Appendix 15

A15.1 Chi-squared goodness-of-fit test

$H_0: p_1 = .50,\ p_2 = .20,\ p_3 = .15\ \ p_4 = .10\ \ p_5 = .05$

H_1: At least one p_i is not equal to its specified value.

$$\chi^2 = \sum \frac{(f_i - e_i)^2}{e_i}$$

	C	D	E
1	Actual	Expected	
2	183	175	
3	63	70	
4	55	52.5	
5	29	35	
6	20	17.5	
7		p-value=	0.6321

p-value = .6321. There is not enough evidence to conclude that applicants to WLU's MBA program are different in terms of their undergraduate degrees from the population of MBA applicants?

A15.2 t-test of μ_D

$H_0: \mu_D = 0$

$H_1: \mu_D < 0$

$$t = \frac{\bar{x}_D - \mu_D}{s_D / \sqrt{n_D}}$$

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		*First Sat*	*Second SAT*
4	Mean	1175	1190
5	Variance	28422	35392
6	Observations	40	40
7	Pearson Correlation	0.91	
8	Hypothesized Mean Difference	0	
9	df	39	
10	t Stat	-1.20	
11	P(T<=t) one-tail	0.1182	
12	t Critical one-tail	1.6849	
13	P(T<=t) two-tail	0.2365	
14	t Critical two-tail	2.0227	

t = –1.20, p-value = .1182. There is not enough evidence to indicate that repeating the SAT produces higher exam scores.

A15.3 Time to solve the 48 problems: Equal-variances t-test of $\mu_1 - \mu_2$

$$H_0: (\mu_1 - \mu_2) = 0$$

$$H_1: (\mu_1 - \mu_2) > 0$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

	A	B	C
1	t-Test: Two-Sample Assuming Equal Variances		
2			
3		*Diet*	*Not*
4	Mean	581.95	551.5
5	Variance	2716.6	2221.5
6	Observations	20	20
7	Pooled Variance	2469.1	
8	Hypothesized Mean Difference	0	
9	df	38	
10	t Stat	1.94	
11	P(T<=t) one-tail	0.0300	
12	t Critical one-tail	1.6860	
13	P(T<=t) two-tail	0.0601	
14	t Critical two-tail	2.0244	

t = 1.94, p-value = .0300. There is enough evidence to conclude that dieters take longer to solve the 48 problems than do nondieters.

Successfully repeat string of five letters: z-test of $p_1 - p_2$ (case 1)

$$H_0: p_1 - p_2 = 0$$

$$H_1: p_1 - p_2 < 0$$

$$z = \frac{(\hat{p}_1 - \hat{p}_2)}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

	A	B	C	D
1	**z-Test: Two Proportions**			
2				
3			*Diet*	*Not*
4	Sample Proportions		0.50	0.80
5	Observations		20	20
6	Hypothesized Difference		0	
7	z Stat		-1.99	
8	P(Z<=z) one tail		0.0234	
9	z Critical one-tail		1.6449	
10	P(Z<=z) two-tail		0.0468	
11	z Critical two-tail		1.96	

z = –1.99, p-value = .0234. There is enough evidence to conclude that dieters are less successful at repeating string of five letters.

Successfully repeat string of five words: z-test of $p_1 - p_2$ (case 1)

$$H_0: p_1 - p_2 = 0$$

$$H_1: p_1 - p_2 > 0$$

$$z = \frac{(\hat{p}_1 - \hat{p}_2)}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

	A	B	C	D
1	**z-Test: Two Proportions**			
2				
3			*Diet*	*Not*
4	Sample Proportions		0.35	0.60
5	Observations		20	20
6	Hypothesized Difference		0	
7	z Stat		-1.58	
8	P(Z<=z) one tail		0.0567	
9	z Critical one-tail		1.6449	
10	P(Z<=z) two-tail		0.1134	
11	z Critical two-tail		1.96	

z = –1.58, p-value = .0567. There is not enough evidence to conclude that dieters are less successful at repeating string of five words.

A15.4 a t-estimator of μ

$$\bar{x} \pm t_{\alpha/2} \frac{s}{\sqrt{n}}$$

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Overdue*
4	Mean			7.09
5	Standard Deviation			6.97
6	LCL			6.40
7	UCL			7.77

LCL = 6.40, UCL = 7.77

b LCL = 50,000($.25)(6.40) = $80,000

UCL = 50,000($.25)(7.77) = $97,125

It does appear that not all fines are collected

A15.5 One-way analysis of variance

$H_0: \mu_1 = \mu_2 = \mu_3$

$H_1:$ At least two means differ

	A	B	C	D	E	F	G
10	ANOVA						
11	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
12	Between Groups	57512	2	28756	3.23	0.0468	3.16
13	Within Groups	506984	57	8894			
14							
15	Total	564496	59				

F = 3.23; p-value = .0468. There is enough evidence to conclude that differences in sales exist between the three advertising strategies.

