Answers to Selected Problems

Chapter 1: Introduction

1. a. number: 76; object: John; variable: midterm grade
   b. number: 6.98; object: Rolling Stones album; variable: record cost
   c. number: 28; object: 1986 Ford Tempo; variable: miles per gallon
   d. number: brown-eyed; object: Mary; variable: eye color

2. a. interval b. nominal c. ordinal

3. a. 4.20 b. −.60

5. a. .52 b. −.32 c. .84 d. .53
   e. −.48 f. −.13 g. −.13 h. .36

6. a. 39 b. 251 c. 1521 d. 31 e. 38 f. 181

7.

Category	*Proportion*	*Odds*
A	.40	.67
B	.15	.18
C	.11	.12
D	.09	.10

Chapter 2: The Distribution of Scores

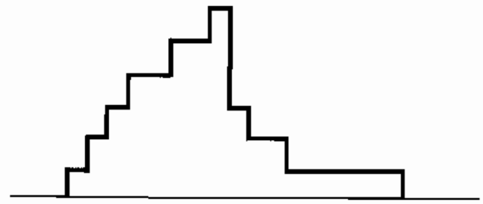
1.

Class Interval	*Frequency*	*Relative Frequency*
46 to 50	1	4.2
51 to 55	0	0.0
56 to 60	1	4.2
61 to 65	3	12.5
66 to 70	3	12.5
71 to 75	3	12.5
76 to 80	5	20.8

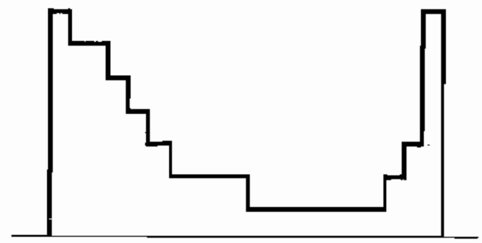
1. *(continued)*

Class Interval	*Frequency*	*Relative Frequency*
81 to 85	5	20.8
86 to 90	1	4.2
91 to 95	1	4.2
96 to 100	1	4.2

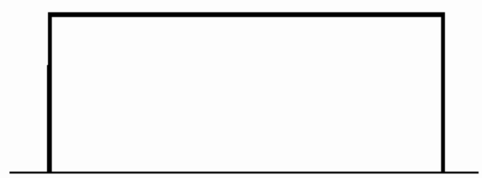
2. a.



b.



c.



3. Assume that the peak is not in the middle. Because the distribution is symmetric, it would have two peaks, one on each side. So the distribution must be peaked in the middle if there is a single peak.

5.

Class Interval	*Frequency*	*Smoothed Frequency*
−1.40 to −1.21	0	.25
−1.20 to −1.01	1	.50
−1.00 to −.81	0	.25
−.80 to −.61	0	.25
−.60 to −.41	1	2.50
−.40 to −.21	8	4.75
−.20 to −.01	2	6.25
0 to .19	13	8.00
.20 to .39	4	5.75
.40 to .59	2	2.25
.60 to .79	1	1.00
.80 to .99	0	.25

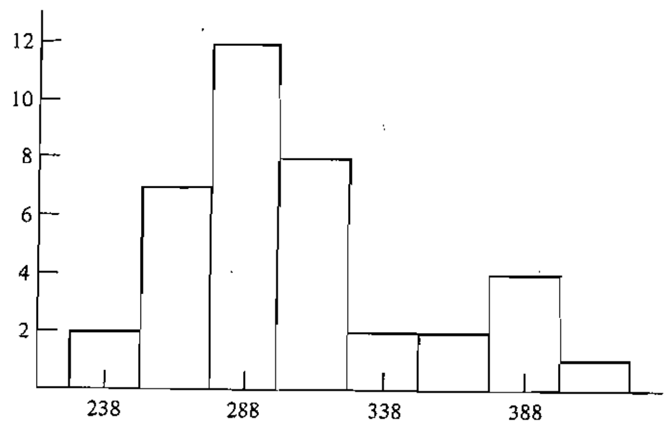
6. a. The unit is one, but most scores are multiples of five so the class width should be a multiple of five. The range is 425 minus 230, which equals 195. The maximum class width is $195/8 = 24.375$ and the minimum is $195/15 = 13$. Reasonable class widths are 15 and 20. The lowest lower limit should be some value less than or equal to 230, the lowest score.

b.

