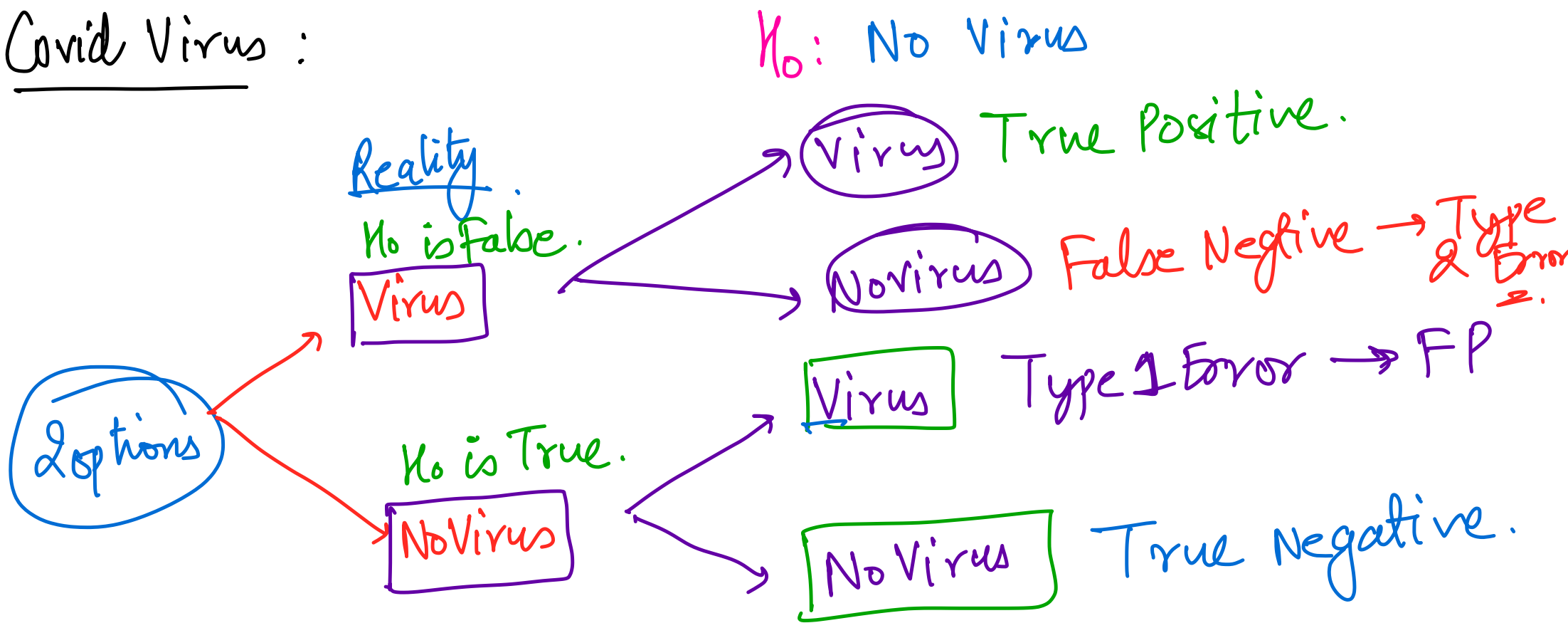
- β (Power)

- "Effect Size"

}] "n"

Let's start in
2 minutes

Covid Virus :

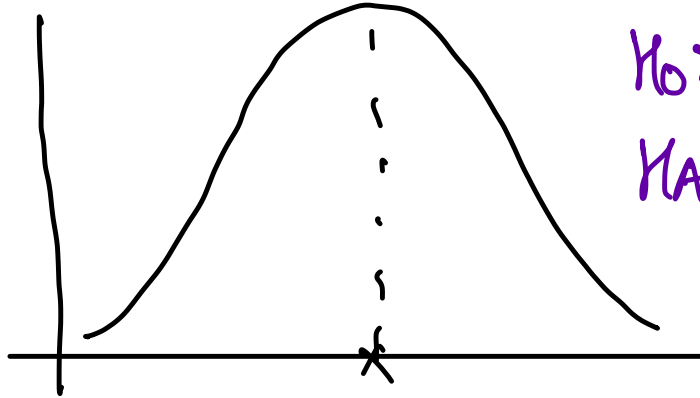


		Decision	
		Accept	Reject
H_0	True	True negative $1 - \alpha$ Confidence level	False positive ✓ α Significance level
	False	False negative β	True positive $1 - \beta$ Power

Height:

Ordinary People

$$\sigma = 4$$



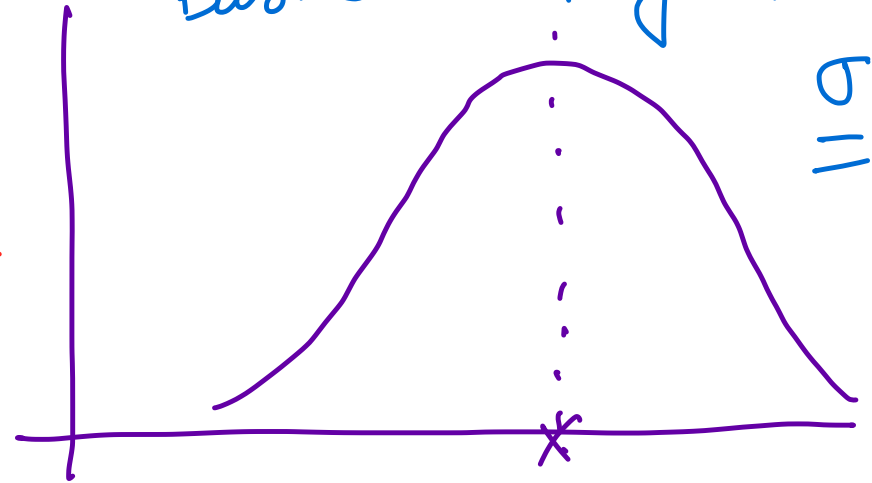
$$H_0: \mu = 65$$

$$H_A: \mu = 72$$

$$\alpha = 0.01$$

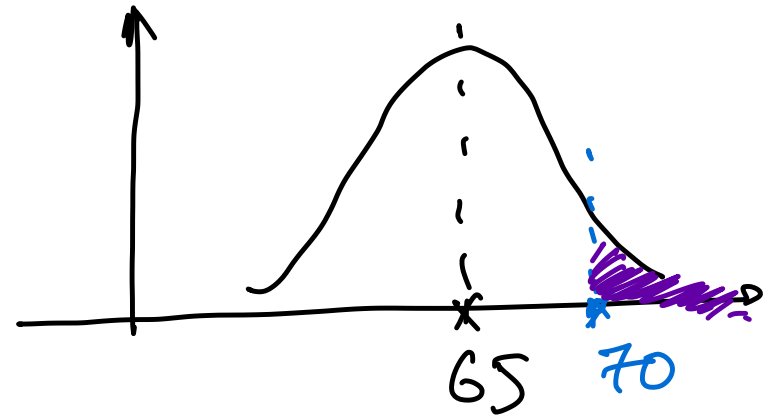
Basketball Players:

