Appendix 16

A16.1 t-test of ρ

$H_0: \rho = 0$

$H_1: \rho \neq 0$

	A	B
1	**Correlation**	
2		
3	*Weight and B/A Level*	
4	Pearson Coefficient of Correlation	0.4177
5	t Stat	3.19
6	df	48
7	P(T<=t) one tail	0.0013
8	t Critical one tail	1.6772
9	P(T<=t) two tail	0.0026
10	t Critical two tail	2.0106

r = .4177, t = 3.19, p–value = .0026. There is sufficient evidence to infer that weight and blood–alcohol level are related.

A16.2 Two-way analysis of variance

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

$H_1:$ At least two means differ

	A	B	C	D	E	F	G
40	ANOVA						
41	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
42	Rows	3708.8	28	132.46	8.63	6.52E-15	1.61
43	Columns	997.0	3	332.33	21.64	1.77E-10	2.71
44	Error	1289.8	84	15.35			
45							
46	Total	5995.5	115				

F = 21.64; p-value = 0. There is enough evidence to conclude that there are differences in the decrease in test scores between the four types of breakfast meals.

A16.3a Chi-squared goodness-of-fit test (the percentages must be converted to actual and expected values and we must include those who did not have cancer)

$$H_0: p_1 = 143/420{,}000,\ p_2 = 9/420{,}000,\ p_3 = 80/420{,}000,\ p_4 = 52/420{,}000,$$
$$p_5 = 57/420{,}000,\ p_6 = 12/420{,}000,\ p_7 = 13/420{,}000,\ p_8 = 419.634/420{,}000$$

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

$$\chi^2 = \sum_{i=1}^{8} \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D
1	Actual	Expected		
2	135	143		
3	7	9		
4	77	80		
5	32	52		
6	42	57		
7	8	12		
8	13	13		
9	419686	419634	p-value =	0.0515

p-value = .0515. There is not enough evidence to conclude that there is a relationship between cell phone use and cancer.

b The data are observational. Even if we regard the statistical result as significant we cannot automatically infer that cell phone use causes cancer. Additionally, an examination of the actual and expected values reveals that in all 7 types of cancers the actual values are *less than or equal* to the expected values, indicating that (if anything) cell phone use prevents cancer.

A16.4 t-test of ρ or t-test of β_1

$$H_0 : \rho = 0$$

$$H_1 : \rho > 0$$

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

	A	B	C	D
1	**Correlation**			
2				
3	*Age and Duration*			
4	Pearson Coefficient of Correlation			0.558
5	t Stat			7.90
6	df			138
7	P(T<=t) one tail			0
8	t Critical one tail			1.6560
9	P(T<=t) two tail			0
10	t Critical two tail			1.9773

t = 7.90; p-value = 0. There is overwhelming evidence to infer that the older the patient the longer it takes for the symptoms to disappear?

A16.5a 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		*Home*	*Outside*
4	Mean	59.21	54.91
5	Variance	102.03	88.28
6	Observations	196	152
7	Pooled Variance	96.03	
8	Hypothesized Mean Difference	0	
9	df	346	
10	t Stat	4.06	
11	P(T<=t) one-tail	0.0000	
12	t Critical one-tail	1.6493	
13	P(T<=t) two-tail	0.0001	
14	t Critical two-tail	1.9668	

t = 4.06, p-value = 0. There is enough evidence to infer that men whose wives stay at home earn more than men whose wives work outside the home.

b It may be that men whose wives stay at home work harder, and thus earn more.

A16.6 Question 1: 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		*US Days*	*Canada Days*
4	Mean	26.98	29.44
5	Variance	55.90	56.82
6	Observations	300	300
7	Pooled Variance	56.36	
8	Hypothesized Mean Difference	0	
9	df	598	
10	t Stat	-4.00	
11	P(T<=t) one-tail	0.0000	
12	t Critical one-tail	1.6474	
13	P(T<=t) two-tail	0.0001	
14	t Critical two-tail	1.9639	

t = –4.00, p-value = 0. There is enough evidence to indicate that recovery is faster in the United States.