A15.6 Chi-squared test of a contingency table

$H_0:$ The two variables (income category and mutual fund ownership) are independent

$H_1:$ The two variables are dependent

$$\chi^2 = \sum \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D	E
1	**Contingency Table**				
2					
3		*Income category*			
4	*Mutual fund*		1	2	TOTAL
5		1	71	13	84
6		2	59	28	87
7		3	86	55	141
8		4	87	157	244
9		5	32	145	177
10		6	58	205	263
11		TOTAL	393	603	996
12					
13					
14		chi-squared Stat			196.77
15		df			5
16		p-value			0
17		chi-squared Critical			11.0705

$\chi^2 = 196.77$;p-value = 0. There is overwhelming evidence to infer that household income and ownership of mutual funds are related

A15.7 Two-factor analysis of variance

	A	B	C	D	E	F	G
23	ANOVA						
24	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
25	Sample	13172	1	13172	1.42	0.2387	4.02
26	Columns	98839	2	49419	5.33	0.0077	3.17
27	Interaction	1610	2	805	0.09	0.9171	3.17
28	Within	501137	54	9280			
29							
30	Total	614757	59				

Interaction: F = .09; p-value = .9171. There is no evidence of interaction.

Advertising strategy (Columns): F = 5.33; p-value = .0077. There is sufficient evidence to conclude that advertising strategies differ with respect to sales.

Media (Sample): F = 1.42; p-value = .2387. There is not enough evidence to conclude that differences in the medium for advertising differ in terms of sales.

A15.8 z-test of $p_1 - p_2$ (case 1) Code 3 results were omitted.

$$H_0 : (p_1 - p_2) = 0$$

$$H_1 : (p_1 - p_2) < 0$$

$$z = \frac{(\hat{p}_1 - \hat{p}_2)}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

	A	B	C	D
1	**z-Test: Two Proportions**			
2				
3			*Folic acid*	*Placebo*
4	Sample Proportions		0.0101	0.0343
5	Observations		597	612
6	Hypothesized Difference		0	
7	z Stat		-2.85	
8	P(Z<=z) one tail		0.0022	
9	z Critical one-tail		1.6449	
10	P(Z<=z) two-tail		0.0044	
11	z Critical two-tail		1.9600	

z = –2.85, p-value = .0022. There is overwhelming evidence to conclude that folic acid reduces the incidence of spina bifida.

A15.9 Unequal-variances t-test of $\mu_1 - \mu_2$

$$H_0: (\mu_1 - \mu_2) = 0$$

$$H_1: (\mu_1 - \mu_2) < 0$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}} =$$

	A	B	C
1	t-Test: Two-Sample Assuming Unequal Variances		
2			
3		*British*	*American*
4	Mean	238.0	252.0
5	Variance	149.9	220.2
6	Observations	263	279
7	Hypothesized Mean Difference	0	
8	df	531	
9	t Stat	-12.00	
10	P(T<=t) one-tail	7.64E-30	
11	t Critical one-tail	1.6477	
12	P(T<=t) two-tail	1.53E-29	
13	t Critical two-tail	1.9644	

z = –12.00, p-value = 0. There is enough evidence to infer that British golfers play golf in less time than do American golfers.

A15.10 one-way analysis of variance

$H_0: \mu_1 = \mu_2 = \mu_3$

$H_1:$ At least two means differ

	A	B	C	D	E	F	G
10	ANOVA						
11	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
12	Between Groups	626046	2	313023	58.37	0.0000	3.03
13	Within Groups	1523047	284	5363			
14							
15	Total	2149093	286				

F = 58.37, p-value = 0. There is enough evidence to conclude that there are differences between the three groups.

Multiple Comparisons

	A	B	C	D	E
1	**Multiple Comparisons**				
2					
3				LSD	Omega
4	Treatment	Treatment	Difference	Alpha = 0.0167	Alpha = 0.05
5	*Before 1976*	*After 1986*	122.62	28.03	25.46
6		*Canadian*	78.04	24.67	25.46
7	*After 1986*	*Canadian*	-44.58	25.75	25.46

All three groups differ from each other.

