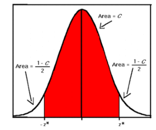
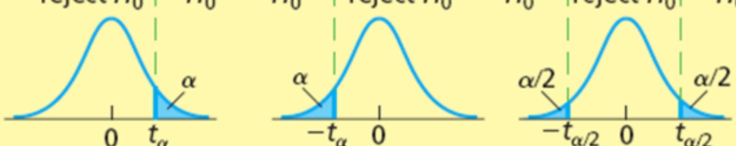
Test Hypothesis Procedure	**Step 1** State the null and alternative hypotheses	**Step 2** Compute the Test Statistic	Confidence Interval	Sample Size Calculation
One sample Z-test for μ Population is normal or n large	$H_0: \mu \le \mu_0$ vs. $H_a: \mu > \mu_0$ or $H_0: \mu \ge \mu_0$ vs. $H_a: \mu < \mu_0$ or $H_0: \mu = \mu_0$ vs. $H_a: \mu \ne \mu_0$	$z = \dfrac{\bar{x}-\mu_0}{\sigma/\sqrt{n}}$	$\bar{x} \pm \boxed{z^* \dfrac{\sigma}{\sqrt{n}}}$ margin of error	$n = \left(\dfrac{z^*\sigma}{E}\right)^2$ key word "within" margin of error
One sample t-test for μ → ใช้ sd จากตัวอย่าง Population is normal or n large and the population sd is unknown.	$H_0: \mu \le \mu_0$ vs. $H_a: \mu > \mu_0$ or $H_0: \mu \ge \mu_0$ vs. $H_a: \mu < \mu_0$ or $H_0: \mu = \mu_0$ vs. $H_a: \mu \ne \mu_0$	$t = \dfrac{\bar{x}-\mu_0}{s/\sqrt{n}}$, df = n-1	$\bar{x} \pm t^* \dfrac{s}{\sqrt{n}}$	Use the above formula.
Paired t-test differences are normal or n large	$H_0: \mu_d \le 0$ vs. $H_a: \mu_d > 0$ or $H_0: \mu_d \ge 0$ vs. $H_a: \mu_d < 0$ or $H_0: \mu_d = 0$ vs. $H_a: \mu_d \ne 0$	$t = \dfrac{\bar{d}-0}{s/\sqrt{n}}$, df = n-1 $\dfrac{\Sigma D}{n}$	 C = confidence level.	*Confidence Level* / *Confidence Coefficient, $1-\alpha$* / *z^* or $Z_{\alpha/2}$ value*: 80% / 0.80 / 1.28 90% / 0.90 / 1.645 95% / 0.95 / 1.96 98% / 0.98 / 2.33 99% / 0.99 / 2.58 99.8% / 0.998 / 3.08 99.9% / 0.999 / 3.27
One sample Z-test for p สัดส่วน n is large ie. $n\hat{p} \ge 5$ and $n(1-\hat{p}) \ge 5$ ตอบคำถามใช่ / ไม่ใช่	$H_0: p \le p_0$ vs. $H_a: p > p_0$ or $H_0: p \ge p_0$ vs. $H_a: p < p_0$ or $H_0: p = p_0$ vs. $H_a: p \ne p_0$ p = population , $\hat{p}$ = sample , $\hat{p}$ = proportion	$z = \dfrac{\hat{p}-p_0}{\sqrt{\dfrac{p_0(1-p_0)}{n}}}$ hypothesis	$\hat{p} \pm z_{\alpha/2}\sqrt{\dfrac{\hat{p}(1-\hat{p})}{n}}$	$n = p(1-p)\left(\dfrac{z^*}{E}\right)^2$ If do not know p, let p = 0.5. or $\frac{1}{4}\left(\frac{z^*}{E}\right)^2$
Binomial-test for p ~Bin (n, p) p (X ≥ ...)	$H_0: p \le p_0$ vs. $H_a: p > p_0$ or $H_0: p \ge p_0$ vs. $H_a: p < p_0$ or $H_0: p = p_0$ vs. $H_a: p \ne p_0$	X = count of "successes" among a random sample of size n	<u>Type of Errors</u> Type I: Reject H_0 when H_0 is true. Type II: Reject H_a when H_a is true.	
Two sample t-test for comparing two means Each of the two populations is normal or sample sizes are large. Two populations have equal variance.	$H_0: \mu_1 \le \mu_2$ vs. $H_0: \mu_1 > \mu_2$ or $H_0: \mu_1 \ge \mu_2$ vs. $H_0: \mu_1 < \mu_2$ or $H_0: \mu_1 = \mu_2$ vs. $H_0: \mu_1 \ne \mu_2$	$t = \dfrac{\bar{x}_1-\bar{x}_2}{\sqrt{s_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$, $\underbrace{s_p^2}_{\text{pool varience}} = \dfrac{(n_1-1)s_1^2+(\overset{n_2-1}{\cancel{n_1-2}})s_2^2}{n_1+n_2-2}$, $df = \underbrace{n_1+n_2-2}_{\text{size sample}}$ varience pop 1 varience pop 2		