$$\sigma = 3$$



① $n = 2$, $\bar{x} \rightarrow 70$

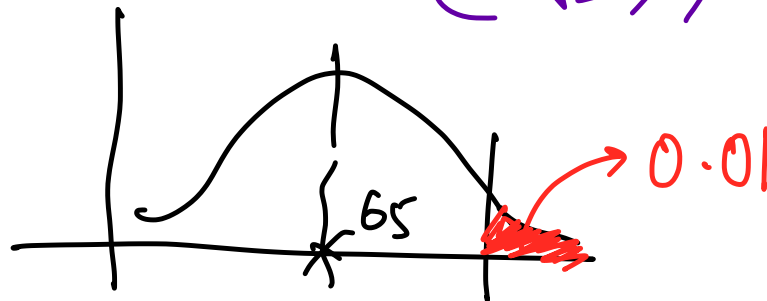
with 99% Confidence
would you reject H_0

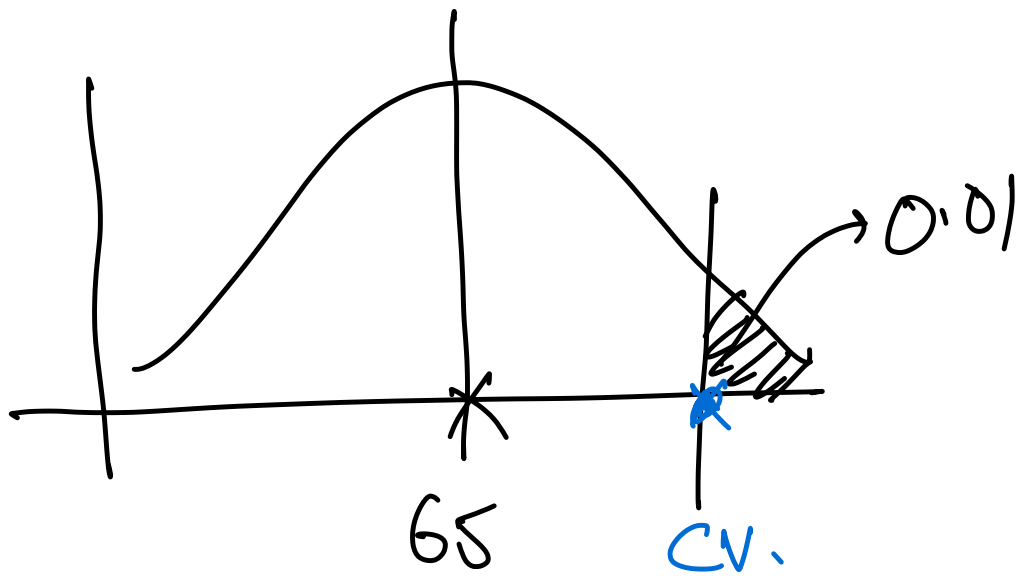


$$p\text{-value} = 1 - \text{norm.cdf}\left(\frac{70 - 65}{(4/\sqrt{2})}\right) = 0.038$$

fail to reject H_0

• Critical Region \rightarrow ?

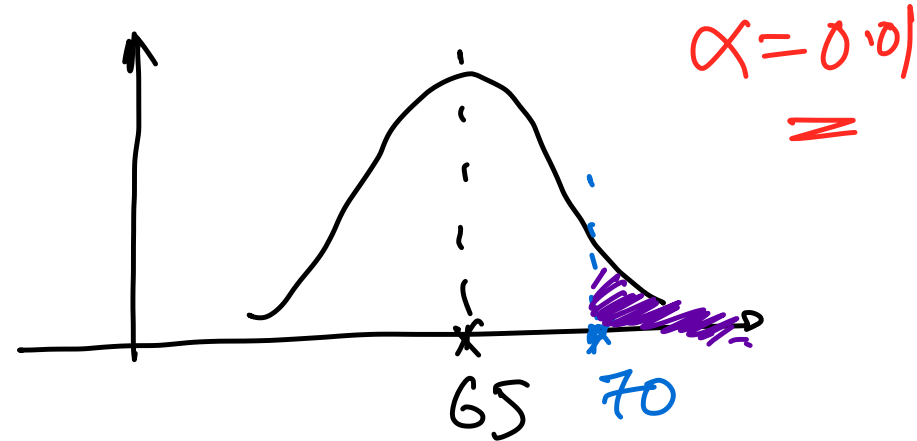




$$CV = 65 + \text{norm. ppf}(0.99) \times \left(\frac{4}{\sqrt{2}} \right).$$

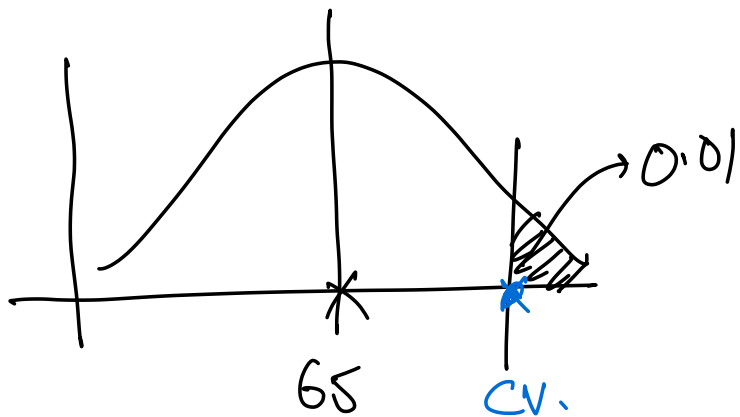
$$CV = 71.57 \quad \checkmark$$

① $n = 5$, $\bar{x} \rightarrow 70$ ✓
 with 99% Confidence
 would you reject H_0 ?