A15.11 Chi-squared test of a contingency table

$H_0:$ The two variables (year and sport) are independent

$H_1:$ The two variables are dependent

$$\chi^2 = \sum \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D	E
1	**Contingency Table**				
2					
3		*Sport*			
4	*Year*		1	2	TOTAL
5		1	116	122	238
6		2	119	92	211
7		3	29	58	87
8		4	52	39	91
9		5	48	34	82
10		6	16	33	49
11		7	26	29	55
12		8	24	21	45
13		9	70	72	142
14		TOTAL	500	500	1000
15					
16					
17		chi-squared Stat			23.8101
18		df			8
19		p-value			0.0025
20		chi-squared Critical			15.5073

χ^2 = 23.8101, p-value = .0025. There is enough evidence to infer that North Americans changed their favorite sport between 1985 and 1992.

A15.12 t-estimator of μ

$$\bar{x} \pm t_{\alpha/2} \frac{s}{\sqrt{n}}$$

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Cars*
4	Mean			165.79
5	Standard Deviation			51.59
6	LCL			157.17
7	UCL			174.41

Five minute interval: LCL = 157.17, UCL = 174.41

Twenty-four hour day (12 5-minute intervals, 24 hours per day):

$$LCL = 12 \times 24 \times 157.17 = 45{,}265$$

$$UCL = 12 \times 24 \times 174.41 = 50{,}230$$

A15.13 z-estimator of p

$$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$$

	A	B
1	**z-Estimate: Proportion**	
2		*Exercise?*
3	Sample Proportion	0.551
4	Observations	671
5	LCL	0.514
6	UCL	0.589

Total number of adults who exercise:

LCL = 205.9 million (.514) = 105.8 million

UCL = 205.9 million (.589) = 121.3 million

A15.14 Equal-variances t-test of $\mu_1 - \mu_2$

$$H_0: (\mu_1 - \mu_2) = 0$$

$$H_1: (\mu_1 - \mu_2) < 0$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

	A	B	C
1	t-Test: Two-Sample Assuming Equal Variances		
2			
3		*Activity*	*Usual*
4	Mean	57.06	87.28
5	Variance	296.18	215.42
6	Observations	67	67
7	Pooled Variance	255.80	
8	Hypothesized Mean Difference	0.00	
9	df	132	
10	t Stat	-10.94	
11	P(T<=t) one-tail	0.0000	
12	t Critical one-tail	1.6565	
13	P(T<=t) two-tail	0.0000	
14	t Critical two-tail	1.9781	

t = –10.94, p-value = 0. There is enough evidence to indicate to infer that graded activity is effective.

A15.15 Chi-squared test of a contingency table

H_0 : The two variables (group and improvement) are independent

H_1 : The two variables are dependent

$$\chi^2 = \sum \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D	E
1	**Contingency Table**				
2					
3		*Group*			
4	*Improvement*		1	2	TOTAL
5		1	42	8	50
6		2	32	18	50
7		3	13	37	50
8		TOTAL	87	63	150
9					
10					
11		chi-squared Stat			35.63
12		df			2
13		p-value			0
14		chi-squared Critical			5.9915

χ^2 = 35.63, p-value = 0. There is sufficient evidence to infer there are differences between the three groups.

A15.16 z-estimator of p

$$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$$

	A	B	C	D	E
1	**z-Estimate of a Proportion**				
2					
3	**Sample proportion**	0.774	**Confidence Interval Estimate**		
4	**Sample size**	780	**0.774**	±	**0.0294**
5	**Confidence level**	0.95	**Lower confidence limit**		**0.7446**
6			**Upper confidence limit**		**0.8034**

Total number of on-time departures:

LCL = 7,140,596(.7446) = 5,316,888

UCL = 7,140,596(.8034) = 5,736,755

Case A15.1 One-way analysis of variance

$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4$

$H_1:$ At least two means differ

Weight loss:

	A	B	C	D	E	F	G
11	ANOVA						
12	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
13	Between Groups	189.4	3	63.14	1.78	0.1532	2.66
14	Within Groups	5533.6	156	35.47			
15							
16	Total	5723.0	159				

F = 1.78, p-value = .1532. There is not enough evidence to conclude that there are differences in weight loss between the four diets.

Percent LDL decrease:

	A	B	C	D	E	F	G
11	ANOVA						
12	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
13	Between Groups	2569.4	3	856.48	32.56	0.0000	2.66
14	Within Groups	4104.0	156	26.31			
15							
16	Total	6673.4	159				

F = 32.56, p-value = 0. There is enough evidence to conclude that there are differences in bad cholesterol reduction between the four diets.

Percent HDL Increase:

	A	B	C	D	E	F	G
11	ANOVA						
12	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
13	Between Groups	5595.0	3	1864.99	92.62	0.0000	2.66
14	Within Groups	3141.3	156	20.14			
15							
16	Total	8736.2	159				

F = 96.62, p-value = 0. There is enough evidence to conclude that there are differences in good cholesterol increase between the four diets.

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