Question 2: z-tests 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			*U.S.*	*Canada*
4	Sample Proportions		0.6267	0.6867
5	Observations		300	300
6	Hypothesized Difference		0	
7	z Stat		-1.55	
8	P(Z<=z) one tail		0.0609	
9	z Critical one-tail		1.6449	
10	P(Z<=z) two-tail		0.1218	
11	z Critical two-tail		1.9600	

z = –1.55, p-value = .0609. There is not enough evidence to infer that recovery is faster in the United States.

6 months after heart attack:

	A	B	C	D
1	**z-Test: Two Proportions**			
2				
3			*U.S.*	*Canada*
4	Sample Proportions		0.1867	0.1733
5	Observations		300	300
6	Hypothesized Difference		0	
7	z Stat		0.43	
8	P(Z<=z) one tail		0.3354	
9	z Critical one-tail		1.6449	
10	P(Z<=z) two-tail		0.6708	
11	z Critical two-tail		1.9600	

z = .43, p-value = 1 - .3354 = .6646. There is no evidence to infer that recovery is faster in the United States.

12 months after heart attack

	A	B	C	D
1	**z-Test: Two Proportions**			
2				
3			*U.S.*	*Canada*
4	Sample Proportions		0.1167	0.1100
5	Observations		300	300
6	Hypothesized Difference		0	
7	z Stat		0.26	
8	P(Z<=z) one tail		0.3984	
9	z Critical one-tail		1.6449	
10	P(Z<=z) two-tail		0.7968	
11	z Critical two-tail		1.9600	

z = .26, p-value = 1 – .3984 = .6016. There is no evidence to infer that recovery is faster in the United States.

A16.7 Chi-squared test of a contingency table

H_0 : The two variables are independent

H_1 : The two variables are dependent

$$\chi^2 = \sum_{i=1}^{12} \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D	E	F
1	**Contingency Table**					
2						
3		*Favored*				
4	*Result*		1	2	3	TOTAL
5		1	31	25	17	73
6		2	46	16	19	81
7		3	27	7	15	49
8		4	16	2	3	21
9		TOTAL	120	50	54	224
10						
11						
12		chi-squared Stat			13.4477	
13		df			6	
14		p-value			0.0365	
15		chi-squared Critical			12.5916	

$\chi^2 = 13.4477$, p-value = .0365. There is enough evidence to infer that Pro-Line's forecasts are related to outcomes and thus, can be useful to bettors.

A16.8 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		*No-Slide*	*Slide*
4	Mean	3.73	3.78
5	Variance	0.0653	0.0727
6	Observations	25	25
7	Pearson Correlation	0.96	
8	Hypothesized Mean Difference	0	
9	df	24	
10	t Stat	-3.04	
11	P(T<=t) one-tail	0.0028	
12	t Critical one-tail	1.7109	
13	P(T<=t) two-tail	0.0057	
14	t Critical two-tail	2.0639	

t = –3.04, p-value = .0028. There is overwhelming evidence to indicate that sliding is slower.

A16.9 z-test of $p_1 - p_2$ (case 1) (The data were unstacked prior to applying the z-test.)

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

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

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

	A	B	C	D
1	**z-Test: Two Proportions**			
2				
3			*Optimist*	*Pessimist*
4	Sample Proportions		0.9499	0.8797
5	Observations		1478	241
6	Hypothesized Difference		0	
7	z Stat		4.26	
8	P(Z<=z) one tail		0	
9	z Critical one-tail		1.6449	
10	P(Z<=z) two-tail		0	
11	z Critical two-tail		1.9600	

z = 4.26, p-value = 0. There is sufficient evidence that pessimists are less likely to survive than optimists.