Rent	*Frequency*	*Relative Frequency*
226–250	2	5
251–275	7	18
276–300	12	32
301–325	8	21
326–350	2	5
351–375	2	5
376–400	4	11
401–425	1	3

c. The distribution is positively skewed.

7.



8. a. Males

Class Interval	*Frequency*	*Relative Frequency*
35.0 to 39.9	2	7
40.0 to 44.9	3	10
45.0 to 49.9	4	13
50.0 to 54.9	4	13
55.0 to 59.9	5	17
60.0 to 64.9	3	10
65.0 to 69.9	8	27
70.0 to 74.9	1	3

Females

Class Interval	*Frequency*	*Relative Frequency*
35.0 to 39.9	2	7
40.0 to 44.9	1	3
45.0 to 49.9	5	17
50.0 to 54.9	4	13
55.0 to 59.9	2	7
60.0 to 64.9	4	13
65.0 to 69.9	2	7
70.0 to 74.9	6	20
75.0 to 79.9	4	13

b. Both distributions are negatively skewed. Females live longer than males.

9.

Males

35	67
40	113
45	5789
50	1333
55	67799
60	234
65	56788999
70	2

Females

35	69
40	0
45	56678
50	1333
55	78
60	0123
65	67
70	134444
75	5667

14. a. .25 b. 20

Chapter 3: Central Tendency

1. a. mode = 6; median = 6; mean = 5.29
   b. mode = 2; median = 3.5; mean = 3.5
   c. modes = 2, 8; median = 4.5; mean = 5
   d. mode = 3; median = 4.5; mean = 16

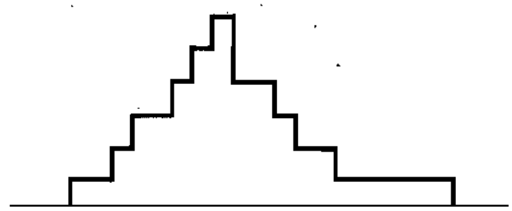
2. sample c, because of the two modes;
   sample d, because of the outlier of 96

3. a. mean = 3.90; median = 3.5; mode = 3
   b. mean = 12.64; median = 4; mode = 3
   The mean changed the most.
   c. mean = 4.45; median = 4; mode = 3
   The mean is most affected.

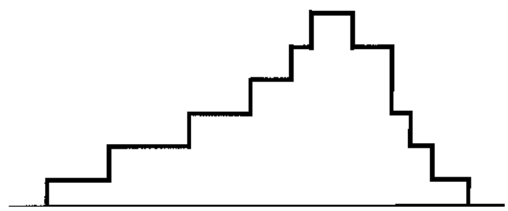
5. a. mean = 11101.33; median = 8780.5
   b. the median

7. negatively skewed

9. a.



b.



14. a. mean: \$28.49; median: \$22; mode: \$8 and \$45
    b. the median because of the outlier of \$120

Chapter 4: Variability

1. a. range = 10; interquartile range = 6; s = 3.54
   b. range = 13; interquartile range = 8.5; s = 4.54
   c. range = 13; interquartile range = 9; s = 4.72

2. a. 42.25 b. 84.50

3. a. s = 46.11; range = 144; interquartile range = 10
   b. s = 5.01; range = 16; interquartile range = 6
   c. the interquartile range

4. a. Marvel Motors: range = 8; interquartile range = 6; s = 3.22
   Amazing Auto: range = 2; interquartile range = 2; s = .89
   b. Amazing Auto

6. a. yes b. no c. no d. no

7. a. Control: $\overline{X}$ = 87.00; s = 7.24; s^2 = 52.44
   Experimental: $\overline{X}$ = 94.57; s = 4.06; s^2 = 16.48
   b. The control group is more variable.

9. The median is 19 and the interquartile range is 8.5. To be an outlier a score must be less than 2.00 or greater than 36.00. Using these criteria, the score 37 qualifies as an outlier.

Chapter 5: Transformation

1. a. 2.303 b. 6.245 c. 2.094 d. .021 e. .412 f. .160

3.

