#	1-Tailed Hyp	2-Tailed Hyp	Assumptions	Formulas	Decision (2-tailed)	CI (2-Sided)	CI (1-Sided Upper)	CI (1-Sided Lower)
1	**1 Sample Z-Test** Ho: $\mu=5$ Ha: $\mu>5$	Ho: $\mu=3$ Ha: $\mu\neq3$	-Random Sample -Sample mean is normally distributed	$Z_{stat}=\frac{\bar{x}-\mu}{\sigma/\sqrt{(n)}}$	Reject Ho if $\lvert Z_{stat}\rvert>\lvert Z_{crit}\rvert$ or $p<\alpha$	$\bar{x}\pm Z_{\alpha/2}\,\sigma/\sqrt{(n)}$	if ">" in Ha UB="infinite" LB= $\bar{x}-Z_{\alpha}\,\sigma/\sqrt{(n)}$	if "<" in Ha UB= $\bar{x}+Z_{\alpha}\,\sigma/\sqrt{(n)}$ LB="0" or "-infinite"
2	**1 Sample T-Test** Ho: $\mu=6$ Ha: $\mu>6$	Ho: $\mu=8$ Ha: $\mu\neq8$	-Random Sample -Sample mean is normally distributed	$T_{stat}=\frac{\bar{x}-\mu}{s/\sqrt{(n)}}$ df = n -1	Reject Ho if $\lvert T_{stat}\rvert>\lvert T_{crit}\rvert$ or $p<\alpha$	$\bar{x}\pm T_{\alpha/2}\,s/\sqrt{(n)}$	if ">" in Ha UB="infinite" LB= $\bar{x}-T_{\alpha}\,s/\sqrt{(n)}$	if "<" in Ha UB= $\bar{x}+T_{\alpha}\,s/\sqrt{(n)}$ LB="0" or "-infinite"
3	**Paired T-Test** Ho: $\mu_d=0$ Ha: $\mu_d<0$	Ho: $\mu_d=0$ Ha: $\mu_d\neq0$	-Dependent Samples -Sample mean of differences is normally distributed	$T_{stat}=\frac{\bar{d}-\mu_d}{s_d/\sqrt{(n)}}$ df = n -1	Reject Ho if $\lvert T_{stat}\rvert>\lvert T_{crit}\rvert$ or $p<\alpha$	$\bar{d}\pm T_{\alpha/2}\,s_d/\sqrt{(n)}$	if ">" in Ha UB="infinite" LB= $\bar{d}-T_{\alpha}\,s_d/\sqrt{(n)}$	if "<" in Ha UB= $\bar{d}+T_{\alpha}\,s_d/\sqrt{(n)}$ LB="-infinite"
4	**2 Sample T-Test** Ho: $\mu_1-\mu_2=0$ Ha: $\mu_1-\mu_2<0$	Ho: $\mu_1-\mu_2=0$ Ha: $\mu_1-\mu_2\neq0$	-Independent Samples -Population Variances are Equal -Sample means are both normally distributed	$T_{stat}=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)}{s_p\sqrt{(1/n_1+1/n_2)}}$ $s_p=\sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}$ df $=n_1+n_2-2$	Reject Ho if $\lvert T_{stat}\rvert>\lvert T_{crit}\rvert$ or $p<\alpha$	$(\bar{x}_1-\bar{x}_2)\pm\overbrace{T_{\alpha/2}{}^{*}\underbrace{s_p\sqrt{(1/n_1+1/n_2)}}_{SE}}^{ME}$	if ">" in Ha UB="infinite" LB= $(\bar{x}_1-\bar{x}_2)-T_{\alpha}{}^{*}s_p\sqrt{(1/n_1+1/n_2)}$	if "<" in Ha UB= $(\bar{x}_1-\bar{x}_2)+T_{\alpha}{}^{*}s_p\sqrt{(1/n_1+1/n_2)}$ LB="-infinite"