A16.10 Simple linear regression with cholesterol reduction (Before – After) as the dependent variable

a t-test of β_1 or test of ρ

$$H_0: \beta_1 = 0$$

$$H_1: \beta_1 \neq 0$$

We used the t-test of β_1 because parts (b) and (c) use the regression equation to predict and estimate.

	A	B	C	D	E	F
1	SUMMARY OUTPUT					
2						
3	*Regression Statistics*					
4	Multiple R	0.7138				
5	R Square	0.5095				
6	Adjusted R Square	0.4993				
7	Standard Error	10.53				
8	Observations	50				
9						
10	ANOVA					
11		*df*	*SS*	*MS*	*F*	*Significance F*
12	Regression	1	5528	5528.5	49.87	5.92E-09
13	Residual	48	5322	110.9		
14	Total	49	10850			
15						
16		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	
17	Intercept	2.05	3.94	0.52	0.6051	
18	Exercise	0.0909	0.0129	7.06	5.92E-09	

t = 7.06; p-value = 0. There is overwhelming evidence to infer that exercise and cholesterol reduction are related.

b. Prediction interval

$$\hat{y} \pm t_{\alpha/2,n-2} s_{\varepsilon} \sqrt{1 + \frac{1}{n} + \frac{(x_g - \bar{x})^2}{(n-1)s_x^2}}$$

	A	B	C
1	**Prediction Interval**		
2			
3			Reduction
4			
5	Predicted value		11.14
6			
7	Prediction Interval		
8	Lower limit		-10.76
9	Upper limit		33.05
10			
11	Interval Estimate of Expected Valu		
12	Lower limit		5.54
13	Upper limit		16.75

The cholesterol reduction is predicted to fall between −10.76 and 33.05.

c Confidence interval estimator of the expected value of y

$$\hat{y} \pm t_{\alpha/2,n-2} s_{\varepsilon} \sqrt{\frac{1}{n} + \frac{(x_g - \bar{x})^2}{(n-1)s_x^2}}$$

	A	B	C
1	**Prediction Interval**		
2			
3			Reduction
4			
5	Predicted value		12.96
6			
7	Prediction Interval		
8	Lower limit		-8.83
9	Upper limit		34.76
10			
11	Interval Estimate of Expected Valu		
12	Lower limit		7.79
13	Upper limit		18.14

We estimate that the mean reduction in cholesterol lies between 7.79 and 18.14.

A16.11 Instructors: 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		*Public-Instructors*	*Private-Instructors*
4	Mean	39.40	41.23
5	Variance	18.38	24.66
6	Observations	56	130
7	Hypothesized Mean Difference	0	
8	df	120	
9	t Stat	-2.54	
10	P(T<=t) one-tail	0.0061	
11	t Critical one-tail	1.6577	
12	P(T<=t) two-tail	0.0122	
13	t Critical two-tail	1.9799	

t = −2,54; p-value = .0061. There is enough evidence to conclude that the salaries of instructors at publicly-funded colleges and universities are less than the salaries of instructors at private colleges and universities.

Assistant professors: 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		*Public-Assistant*	*Private-Assistant*
4	Mean	54.08	59.37
5	Variance	26.10	32.84
6	Observations	137	130
7	Pooled Variance	29.38	
8	Hypothesized Mean Difference	0	
9	df	265	
10	t Stat	-7.98	
11	P(T<=t) one-tail	2.18E-14	
12	t Critical one-tail	1.6506	
13	P(T<=t) two-tail	4.36E-14	
14	t Critical two-tail	1.9690	

$t = -7.98$; p-value = 0. There is overwhelming evidence to conclude that the salaries of assistant professors at publicly-funded colleges and universities are less than the salaries of assistant professor at private colleges and universities.