$$p\text{-value} = 1 - \text{norm.cdf}\left(\frac{70 - 65}{(4/\sqrt{5})}\right) = 0.0025$$

Reject H_0

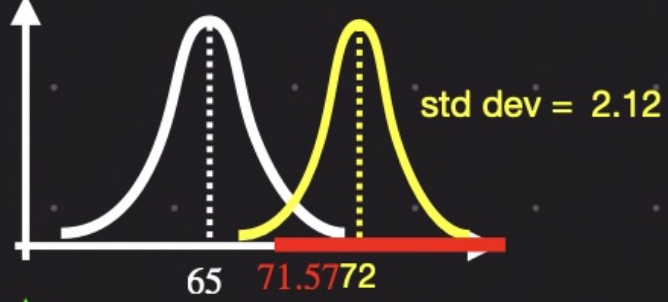


$$CV = 65 + \text{norm.ppf}(0.99) \times \left(\frac{4}{\sqrt{5}}\right)$$

$$CV = 69.16 \quad \checkmark$$

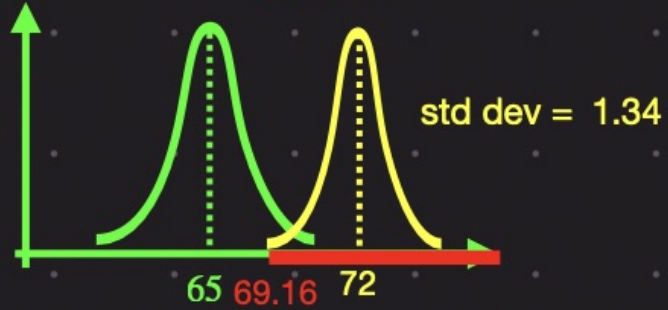
2 samples

std dev = 2.82

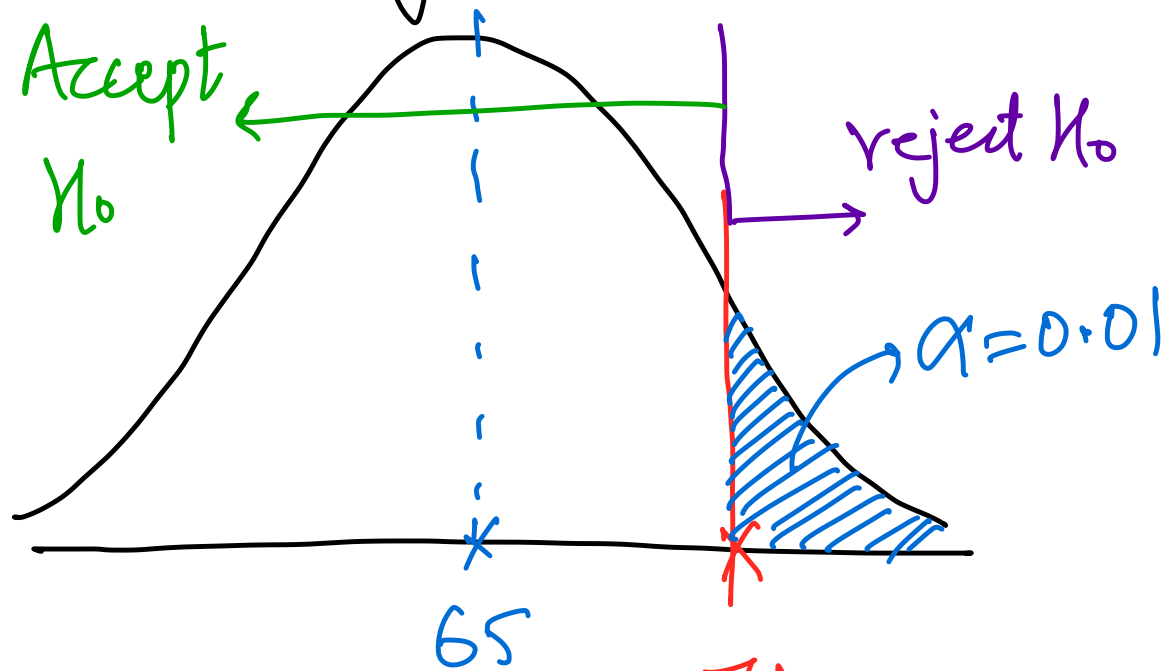


5 samples

std dev = 1.78



H_0 : Ordinary People ✓



H_0 : No Virus.
 H_A : Virus

FP → Virus

• max. prob. of rejecting $H_0 = 0.01 = \alpha$
p-value

• Type I Error if rejecting True H_0
max. prob. of making Type I Error is α

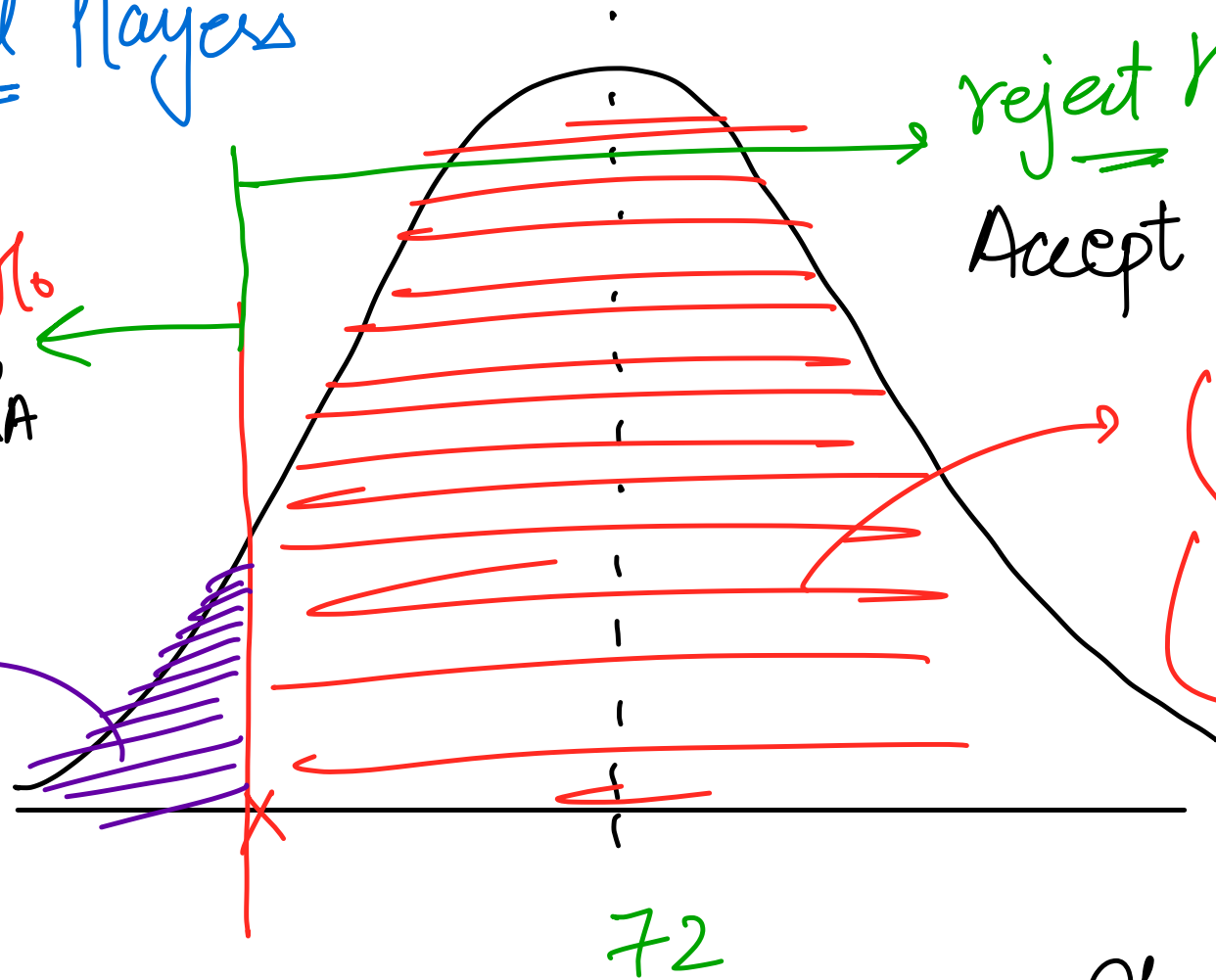
H_A : Basketball players

type II β Error.

accept H_0
reject H_A

reject H_0
Accept H_A

$(1 - \beta)$