5	**2 Sample T-Test** Ho: $\mu_1-\mu_2=0$ Ha: $\mu_1-\mu_2<0$	Ho: $\mu_1-\mu_2=0$ Ha: $\mu_1-\mu_2\neq0$	-Independent Samples -Population Variances are NOT Equal -Sample means are both normally distributed	$T_{stat}=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)}{\sqrt{(s_1^2/n_1+s_2^2/n_2)}}$ df $=\frac{(s_1^2/n_1+s_2^2/n_2)^2}{\left(\frac{(s_1^2/n_1)^2}{n_1-1}+\frac{(s_2^2/n_2)^2}{n_2-1}\right)}$	Reject Ho if $\lvert T_{stat}\rvert>\lvert T_{crit}\rvert$ or $p<\alpha$	$(\bar{x}_1-\bar{x}_2)\pm T_{\alpha/2}{}^{*}\sqrt{(s_1^2/n_1+s_2^2/n_2)}$	if ">" in Ha UB="infinite" LB= $(\bar{x}_1-\bar{x}_2)-T_{\alpha}{}^{*}\sqrt{(s_1^2/n_1+s_2^2/n_2)}$	if "<" in Ha UB= $(\bar{x}_1-\bar{x}_2)+T_{\alpha}{}^{*}\sqrt{(s_1^2/n_1+s_2^2/n_2)}$ LB="-infinite"
7	**Wilcoxin** Ho: $M_d=0$ Ha: $M_d<0$	Ho: $M_d=0$ Ha: $M_d\neq0$	-Dependent Samples -Sample of Diff is NOT Normally Distributed	p-value = from Minitab output	Reject Ho if $p<\alpha$	Minitab	Minitab	Minitab
8	**Mann-Whitney** Ho: $M_1-M_2=0$ Ha: $M_1-M_2<0$	Ho: $M_1-M_2=0$ Ha: $M_1-M_2\neq0$	-Independent Samples -One or both of the samples is NOT normally distributed	p-value = from Minitab output - is significant at	Reject Ho if $p<\alpha$	Minitab	Minitab	Minitab
9	**1 Proportion** Ho: $p=0.3$ Ha: $p<0.3$	Ho: $p=0.4$ Ha: $p\neq0.4$	$-np\geq10$ $-nq\geq10$ Sample Proportion normally distributed	$Z_{stat}=\frac{\hat{p}-p}{\sqrt{(pq/n)}}$ $\hat{p}=x/n$ $\hat{q}=1-\hat{p}$	Reject Ho if $\lvert Z_{stat}\rvert>\lvert Z_{crit}\rvert$ or $p<\alpha$	$\hat{p}\pm Z_{\alpha/2}\sqrt{(\hat{p}\hat{q}/n)}$	if ">" in Ha UB="1" LB= $\hat{p}-Z_{\alpha}\sqrt{(\hat{p}\hat{q}/n)}$	if "<" in Ha UB= $\hat{p}+Z_{\alpha}\sqrt{(\hat{p}\hat{q}/n)}$ LB="0"