Associate professors: 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		*Public-Associate*	*Private-Associate*
4	Mean	64.45	71.07
5	Variance	30.96	30.96
6	Observations	162	160
7	Pooled Variance	30.96	
8	Hypothesized Mean Difference	0	
9	df	320	
10	t Stat	-10.69	
11	P(T<=t) one-tail	2.65E-23	
12	t Critical one-tail	1.6496	
13	P(T<=t) two-tail	5.31E-23	
14	t Critical two-tail	1.9674	

$t = -10.69$; p-value = 0. There is overwhelming evidence to conclude that the salaries of associate professors at publicly-funded colleges and universities are less than the salaries of associate professor at private colleges and universities.

Professors: 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		*Public-Professor*	*Private-Professor*
4	Mean	88.89	107.39
5	Variance	49.14	74.99
6	Observations	268	172
7	Hypothesized Mean Difference	0	
8	df	310	
9	t Stat	-23.51	
10	P(T<=t) one-tail	3.61E-71	
11	t Critical one-tail	1.6498	
12	P(T<=t) two-tail	7.22E-71	
13	t Critical two-tail	1.9676	

t = −23.51; p-value = 0. There is overwhelming evidence to conclude that the salaries of professors at publicly-funded colleges and universities are less than the salaries of professors at private colleges and universities.

A16.12a 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	1.65	2	0.823	0.1332	0.8753	3.0259
13	Within Groups	1847.2	299	6.18			
14							
15	Total	1848.9	301				

F = .1332; p-value = .8753. There is no evidence to infer that there are differences between the three groups of patients.

b 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	247.0	2	123.48	15.81	2.96E-07	3.03
13	Within Groups	2334.6	299	7.81			
14							
15	Total	2581.6	301				

F = 15.81; p-value = 0. There is overwhelming evidence to conclude that there are differences between the three groups of patients.

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	*Group 1 After*	*Group 2 After*	0.099	0.949	0.922
6		*Group 3 After*	-1.867	0.942	0.922
7	*Group 2 After*	*Group 3 After*	-1.965	0.954	0.922

Group 3 differs from both group 1 and group 2. Groups 1 and 2 do not differ.

c. The test assures researchers that the three groups of patients were very similar prior to treatments.

A16.13 a. One-way analysis of variance

$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6$

$H_1:$ At least two means differ

	A	B	C	D	E	F	G
13	ANOVA						
14	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
15	Between Groups	527,465	5	105,493	4.43	0.0015	2.3538
16	Within Groups	1,571,667	66	23,813			
17							
18	Total	2,099,132	71				

F = 4.43; p-value = .0015. There is enough evidence to infer that differences exist between the six groups.

b. Two-factor analysis of variance

	A	B	C	D	E	F	G
29	ANOVA						
30	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
31	Sample	303,247	2	151,623	6.37	0.0030	3.1359
32	Columns	190,139	1	190,139	7.98	0.0062	3.9863
33	Interaction	34,080	2	17,040	0.72	0.4927	3.1359
34	Within	1,571,667	66	23,813			
35							
36	Total	2,099,132	71				

Test for interaction: F = .72; p-value = .4927. There is no evidence of interaction.

Test for gender (columns): F = 7.98; p-value = .0062. There is enough evidence to conclude that there are differences in cash offers between males and females.

Test for age: F = 6.37; p-value = .0030. There is enough evidence to conclude that there are differences in cash offers between the three age groups.

A16.14 a Chi-squared test of a contingency table

H_0 : The two variables (year and party) are independent

H_1 : The two variables are dependent

$$\chi^2 = \sum_{i=1}^{8} \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D	E	F
1	**Contingency Table**					
2						
3		*1990*	*1996*	*2000*	*2004*	TOTAL
4	*Democrats*	154	161	159	152	626
5	*Republican*	99	100	97	87	383
6	*Other*	22	42	56	60	180
7	TOTAL	275	303	312	299	1189
8						
9	chi-squared Stat			19.27		
10	df			6		
11	p-value			0.0037		
12	chi-squared Critical			12.5916		

χ^2 = 19.27; p-value = .0037. There is overwhelming evidence to infer that party affiliation in Broward County changed over the four years.