(Power)
TP



$H_A \rightarrow \text{True} \Rightarrow H_0 \rightarrow \text{False}$ \rightarrow ground truth = .
Type 2 Error: \rightarrow we failed to reject false H_0 = .

H_0 : no plane / no virus

H_A : plane / virus.

Type I Error :: ($H_0 \rightarrow \text{True} \rightarrow \text{reject it}$)

no plane \rightarrow plane \rightarrow (FP)
no virus \rightarrow virus \rightarrow (FP) } α

Type II Error ($H_0 \rightarrow \text{False} \rightarrow \text{accepting } H_0$)

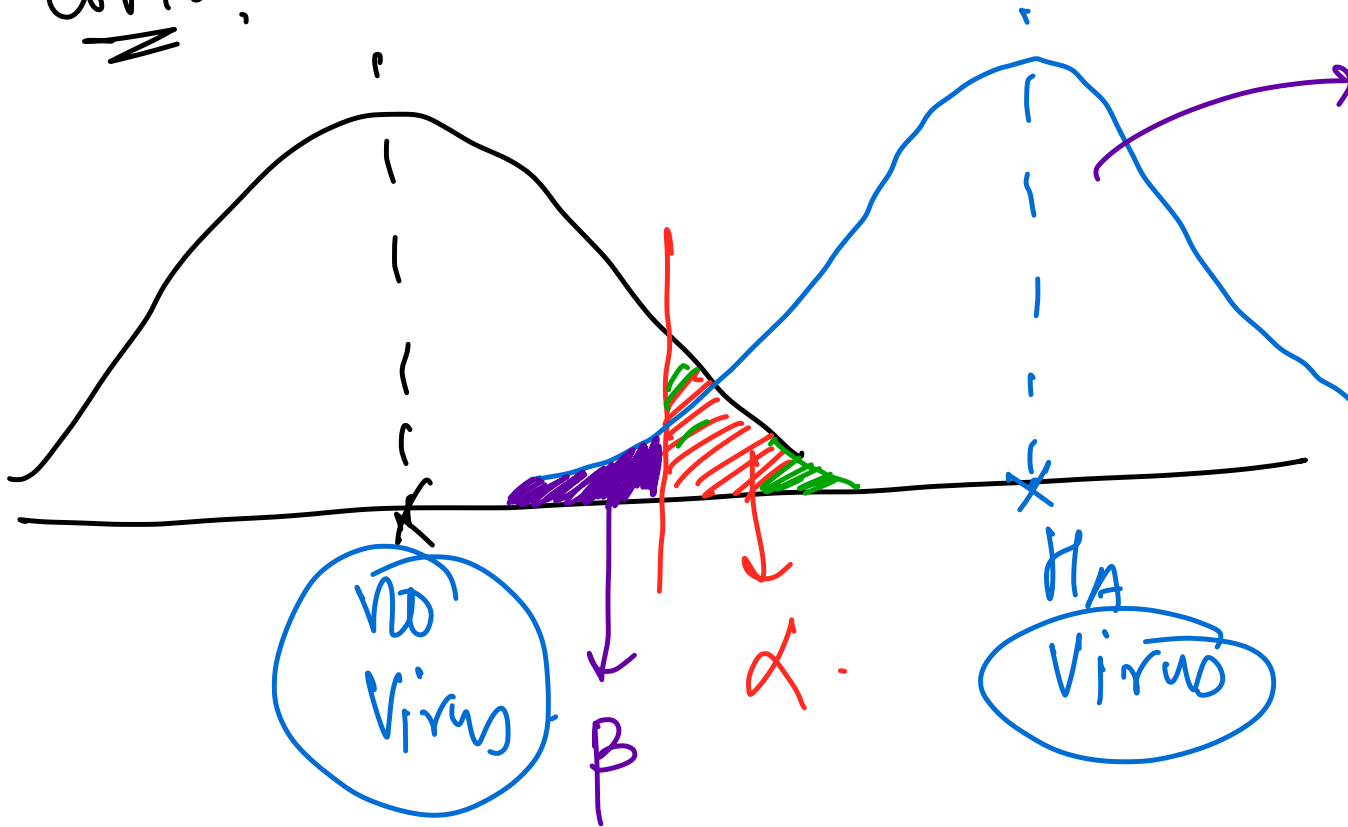
plane \rightarrow no plane
virus \rightarrow no virus } (FN) } β

$\beta \rightarrow \text{Error} \rightarrow (1 - \beta) \equiv \text{Power.}$

\downarrow
Prob. of Detection

plane \rightarrow Plane
 Virus \rightarrow Virus.

