Test statistic (z or t) for Hypothesis Testing About a population mean

σ KNOWN	σ NOT KNOWN
$z = \dfrac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$	$t = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}}$

μ_0 = hypothesized mean

z & t = calculated test statistic, used to determine whether to reject the Null Hypothesis. Compare z or t to critical value to make decision, or used to calculate p-value. z & t = number of Standard Errors above/below Hypothesized mean.

$\bar{x}$ = sample mean

σ = population standard deviation

s = sample standard deviation

n = sample size

Test statistic for Hypothesis Tests About A Population Proportion

$$Z = \frac{\bar{P} - P_0}{\sqrt{\dfrac{P_0 * (1-P_0)}{n}}}$$

$\bar{P}$ = sample proportion = $\frac{\text{successes}}{n}$

P_0 hypothesized pop. proportion

n = sample size

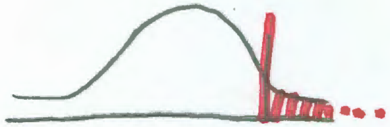
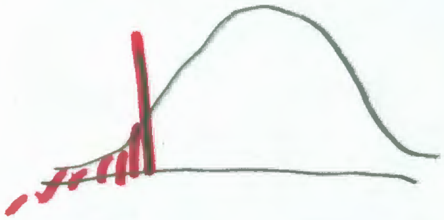
$$SE = \sigma_{\bar{P}} = \sqrt{\frac{P_0 * (1-P_0)}{n}}$$

Must verify:

1. Are there fixed # Trials?
2. Are results Independent?
3. Does each Trial result in success or Failure?
4. P stay same on each trial?
5. $\left.\begin{array}{l} n*p > 5 \\ n*(1-p) > 5 \end{array}\right\}$ text book assumes true for all problems.

* since exact sampling Distribution of $\bar{P}$ (P_{Bar}) is Descrete, small samples require additional steps that we will not do in this textbook.

Excel Functions

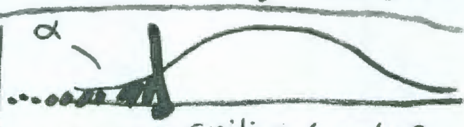
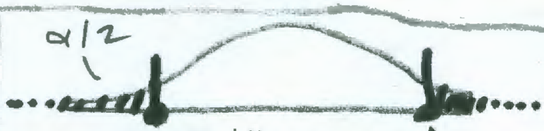
	Z Distribution	t Distribution
1 tail to Right upper 	P-value = 1-NORM.S.DIST(Z,1) upper critical value = NORM.S.INV(1-α)	P-value = 1-T.DIST(t, df, 1) or = T.DIST.RT(t, df) upper critical value = T.INV(1-α, df)
Two tail 	P-value = NORM.S.DIST(Z,1)*2 Z on Low end Low critical value = NORM.S.INV(α/2) upper = NORM.S.INV(1-α/2) or +/- critical values = +/-NORM.S.INV(α/2)	P-value = T.DIST(lower t, df, 1)*2 or = T.DIST.2T(upper t, df) Low critical value T.INV(α/2, df) upper = T.INV(1-α/2, df) or +/- critical values = +/- T.INV(α/2, df)
1 tail to Left upper 	P-value = NORM.S.DIST(Z,1) Low critical value = NORM.S.INV(α)	P-value = T.DIST(t, df, 1) Lower critical value = T.INV(α, df)
When to use:	sigma known and proportions, when 4 tests met.	sigma not known

Z

Hypothesis Testing Z Distribution (Sigma Known)

