1. \[ P(Z > z) = 0.04 \] Find \[ z \]

**Random Normal**

\[ \mu = 0 \quad \sigma = 1 \]

\[ P(Z > z) = 0.04 \]

So \[ z = 1.75 \]

\[ z \text{ means } P(Z > 1.75) = 0.04 \]

\[ \boxed{0.9509} \]

\[ \boxed{0.96} \]

\[ \boxed{0.04} \]
2. Find $z$ with $P(Z < z) = 0.03$

\[
\begin{align*}
0.03 &\quad \uparrow \\
0.0301 &\quad \Rightarrow -1.8 \\
\end{align*}
\]

so $P(Z < -1.88) = 0.031$

3. Sample $n = 400$ surgeries. Find $32$ require repeat.

Test: involves $p = \text{population rate requiring }$.

(Aside) Perhaps in past $\sim 6\%$ required repeat.

or "new policy or insurance requirements have set 6\% goal."
Set up as test: (past 60) $H_0: \hat{p} = 0.06$ (just like the past)

$H_a: \hat{p} > 0.06$ (worry that rate of repeal is increasing)

Know that: A test tends to stay with $H_0$ unless there is overwhelming evidence against $H_0$.

What is $p$-value of finding 32 repeals in 400?

$p = \frac{32}{400} = 0.08$

Evidence against $H_0: \hat{p} = 0.06$ is summarized.
IN P-VALUE \( P(X \geq 32) \) IF \( \rho = (\rho_0) = 0.06 \)

MEANING: IF \( \rho = .06 (H_0) \) WHAT IS CHANCE WE'D FIND \( \geq 32 \) IN 400 (EVIDENCE AS STRONG OR STRONGER AGAINST \( H_0 \) THAN WHAT WE FOUND).

\[
P-VALUE = P(X \geq 32) = P(Z > \frac{32 - 5 - 400 \cdot 0.06}{\sqrt{400 \cdot 0.06 \cdot 0.94}})
\]

CALC FOR \( \rho = 0.06 \)

\[
= P(Z > \frac{8.5}{20 \sqrt{0.06 \cdot 0.94}})
\]
\[ P(\bar{z} > 1.78) = 1 - .9625 = .0375 \]

Calc. using \( \bar{z} \) instead of \( X \) (but without continuity cor.)

\[ P(\bar{z} > 0.08) \approx P(\bar{z} > \frac{0.08 - 0.06}{\sqrt{0.06/194/400}}) \]

What we found to be \( \bar{z} \)
\[
\frac{\hat{p} - 0.06}{\sqrt{\hat{p}_0 (1 - \hat{p}_0) / 400}} = \frac{X - 24}{\sqrt{400 \cdot 0.06 \cdot 0.94}}
\]

So if we ignore the continuity correction you can do the value either as
\[
P(X \geq 32) \sim P\left( Z \geq \frac{32 - 400 \cdot 0.06}{\sqrt{400 \cdot 0.06 \cdot 0.94}} \right)
\]
or (very same) \[
P(X \geq 32) \sim P\left( Z \geq \frac{0.88 - 0.06}{\sqrt{0.06 \cdot 0.94}} \right)
\]
In formulas: \[ P(X \geq 32) = P\left( Z > \frac{32 - \mu_0}{\sqrt{\sigma^2}} \right) \]

\[ P(\hat{p} \geq 32/400) \sim P\left( Z > \frac{.08 - \mu_0}{\sqrt{\mu_0 (1 - \mu_0)/m}} \right) \] identical.

4. A journal requires P-value < 0.001 to publish.

H₀ : MEO has no effect.
Hₐ : MEO has desired effect.

To publish, you observed effect must be rarer than 1/10000 - meaning it would rarely be seen in sample data if H₀ : MEO no effect is correct.
Now imagine all papers reporting on MEDS having no value but making the p-value < 0.0001 criterion.

Of all such studies N is satisfied so \( P(\text{MED passes above criterion}) \approx .0001. \)

\( \frac{1}{10000} \) valueless MEDS's studies can pass this barrier to publication.

5. Sample of 900 X-ray orders finds 80 for which additional images are requested.
Test: $H_0: p = 0.12$ (or 0.12)

$H_a: p < 0.12$

So we've "improved" the form used by radiologists.

If $p = 0.12$ (our $H_0$)

Unless we get convincing evidence ($p \ll 0.12$)

How? $P$-value $\ll$ small

$P$-value $= P$(evidence more extreme against $H_0$)

$= P(X \leq 80) \approx P(Z < \frac{80 - 900(0.12)}{\sqrt{900 \cdot 0.12 \cdot 0.88}})$

$\approx$ Reversed because $H_a \ll H_0$

$= P(Z < \frac{80 - 108}{30 \sqrt{0.12 \cdot 0.88}}) = P(Z > -2.87)$
P-VALUE = .0021

Is this small enough to reject $H_0$?

It does seem $2/1000$ is sufficient evidence against $H_0$. So let's roll out the new form!
6. **Design a test to "Call Election."**

\[
\frac{\text{Dem}}{\text{won}} \times \frac{\text{Rep}}{\text{won}} \quad \rho = \text{fraction voted Republican}
\]

\[
\rho_0 = 0.48, \quad \rho_1 = 0.52
\]

\[
\rho \approx 0.5, \quad \lambda = 2.33, \quad 2.33 \quad 0.03 \\
\text{when} \quad \rho = 0.48
\]

Let's impose type I error probability 0.01.

\[
P(Z > z_0) = 0.01
\]
TYPE 2 ERROR

IMPOSE .01 ALSO

THIS TIME

\[ P(Z < \bar{z}_1) = .01 \]

\[ \bar{z}_1 = -2.33 \]

WHEN \( p = .5 \)

\[ \bar{z}_1 = -2.33 \]

SO REQUIRED \( n = \left( \frac{\sqrt{.48} \cdot 2.33 + \sqrt{.52} \cdot 48}{.52 - .48} \right)^2 \]

\[ 3000 \text{?} \]

AND \( C = 2.33 \sqrt{n \cdot .48} \cdot .5 + n \cdot (48) \)