Critical Value Rule

$H_a: \mu > \mu_0$ — Do not reject H_0 / Reject H_0

$H_a: \mu < \mu_0$ — Reject H_0 / Do not reject H_0

$H_a: \mu \ne \mu_0$ — Reject H_0 / Do not reject H_0 / Reject H_0



Reject H_0 if $t > t_\alpha$ CV

Reject H_0 if $t < -t_\alpha$

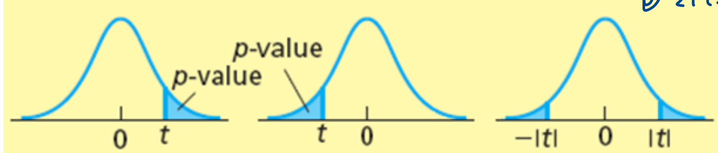
Reject H_0 if $|t| > t_{\alpha/2}$—that is, $t > t_{\alpha/2}$ or $t < -t_{\alpha/2}$

p-Value (Reject H_0 if p-Value < α)

$H_a: \mu > \mu_0$

$H_a: \mu < \mu_0$

$H_a: \mu \ne \mu_0$ p-value 2P(Z > ...)



p-value = area to the right of t

p-value = area to the left of t

p-value = twice the area to the right of |t|

<u>Sampling distribution of the sample mean (Central limit Theorem)</u>

The distribution of all sample mean is approximately normal with mean μ and standard deviation $\sigma/\sqrt{n}$ as n large. Note that if the population is already normal, CLT applies for any n. $P(\bar{X} > ..) = P\left(Z > \dfrac{x-\mu}{\frac{\sigma}{\sqrt{n}}}\right)$

P-value = probability of getting the test statistic or more extreme (in the direction of alternative hypothesis) assuming the null hypothesis is true.

ค่า CI ที่พบบ่อย

- 90% → $z^* = 1.645$
- 95% → $z^* = 1.96$
- 99% → $z^* = 2.58$

$$\sigma^2 = \frac{\Sigma(x_i-\bar{x})^2}{N}$$

$$s^2 = \frac{\Sigma(x_i-\bar{x})^2}{n-1}$$

less than → $H_0 : \mu \geq \ldots$, $H_a : \mu < \ldots$

ทดสอบ pair t-test

$$t = \frac{\bar{D}-\mu_D}{s/\sqrt{n}}$$

$$\bar{D} = \frac{\Sigma D}{n}$$

$$s_D = \sqrt{\frac{\Sigma(D_i-\bar{D})^2}{n-1}}$$

Type 1 error H_0 ถูก แต่ reject H_0

Type 2 error H_a ถูก แต่ reject H_a

p-value $\leq \alpha$ reject H_0

p-value $> \alpha$ not reject H_0

Example

b. A random sample of 50 students is obtained. What is the probability that the ***mean score*** for these 50 students will be 21 or higher?

From CLT , $\bar{x} \sim N(\mu_{\bar{x}} = 18.6,\ \sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{5.9}{\sqrt{50}}) = 0.834$

$P(\bar{x} > 21) = P(z > \frac{21-18.6}{\frac{5.9}{\sqrt{50}}})$

$= P(z > \ldots)$

$= 0.0021$

central limit theorem

Example

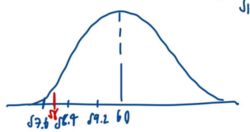
$\sigma = 8$

Achievement test scores of all high school seniors in a state have mean $\boxed{60}$ and variance 64. A random sample of 100 students from one large high school had a mean score of $\boxed{58}$. Is there evidence to suggest that this high school is inferior?

$\bar{x}$

$\bar{x} =$
$N = 100$

$\sigma_{\bar{x}} = \frac{8}{\sqrt{100}} = 0.8$



Confidence Level	Confidence Coefficient, $1-\alpha$	z^* or $Z_{\alpha/2}$ value
80%	0.80	1.28
90%	0.90	1.645
95%	0.95	1.96
98%	0.98	2.33
99%	0.99	2.58
99.8%	0.998	3.08
99.9%	0.999	3.27

Descriptives

	Difference
N	8
Missing	0
Mean	190.50000
Median	231.50000
Standard deviation	284.10411
Minimum	-229
Maximum	559

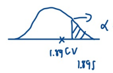
Diff = step - high

$H_0 : \mu_D \leq 0$, $H_a ; \mu_D > 0$

$t = \frac{\bar{x}-0}{SD/\sqrt{n}} = \frac{190.5}{284.10/\sqrt{8}}$

$t = 1.89$

$t \neq$ reject H_0



∴ Not Reject H_0

Given the following information, calculate the value of test statistics, set up the rejection region, and interpret the result

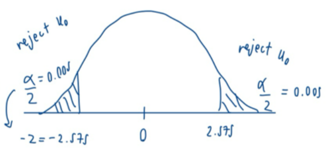
H_0: $\mu = 1000$
H_1: $\mu \neq 1000$

$\sigma = 200, n = 100, \bar{x} = 980, \alpha = 0.01$

SD

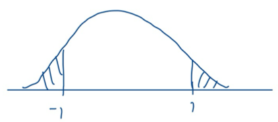
$z = \frac{\bar{x}-\mu}{\sigma/\sqrt{n}} = \frac{980-1000}{200/\sqrt{100}} = \frac{-20}{20} = -1$

critical value



2 ไม่อยู่ใน rejection region do not reject

p-value



P-value $= 2P(z > 1)$
$= 2(0.1587) = 0.3174 > \alpha = 0.01$
Not reject