Test Type	 α critical value 1 Tail Test To Left ← Lower Tail	 α/2 critical values ← Two-tail Test →	 α/2 critical value 1 Tail Test to Right Upper Tail →
Hypothesis	$H_0 : \mu >= \mu_0$ $H_a : \mu < \mu_0$	$H_0 : \mu = \mu_0$ $H_a : \mu <> \mu_0$ * <> → Not Equal To	$H_0 : \mu <= \mu_0$ $H_a : \mu > \mu_0$
Test statistic	$Z = \dfrac{\bar{X} - \mu_0}{\sigma / \sqrt{n}}$		
p-value Rejection Rule	If: p-value $\le \alpha$ Then: Reject Ho, Accept Ha		
Excel p-value	=NORM.S.DIST(z,1)	=NORM.S.DIST(z,1)*2 Z on Low End	=1-NORM.S.DIST(z,1)
Critical value Rejection Rule (for 1 tail) Fail to Reject (for 2-Tail)	If: $Z \le -Z_\alpha$ Then: Reject Ho, Accept Ha $-Z_\alpha$ = critical value (low End)	If: $-Z_{\alpha/2} < Z < Z_{\alpha/2}$ Then: Fail To Reject Ho $-Z_{\alpha/2}$ = Low critical value $Z_{\alpha/2}$ = Upper critical value	If: $Z \ge Z_\alpha$ Then: Reject Ho, Accept Ha
Excel critical value	$-Z_\alpha$ = NORM.S.INV(α)	+/- critical value = = NORM.S.INV(α/2)	Z_α = NORM.S.INV(1-α)

(Z) Hypothesis Testing Z Distribution (Proportions)

Test Type	 1 Tail Test To Left ← Lower Tail	 ← Two-tail Test →	 1 Tail Test to Right Upper Tail →
Hypothesis	$H_o: p >= p_o$ $H_a: p < p_o$	$H_o: p = p_o$ $H_a: p <> p_o$	$H_o: p <= p_o$ $H_a: p > p_o$
Test statistic	{Standard Error} $= SE = \sigma_{\bar{p}} = \sqrt{\dfrac{p_o * (1-p_o)}{N}}$ / $Z = \dfrac{\bar{p} - p_o}{SE}$		
p-value Rejection Rule	If: p-value $\leq \alpha$ Then: Reject H_o, Accept H_a		
Excel p-value	=NORM.S.DIST(z,1)	=NORM.S.DIST(z,1)*2 z on Low End	=1-NORM.S.DIST(z,1)
Critical value Rejection Rule (For 1 tail) Fail To Reject (for 2-Tail)	If: $Z \leq -Z_\alpha$ Then: Reject H_o, Accept H_a $-Z_\alpha$ = critical value (low End)	If: $-Z_{\alpha/2} < Z < Z_{\alpha/2}$ Then: Fail To Reject H_o $-Z_{\alpha/2}$ = Low critical value $Z_{\alpha/2}$ = Upper critical value	If: $Z \geq Z_\alpha$ Then: Reject H_o, Accept H_a
Excel critical value	$-Z_\alpha$ = NORM.S.INV(α)	+/- critical value = = NORM.S.INV($\alpha/2$)	Z_α = NORM.S.INV($1-\alpha$)

t Hypothesis Testing t Distribution (Sigma Not Known)

Test Type	 ← Lower Tail 1 Tail Test To Left	 ← Two-tail Test →	 Upper Tail → 1 Tail Test o Right
Hypothesis	$H_0: \mu >= \mu_0$ $H_a: \mu < \mu_0$	$H_0: \mu = \mu_0$ $H_a: \mu <> \mu_0$	$H_0: \mu >= \mu_0$ $H_a: \mu > \mu_0$
Test statistic	$t = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}}$		
p-value Rejection Rule	If: p-value $\leq \alpha$ Then: Reject Ho, Accept Ha		
Excel p-value	=T.DIST(t,df,1)	=T.DIST.2T(upper t,df) or =T.DIST(lower t,df,1)*2	=1-T.DIST(t,df,1) or =T.DIST.RT(t,df)
Critical value Rejection Rule (for 1 Tail) Accept Rule (for 2-tail)	If: $t \leq -t_\alpha$ Then: Reject Ho, Accept Ha $-t_\alpha$ = Low Critical Value	If: $-t_{\alpha/2} < t < t_{\alpha/2}$ Then: Fail to Reject Ho $-t_{\alpha/2}$ = Low critical value $t_{\alpha/2}$ = Upper Critical value	If: $t \geq t_\alpha$ Then: Reject Ho, Accept Ha t_α = upper Critical Value
Excel critical Value	$-t_\alpha$ = T.INV(α,df)	Lower = T.INV(α/2,df) Upper = T.INV(1-α/2,df) or +/- = T.INV(α,df)	t_α = T.INV(1-α,df)