Covid.



$\alpha \uparrow \rightarrow \beta \downarrow$

Power \uparrow
 detection rate \uparrow

$\alpha \uparrow$ unnecessary quarantine

* No Virus \rightarrow Virus $\rightarrow \alpha$

* Virus. \rightarrow No Virus $\rightarrow \beta$

$\beta \uparrow$
 spreading Covid

fingerprint Scanner.

M_0 : not owner.

M_A : Owner.

Errors

α :

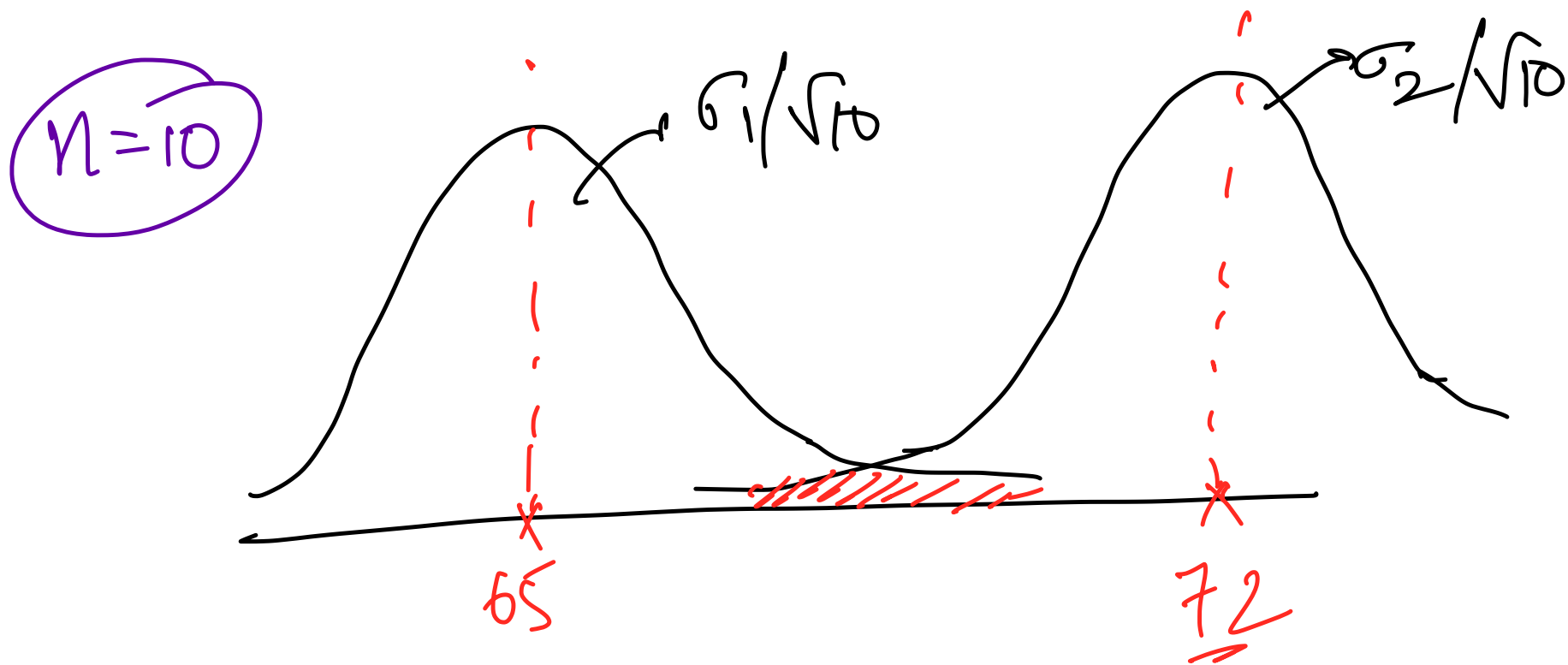
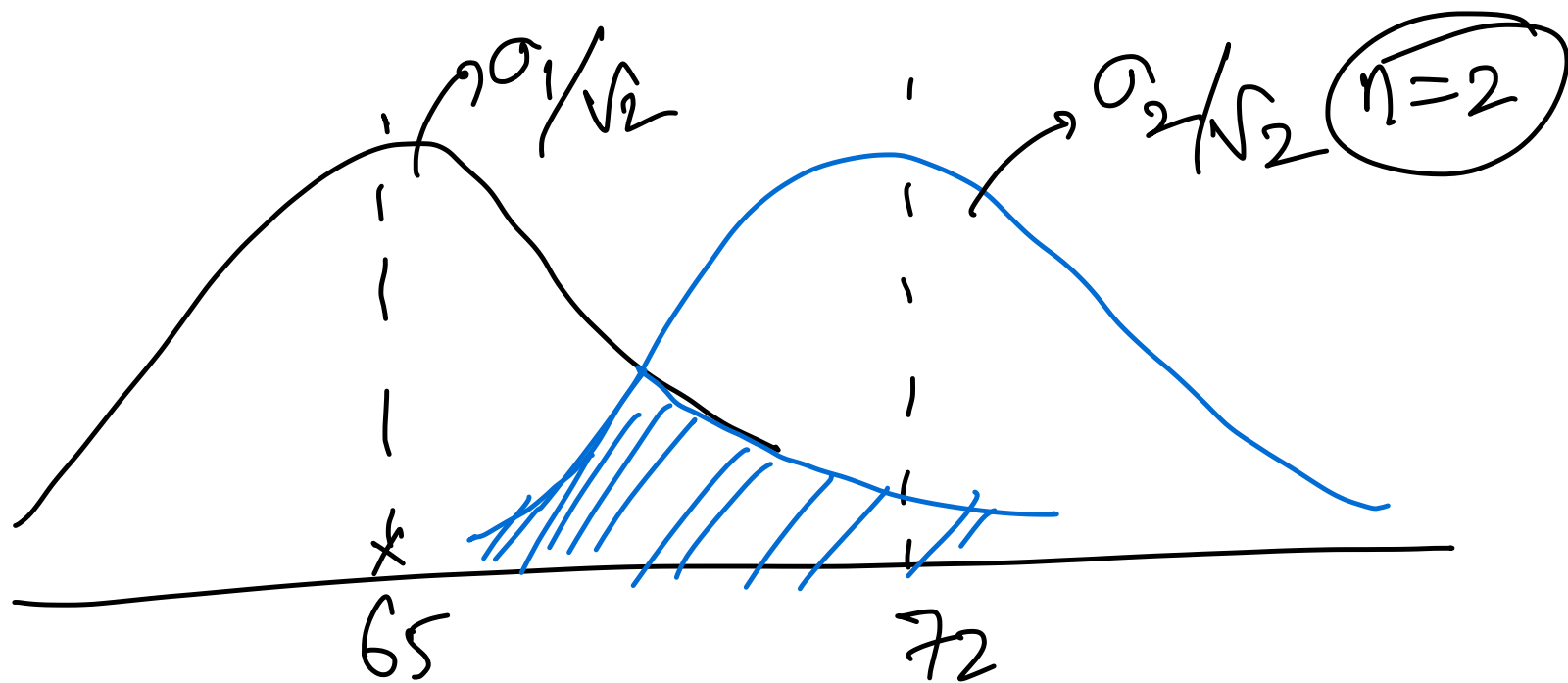
Reality
not owner \longrightarrow Says Owner