b Chi-squared test of a contingency table

H_0 : The two variables (year and party) are independent

H_1 : The two variables are dependent

$$\chi^2 = \sum_{i=1}^{8} \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D	E	F
1	**Contingency Table**					
2						
3		*1990*	*1996*	*2000*	*2004*	TOTAL
4	*Democrats*	173	157	136	146	612
5	*Republicar*	117	128	117	122	484
6	*Other*	25	43	56	63	187
7	TOTAL	315	328	309	331	1283
8						
9	chi-squared Stat			22.65		
10	df			6		
11	p-value			0.0009		
12	chi-squared Critical			12.5916		

$\chi^2 = 22.65$; p-value = .0009. There is overwhelming evidence to infer that party affiliation in Miami-Dade changed over the four years.

c Chi-squared test of a contingency table

H_0 : The two variables (County and party in 2004) are independent

H_1 : The two variables are dependent

$$\chi^2 = \sum_{i=1}^{6} \frac{(f_i - e_i)^2}{e_i}$$

	A	B	C	D
1	**Contingency Table**			
2				
3		*Broward*	*Miami-Dade*	TOTAL
4	*Democrats*	152	146	298
5	*Republicans*	87	122	209
6	*Other*	60	63	123
7	TOTAL	299	331	630
8				
9	chi-squared Stat			4.44
10	df			2
11	p-value			0.1085
12	chi-squared Critical			5.9915

$\chi^2 = 4.44$; p-value = 1095. There is not enough evidence to infer that party affiliation differ between Broward County and Miami-Dade County.

A16.15 t-test of ρ

$H_0 : \rho = 0$

$H_1 : \rho \neq 0$

	A	B
1	**Correlation**	
2		
3	*CO and NO3*	
4	Pearson Coefficient of Correlation	0.8913
5	t Stat	13.62
6	df	48
7	P(T<=t) one tail	0
8	t Critical one tail	1.6772
9	P(T<=t) two tail	0
10	t Critical two tail	2.0106

r = .8913, t = 13.62, p–value = 0; there is enough evidence to infer that the belief is correct.

A16.16 t-estimator of μ

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

	A	B	C	D
1	**t-Estimate: Mean**			
2				
3				*Commute*
4	Mean			24.54
5	Standard Deviation			11.63
6	LCL			23.64
7	UCL			25.45

Total time spent commuting by all workers:

LCL = 129,142,000 (23.64) = 3,052,916,880 minutes

UCL = 129,142,000 (25.45) = 3,286,663,900 minutes

Case A16.1 Relationship between interest rates and sales: t-test of ρ or β_1

$H_0: \rho = 0$

$H_1: \rho \neq 0$

	A	B
1	**Correlation**	
2		
3	*Rates and Sales*	
4	Pearson Coefficient of Correlation	-0.27
5	t Stat	-9.09
6	df	1051
7	P(T<=t) one tail	0
8	t Critical one tail	1.6463
9	P(T<=t) two tail	0
10	t Critical two tail	1.9622

t = –9.09, p-value = 0. There is overwhelming evidence to infer that interest rates and sales are linearly related.

Relationship between interest rates and ages: Spearman rank correlation coefficient test

$H_0: \rho = 0$

$H_1: \rho \neq 0$

	A	B
1	**Correlation**	
2		
3	*Rates and Age*	
4	Pearson Coefficient of Correlation	-0.19
5	t Stat	-6.32
6	df	1051
7	P(T<=t) one tail	0
8	t Critical one tail	1.6463
9	P(T<=t) two tail	0
10	t Critical two tail	1.9622

z = –6.01, p-value = 0. There is overwhelming evidence to infer that interest rates and age of business are linearly related.