10	**2 Proportions** Ho: $p_1-p_2=0.0$ Ha: $p_1-p_2<0.0$ (Independent Pooled)	Ho: $p_1-p_2=0.0$ Ha: $p_1-p_2\neq0.0$	Sample Proportions normally distributed	$Z_{stat}=\frac{(\hat{p}_1-\hat{p}_2)-(p_1-p_2)}{\sqrt{\bar{p}(1-\bar{p})(1/n_1+1/n_2)}}$ $\bar{p}=(n_1\hat{p}_1+n_2\hat{p}_2)/(n_1+n_2)$ $\hat{p}_1=x_1/n_1$ $\hat{p}_2=x_2/n_2$	Reject Ho if $\lvert Z_{stat}\rvert>\lvert Z_{crit}\rvert$ or $p<\alpha$	$(\hat{p}_1-\hat{p}_2)\pm Z_{\alpha/2}{}^{*}\sqrt{(\hat{p}_1\hat{q}_1/n_1+\hat{p}_2\hat{q}_2/n_2)}$	if ">" in Ha UB="1" LB= $(\hat{p}_1-\hat{p}_2)-Z_{\alpha}{}^{*}\sqrt{(\hat{p}_1\hat{q}_1/n_1+\hat{p}_2\hat{q}_2/n_2)}$	if "<" in Ha UB= $(\hat{p}_1-\hat{p}_2)+Z_{\alpha}{}^{*}\sqrt{(\hat{p}_1\hat{q}_1/n_1+\hat{p}_2\hat{q}_2/n_2)}$ LB="-1"
11	**2 Proportions** Ho: $p_1-p_2=0.1$ Ha: $p_1-p_2<0.1$ (Independent)	Ho: $p_1-p_2=0.1$ Ha: $p_1-p_2\neq0.1$	Sample Proportions normally distributed	$Z_{stat}=\frac{(\hat{p}_1-\hat{p}_2)-(p_1-p_2)}{\sqrt{(\hat{p}_1\hat{q}_1/n_1+\hat{p}_2\hat{q}_2/n_2)}}$ $\hat{p}_1=x_1/n_1$ $\hat{p}_2=x_2/n_2$	Reject Ho if $\lvert Z_{stat}\rvert>\lvert Z_{crit}\rvert$ or $p<\alpha$	$(\hat{p}_1-\hat{p}_2)\pm Z_{\alpha/2}{}^{*}\sqrt{(\hat{p}_1\hat{q}_1/n_1+\hat{p}_2\hat{q}_2/n_2)}$	if ">" in Ha UB="1" LB= $(\hat{p}_1-\hat{p}_2)-Z_{\alpha}{}^{*}\sqrt{(\hat{p}_1\hat{q}_1/n_1+\hat{p}_2\hat{q}_2/n_2)}$	if "<" in Ha UB= $(\hat{p}_1-\hat{p}_2)+Z_{\alpha}{}^{*}\sqrt{(\hat{p}_1\hat{q}_1/n_1+\hat{p}_2\hat{q}_2/n_2)}$ LB="-1"
12	**2 Proportions** Ho: $p_1-p_2=0.0$ Ha: $p_1-p_2<0.0$ (Dependent, $\hat{p}_1$ and $\hat{p}_2$ from same sample)	Ho: $p_1-p_2=0.0$ Ha: $p_1-p_2\neq0.0$	Sample Proportions normally distributed	$Z_{stat}=\frac{(\hat{p}_1-\hat{p}_2)-(p_1-p_2)}{\sqrt{(\hat{p}_1\hat{q}_1/n+\hat{p}_2\hat{q}_2/n+2\hat{p}_1\hat{p}_2/n)}}$ $\hat{p}_1=x_1/n$ $\hat{p}_2=x_2/n$	Reject Ho if $\lvert Z_{stat}\rvert>\lvert Z_{crit}\rvert$ or $p<\alpha$	$(\hat{p}_1-\hat{p}_2)\pm Z_{\alpha/2}{}^{*}\sqrt{(\hat{p}_1\hat{q}_1/n+\hat{p}_2\hat{q}_2/n+2\hat{p}_1\hat{p}_2/n)}$	if ">" in Ha UB="1" LB="do only subtraction" *Remember you should be using 1 sided Z	if "<" in Ha UB="Do only addition" LB="-1"