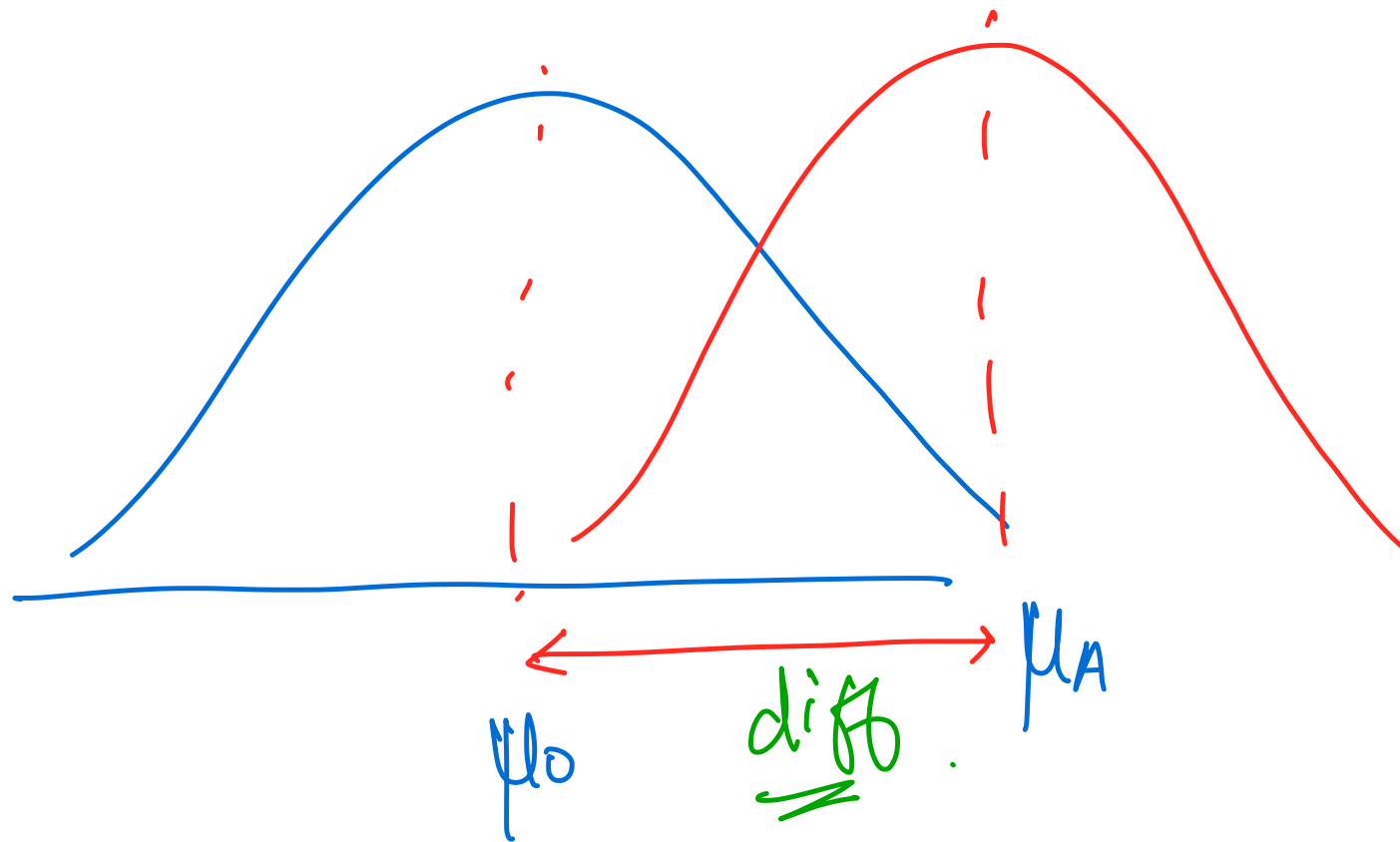
β :

Owner \longrightarrow not owner.

α should be lower.
 \downarrow

Confidence
should be
high.





diff : $(\mu_A - \mu_0)$ ✓

$\mu_0: 65$, $\sigma = 4$ inches. ✓

• Effect Size: 10% increment.