Difference between sales: Unequal variances t- test of $\mu_1 - \mu_2$

$H_0: \mu_1 - \mu_2 = 0$

. $H_1: \mu_1 - \mu_2 < 0$

	A	B	C
1	t-Test: Two-Sample Assuming Unequal Variances		
2			
3		*W Sales*	*M Sales*
4	Mean	552	1183
5	Variance	60133	128618
6	Observations	101	952
7	Hypothesized Mean Difference	0	
8	df	150	
9	t Stat	-23.37	
10	P(T<=t) one-tail	0.0000	
11	t Critical one-tail	1.6551	
12	P(T<=t) two-tail	0.0000	
13	t Critical two-tail	1.9759	

t = –23.37, p-value = 0. There is sufficient evidence to conclude that businesses owned by women have lower sales than businesses owned by men.

Difference between ages: Unequal variances t- test of $\mu_1 - \mu_2$

$H_0: \mu_1 - \mu_2 = 0$

. $H_1: \mu_1 - \mu_2 < 0$

	A	B	C
1	t-Test: Two-Sample Assuming Unequal Variances		
2			
3		*W Age*	*M Age*
4	Mean	9.24	12.58
5	Variance	15.98	27.05
6	Observations	101	952
7	Hypothesized Mean Difference	0	
8	df	139	
9	t Stat	-7.73	
10	P(T<=t) one-tail	0.0000	
11	t Critical one-tail	1.6559	
12	P(T<=t) two-tail	0.0000	
13	t Critical two-tail	1.9772	

t = –7.73, p-value = 0. There is sufficient evidence to conclude that businesses owned by men are older than businesses owned by women.

Interest rates among the 3 types of businesses: 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	3.46	2	1.73	3.88	0.0209	3.0043
13	Within Groups	467.4	1050	0.45			
14							
15	Total	470.9	1052				

F = 3.88, p-value = .0209. There is enough evidence to conclude that there are differences in interest rates among the three types of business.

Gender of type of business: Ch-squared test of a contingency table

H_0 : The two variables (gender of business) are independent

H_1 : The two variables are dependent

	A	B	C	D	E	F
1	**Contingency Table**					
2						
3		*Gender*				
4	*Business*		1	2	3	TOTAL
5		1	31	10	60	101
6		2	162	76	714	952
7		TOTAL	193	86	774	1053
8						
9						
10		chi-squared Stat			12.75	
11		df			2	
12		p-value			0.0017	
13		chi-squared Critical			5.9915	

$X^2 = 12.75$; p-value = .0017. There is enough evidence to conclude that the types of businesses women own are different than those of men.

Case A16.2a t-tests of μ_D

$H_0 : \mu_D = 0$

$H_1 : \mu_D > 0$

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

Weight

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		*Weight 1*	*Weight 2*
4	Mean	79.89	78.62
5	Variance	255.54	251.09
6	Observations	33	33
7	Pearson Correlation	0.99	
8	Hypothesized Mean Difference	0	
9	df	32	
10	t Stat	2.90	
11	P(T<=t) one-tail	0.0034	
12	t Critical one-tail	1.6939	
13	P(T<=t) two-tail	0.0067	
14	t Critical two-tail	2.0369	

t = 2.90, p-value = .0034. There is enough evidence to infer that the program is a success in terms of weight level.

Cholesterol

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		*Choles 1*	*Choles 2*
4	Mean	6.87	6.27
5	Variance	0.583	0.618
6	Observations	33	33
7	Pearson Correlation	0.57	
8	Hypothesized Mean Difference	0	
9	df	32	
10	t Stat	4.83	
11	P(T<=t) one-tail	0.0000	
12	t Critical one-tail	1.6939	
13	P(T<=t) two-tail	0.0000	
14	t Critical two-tail	2.0369	

t = 4.83, p-value = 0. There is enough evidence to infer that the program is a success in terms of cholesterol level.