Variables

- μ = pop. mean
- $\bar{x}$ = sample mean
- σ = pop. SD
- s = sample SD
- σ^2 = pop. variance
- s^2 = sample variance
- μ_d = pop. mean of differences
- $\bar{d}$ = sample mean of differences
- s_d = sample SD of differences
- s_p = pooled SD
- n = sample size
- M_d = pop. median of differences
- E = margin of error
- M = pop. median
- p = pop. proportion
- $\hat{p}$ = sample proportion
- $\bar{p}$ = pooled proportion

Testing Steps

1) State Assumptions
2) Write Hypothesis
3) Calculate STAT Value
4) Calculate CRIT Value
5) Make Decision
6) Write Conclusion

1-Tailed Decision Rules

*If 1 tailed and you have a "<" sign in Ha, reject Ho if Zstat <Zcrit or Tstat<Tcrit,
*If 1 tailed and you have a ">" sign in Ha, reject Ho if Zstat >Zcrit or Tstat>Tcrit
*ALWAYS Reject Ho if $p<\alpha$

Confidence Intervals

*Never input a negative $Z_{\alpha}(Z_{\alpha/2})$ or $T_{\alpha}(T_{\alpha/2})$ in your interval formulas.

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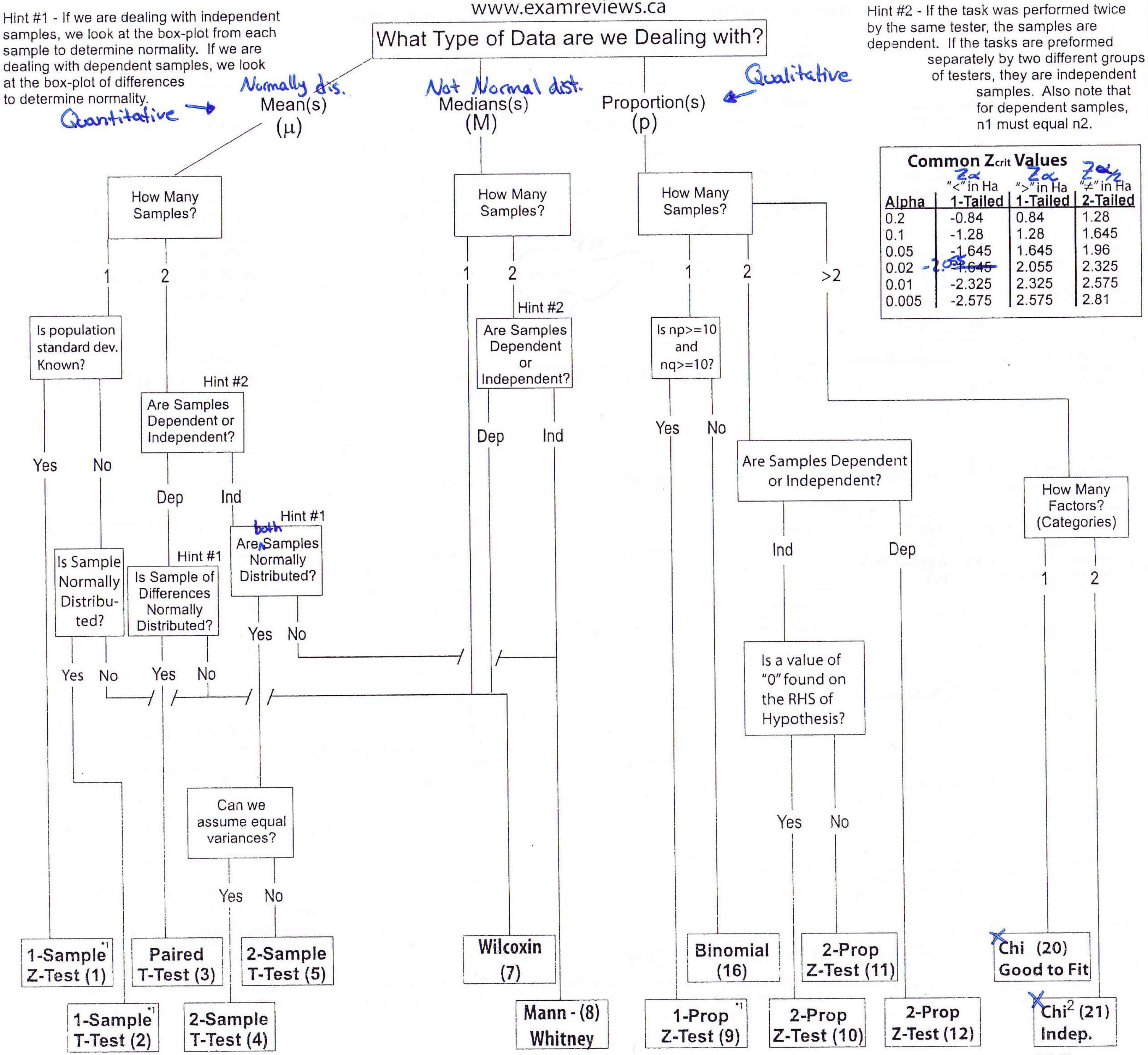
Hint #1 - If we are dealing with independent samples, we look at the box-plot from each sample to determine normality. If we are dealing with dependent samples, we look at the box-plot of differences to determine normality.