Min power $(1-\beta) \rightarrow 95\%$; $\beta = 0.05$

$\alpha \rightarrow 0.01$

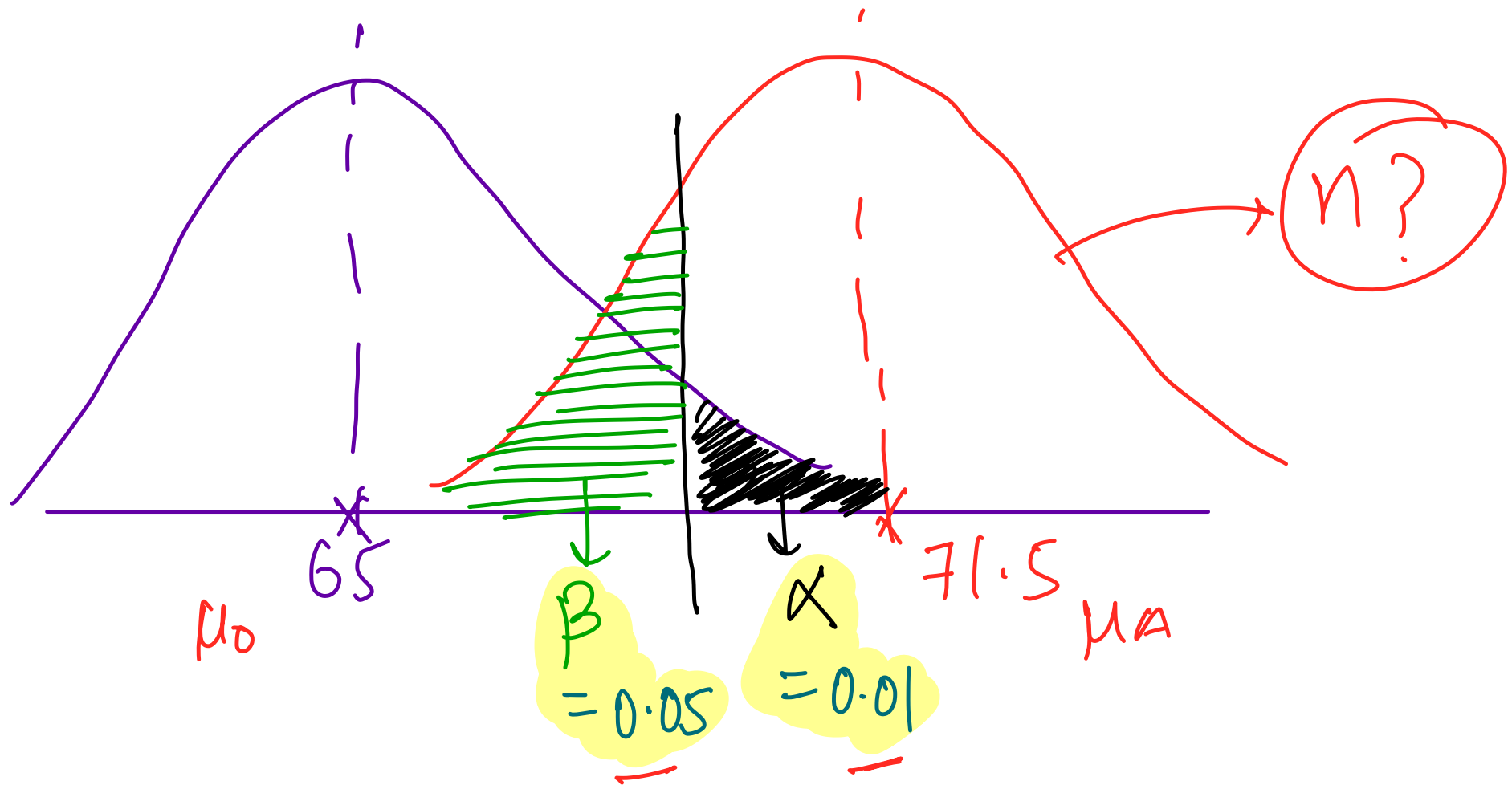
$\eta \rightarrow ?$

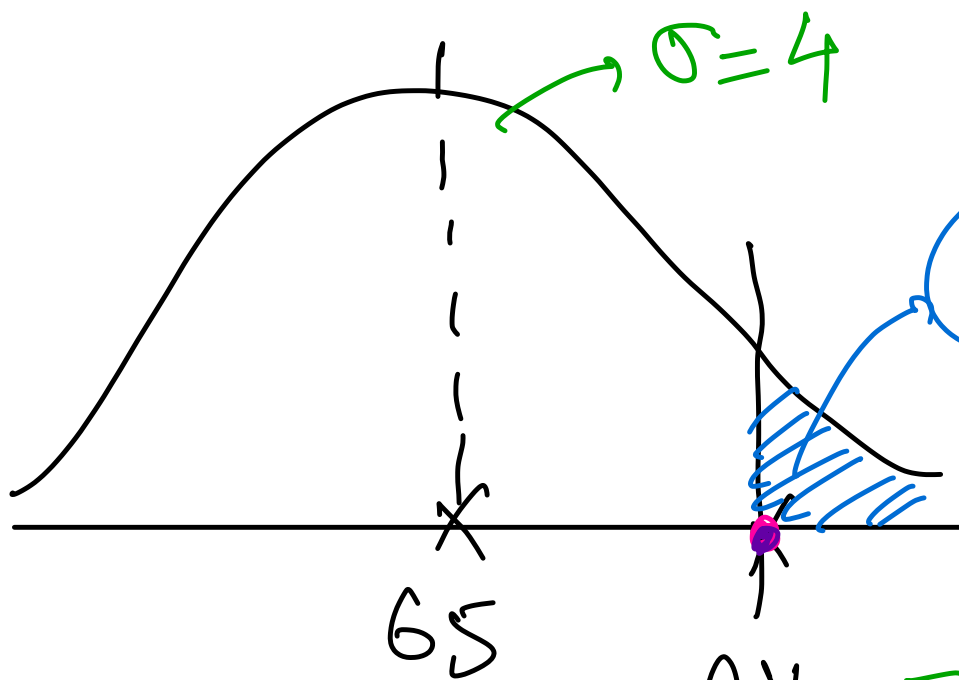
μ_0 : 65 inches

Effect size $\rightarrow 10\%$ $\rightarrow 10\% \cdot 65 \rightarrow \underline{6.5}$