Fat intake

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		*TotFat 1*	*TotFat 2*
4	Mean	66.56	46.72
5	Variance	967.59	533.91
6	Observations	33	33
7	Pearson Correlation	0.63	
8	Hypothesized Mean Difference	0	
9	df	32	
10	t Stat	4.70	
11	P(T<=t) one-tail	0.0000	
12	t Critical one-tail	1.6939	
13	P(T<=t) two-tail	0.0000	
14	t Critical two-tail	2.0369	

t = 4.70, p-value = 0. There is enough evidence to infer that the program is a success in terms of fat intake.

Cholesterol intake

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		*DietC 1*	*DietC 2*
4	Mean	242.42	177.12
5	Variance	30618	13032
6	Observations	33	33
7	Pearson Correlation	0.42	
8	Hypothesized Mean Difference	0	
9	df	32	
10	t Stat	2.29	
11	P(T<=t) one-tail	0.0144	
12	t Critical one-tail	1.6939	
13	P(T<=t) two-tail	0.0288	
14	t Critical two-tail	2.0369	

t = 2.29, p-value = .0144. There is enough evidence to infer that the program is a success in terms of cholesterol intake.

Calories from fat

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		*PDCF 1*	*PDCF 2*
4	Mean	36.54	30.82
5	Variance	56.72	49.71
6	Observations	33	33
7	Pearson Correlation	0.75	
8	Hypothesized Mean Difference	0	
9	df	32	
10	t Stat	6.29	
11	P(T<=t) one-tail	0.0000	
12	t Critical one-tail	1.6939	
13	P(T<=t) two-tail	0.0000	
14	t Critical two-tail	2.0369	

t = 6.29, p-value = 0. There is enough evidence to infer that the program is a success in terms of daily calories from fat.

b Equal-variances t-test of $\mu_1 - \mu_2$

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

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

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

Weight reduction

	A	B	C
1	t-Test: Two-Sample Assuming Equal Variances		
2			
3		*Female*	*Male*
4	Mean	1.32	1.22
5	Variance	1.54	11.17
6	Observations	16	17
7	Pooled Variance	6.51	
8	Hypothesized Mean Difference	0	
9	df	31	
10	t Stat	0.11	
11	P(T<=t) one-tail	0.4551	
12	t Critical one-tail	1.6955	
13	P(T<=t) two-tail	0.9102	
14	t Critical two-tail	2.0395	

t = .31, p-value = .9102. There is no evidence to infer that gender is a factor in weight reduction.

Cholesterol reduction

	A	B	C
1	t-Test: Two-Sample Assuming Equal Variances		
2			
3		*Female*	*Male*
4	Mean	0.48	0.72
5	Variance	0.48	0.55
6	Observations	16	17
7	Pooled Variance	0.52	
8	Hypothesized Mean Difference	0	
9	df	31	
10	t Stat	-0.94	
11	P(T<=t) one-tail	0.1776	
12	t Critical one-tail	1.6955	
13	P(T<=t) two-tail	0.3551	
14	t Critical two-tail	2.0395	

t = –.94, p-value = .3551. There is not enough evidence to infer that gender is a factor in cholesterol reduction.

Fat intake reduction

	A	B	C
1	t-Test: Two-Sample Assuming Equal Variances		
2			
3		*Female*	*Male*
4	Mean	14.50	24.88
5	Variance	229.91	906.76
6	Observations	16	17
7	Pooled Variance	579.26	
8	Hypothesized Mean Difference	0	
9	df	31	
10	t Stat	-1.24	
11	P(T<=t) one-tail	0.1125	
12	t Critical one-tail	1.6955	
13	P(T<=t) two-tail	0.2251	
14	t Critical two-tail	2.0395	

t = –1.24, p-value = .2251. There is not enough evidence to infer that gender is a factor in fat intake reduction.