Hint #2 - If the task was performed twice by the same tester, the samples are dependent. If the tasks are preformed separately by two different groups of testers, they are independent samples. Also note that for dependent samples, n1 must equal n2.



Common Z_{crit} Values

Alpha	"<" in Ha 1-Tailed (Z_α)	">" in Ha 1-Tailed (Z_α)	"≠" in Ha 2-Tailed ($Z_{\alpha/2}$)
0.2	-0.84	0.84	1.28
0.1	-1.28	1.28	1.645
0.05	-1.645	1.645	1.96
0.02	-2.055 ~~-1.645~~	2.055	2.325
0.01	-2.325	2.325	2.575
0.005	-2.575	2.575	2.81

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Binomial

Ho:p = 0.3 Ho:p = 0.4
Ha:p < 0.3 Ha:p ≠ 0.4

$P(X=x) = \frac{n!}{x!(n-x)!}p^x q^{n-x}$

$P(X=x) = nC_x p^x q^{n-x}$

n=# of trials (sample size)
p=probability of a success
q=probability of a failure
q=1-p
x=# of successes in "n" trials

Reject Ho if $p < \alpha$

Required Sample Size (always round up)

-proportion

$n = \frac{Z_{\alpha/2}^2 \hat{p}\hat{q}}{E^2}$

*$\hat{p}$, $\hat{q}$ and E are always entered as decimals
*If $\hat{p}$ and $\hat{q}$ are not given use values of 0.5

-means (σ known)

$n = \frac{Z_{\alpha/2}^2 \sigma^2}{E^2}$

-means (σ unknown)

$n = \frac{T_{\alpha/2}^2 s^2}{E^2}$

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Chi Sq-Goodness to Fit

Ho: Data follows described dist.
Ha: Data follows some other dist.

$Chi^2_{stat} = \sum_{i=1}^{k} \frac{(o_i - e_i)^2}{e_i}$ o=observed, e=expected, df=r-1

Reject Ho if $|Chi^2_{stat}| > |Chi^2_{crit}|$ or $p < \alpha$.

Step 1 - Calculate the total of observed counts
Step 2 - Derive expected values as described in the question
Follow Step 3,4,5 in box below.

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Chi Sq-Test of Independence

Ho: Factor A is independent of Factor B
Ha: Factor A is not independent of Factor B

$Chi^2_{stat} = \sum_{i=1}^{r}\sum_{j=1}^{c} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$ o=observed, e=expected, df=(r-1)(c-1)

$e_{ij} = \frac{(\text{i row total})(\text{j column total})}{\text{Total sample size}}$

Reject Ho if $|Chi^2_{stat}| > |Chi^2_{crit}|$ or $p < \alpha$.

Step 1 - Calculate all row totals, col totals and grand total
Step 2 - Calculate expected value for each cell
Step 3 - Calculate Chi^2 for each cell
Step 4 - Add the Chi^2 from each cell to get your Chi^2_{stat}
Step 5 - Finish Hypothesis Test.

[1]FPCF - If a sample(s) is more than 5% of the population we must apply the FPCF. Therefore, if n/N>0.05, we multiply the denominator by