μ_A : $65 + 6.5 = 71.5 \rightarrow \mu_A$

$\eta \rightarrow ?$

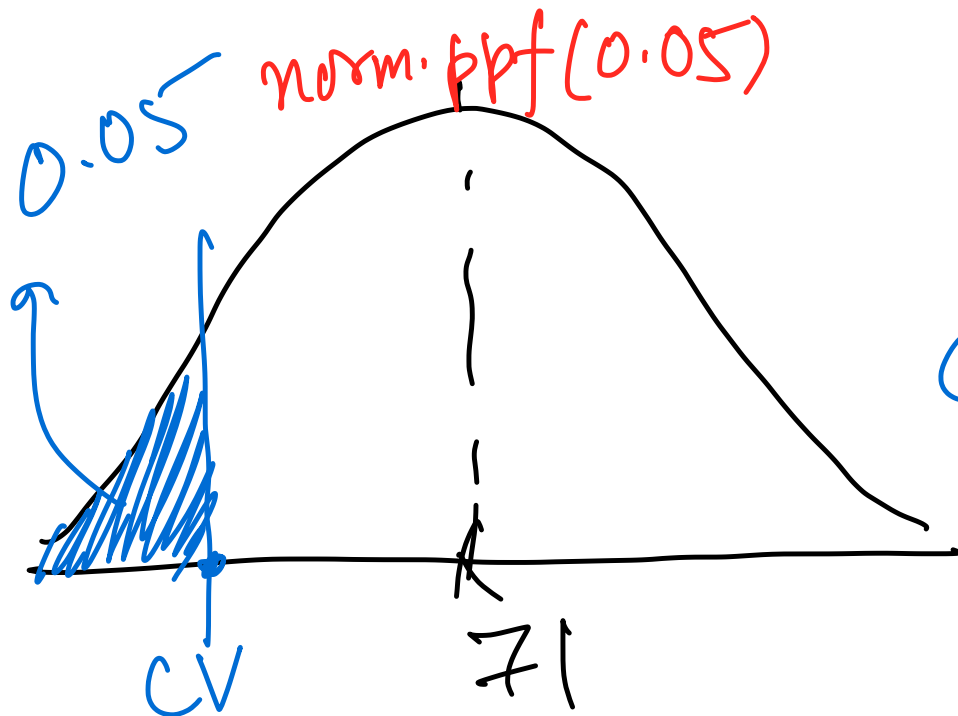




• norm. ppf(0.99)

2.32

$$\underline{CV} = \left(65 + 2.32 \times \frac{4}{\sqrt{n}} \right)$$

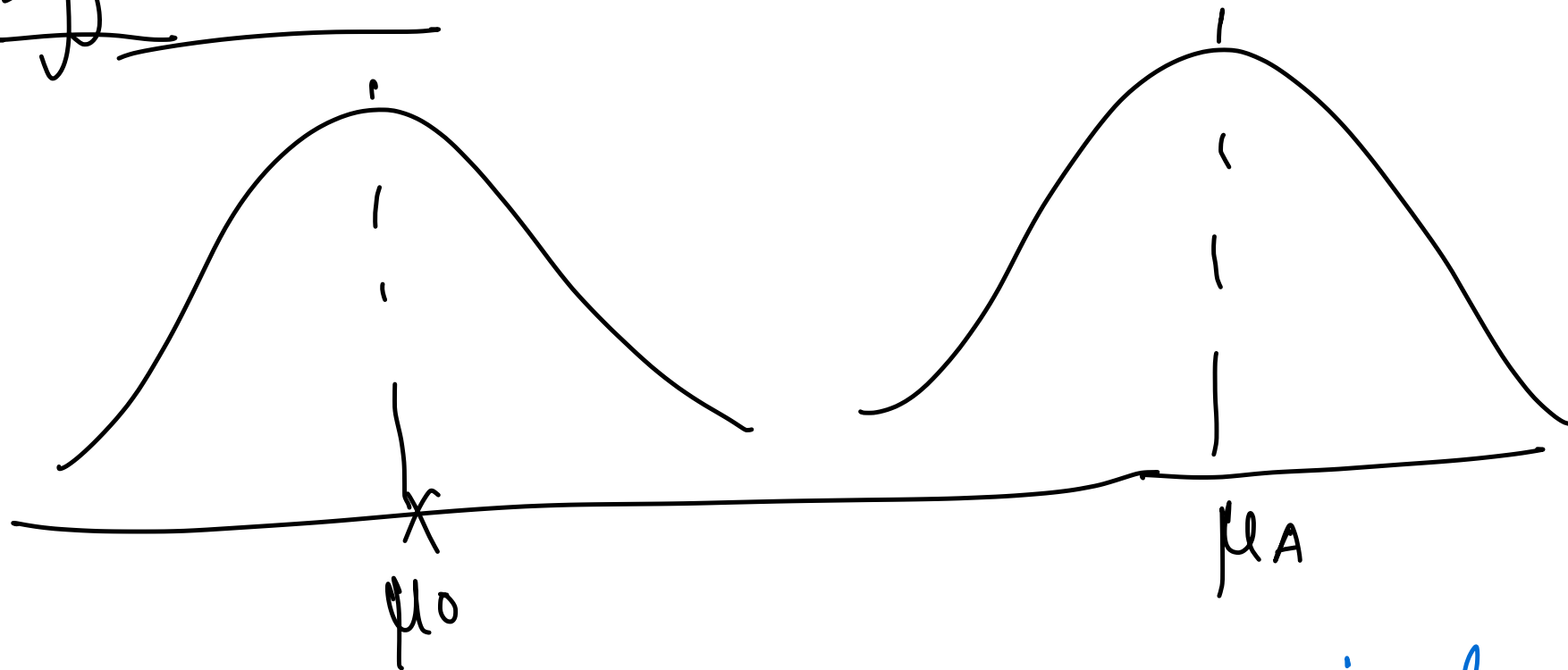


$$\underline{CV} = \left(71 - 1.64 \times \frac{4}{\sqrt{n}} \right)$$

146 *

$$65 + 2.32 \times \frac{4}{\sqrt{n}} = 71 - 1.64 \times \frac{4}{\sqrt{n}}$$

Effect size



Effect size $\Rightarrow \mu_A - \mu_0$ inches
cm.

$$\left(\frac{\mu_A - \mu_0}{\sigma} \right) \rightarrow \text{Cohen's } d$$