Cholesterol intake reduction

	A	B	C
1	t-Test: Two-Sample Assuming Equal Variances		
2			
3		*Female*	*Male*
4	Mean	38.46	90.56
5	Variance	5683	46984
6	Observations	16	17
7	Pooled Variance	27000	
8	Hypothesized Mean Difference	0	
9	df	31	
10	t Stat	-0.91	
11	P(T<=t) one-tail	0.1848	
12	t Critical one-tail	1.6955	
13	P(T<=t) two-tail	0.3697	
14	t Critical two-tail	2.0395	

t = –.91, p-value = .3697. There is not enough evidence to infer that gender is a factor in cholesterol intake reduction.

Calories from fat reduction

	A	B	C
1	t-Test: Two-Sample Assuming Equal Variances		
2			
3		*Female*	*Male*
4	Mean	6.88	4.62
5	Variance	18.69	34.29
6	Observations	16	17
7	Pooled Variance	26.74	
8	Hypothesized Mean Difference	0	
9	df	31	
10	t Stat	1.25	
11	P(T<=t) one-tail	0.1103	
12	t Critical one-tail	1.6955	
13	P(T<=t) two-tail	0.2207	
14	t Critical two-tail	2.0395	

t = 1.25, p-value = .2207. There is not enough evidence to infer that gender is a factor in calories from fat reduction.

c t-test of ρ or β_1

$$H_0 : \rho = 0 \text{ or } H_0 : \beta_1 = 0$$

$$H_1 : \rho \neq 0 \text{ or } H_1 : \beta_1 \neq 0$$

$$t = r\sqrt{\frac{n-2}{1-r^2}} \text{ or } t = \frac{b_1 - \beta_1}{s_{b_1}}$$

Age and weight reduction

	A	B	C	D
1	**Correlation**			
2				
3	*Age and Weight*			
4	Pearson Coefficient of Correlatior			-0.0980
5	t Stat			-0.55
6	df			31
7	P(T<=t) one tail			0.2937
8	t Critical one tail			1.6955
9	P(T<=t) two tail			0.5874
10	t Critical two tail			2.0395

t = –.55, p-value = .5874. There is not enough evidence that age is a factor in weight reduction.

Age and cholesterol reduction

	A	B	C	D
1	**Correlation**			
2				
3	*Age and Choles*			
4	Pearson Coefficient of Correlatior			0.3959
5	t Stat			2.40
6	df			31
7	P(T<=t) one tail			0.0113
8	t Critical one tail			1.6955
9	P(T<=t) two tail			0.0226
10	t Critical two tail			2.0395

t = 2.40, p-value = .0226. There is enough evidence to infer that age is a factor in cholesterol reduction.

Age and Fat intake reduction

	A	B	C	D
1	**Correlation**			
2				
3	*Age and TotFat*			
4	Pearson Coefficient of Correlatior			-0.1492
5	t Stat			-0.84
6	df			31
7	P(T<=t) one tail			0.2037
8	t Critical one tail			1.6955
9	P(T<=t) two tail			0.4074
10	t Critical two tail			2.0395

t = –.84, p-value = .4074. There is not enough evidence that age is a factor in fat intake reduction.

Age and Cholesterol intake reduction

	A	B	C	D
1	**Correlation**			
2				
3	*Age and Dietc*			
4	Pearson Coefficient of Correlatior			-0.1258
5	t Stat			-0.71
6	df			31
7	P(T<=t) one tail			0.2427
8	t Critical one tail			1.6955
9	P(T<=t) two tail			0.4854
10	t Critical two tail			2.0395

t = –.71, p-value = .4854. There is not enough evidence that age is a factor in cholesterol intake reduction.

Age and Calories from fat reduction

	A	B	C	D
1	**Correlation**			
2				
3	*Age and PDCF*			
4	Pearson Coefficient of Correlatior			-0.3628
5	t Stat			-2.17
6	df			31
7	P(T<=t) one tail			0.0190
8	t Critical one tail			1.6955
9	P(T<=t) two tail			0.0380
10	t Critical two tail			2.0395

t = –2.17, p-value = .0380. There is enough evidence to infer that age is a factor in calories from fat reduction.