Original Score	Z Score
1	−1.14
2	−.91
3	−.68
4	−.45
5	−.23
6	.00
7	.23
8	.45
9	.68
15	2.05
18	2.73

4. Multiply each score by .09 and then add 1.0.

5. a. mean: 53; s: 30
   b. mean: 16.8; s: .2

6.

Number	Percentile Rank
8	27.5
12	52.5
17	82.5

7. a. mean = 30; s and s^2 remain the same
   b. mean = 75; s = 9.6; s^2 = 92.16

Chapter 6: Measuring Association: The Regression Coefficient

1. slope: 1.0; intercept: 40

2. a. no cigarettes: 2.23 days; 20 cigarettes: 3.85 days; 40 cigarettes: 5.47 days
   b. 114.21 days (15 × 94 × .081)

3. a. Predictor: similarity; criterion: marital satisfaction
   b. Predictor: effort; criterion: performance
   c. Predictor: sleep; criterion: efficiency
   d. Predictor: mood; criterion: health

4. a. positive b. positive c. negative d. positive

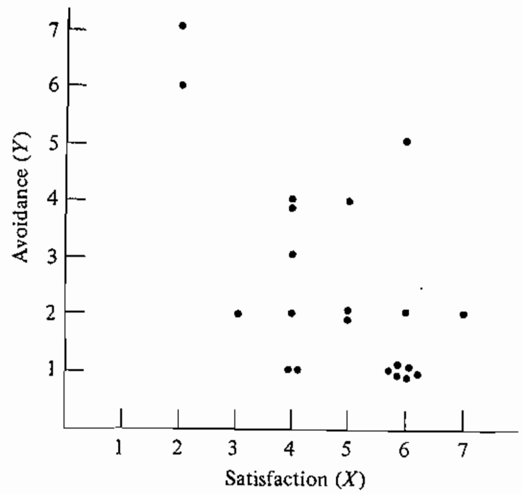
5. a. slope: 3.8793; intercept: –89.138; variance of errors: 534.48

b.

Score	*Predicted Score*	*Error*
140	143.62	–3.62
170	159.14	10.86
210	190.17	19.83
180	174.66	5.35
150	182.41	–32.41

7. a. causal b. predictive

8. a.



b. The relationship appears negative. The slope equals –.77. It shows that less satisfaction with privacy was associated with more avoidance behaviors. The intercept equals 6.18. This is the predicted avoidance score for someone with a score of zero on satisfaction. Because the lowest possible score on satisfaction is one, the intercept is an extrapolation.

c. variance of X: 2.03; variance of Y: 3.31; variance of errors: 2.23

Chapter 7: Relationship: The Correlation Coefficient

1. $r_{XY} = 1.000$

3. $r_{XY} = .404$

4. a. $b_{XY} = .20$ b. $b_{XY} = -1.0$ c. $r_{XY} = .10$

5. $r_{XY} = .463$. There is a fairly large positive correlation between typing and preparing stencils, such that those who perform one of these tasks will tend to perform the other task well. The 2sd advantage is about .762. So someone who is one standard deviation above the mean on typing is

about 75% more likely to better at preparing stencils than someone who is one standard deviation below the mean on typing.

7.
$$\frac{8511 - (749)(195)/16}{\sqrt{(37011 - 749^2/16)(2853 - 195^2/16)}} = -.641$$

The relationship between memory and age is a large negative one. So as persons age, their memory declines. The 2sd advantage is about .887. So someone who is one standard deviation above the mean in age is about 89% more likely to have a worse memory than someone who is one standard deviation below the mean in age.

12. a. Because school and not person is the unit in the correlation, aggregation is likely to increase the size of the correlation.
    b. Because the child's initial height is used to measure how much the child grew (growth equals current height minus initial height), there is a part-whole problem. The most likely outcome is that the correlation will be negative.
    c. Because almost all air-traffic controllers experience high levels of stress, there is likely to be a restriction in range of the stress variable. The size of the correlation will likely be underestimated.
    d. The likely form of this relationship is nonlinear. Persons who eat nothing will not likely be very happy and persons who overconsume will also be unhappy. The resulting pattern will mean that only those who eat moderate amounts will have relatively high scores, resulting in convex curvilinearity. A linear measure of association such as a correlation coefficient will understate the true size of the relationship.
    e. A single item on an intelligence test is not a very reliable measure of intelligence and so the strength of the correlation will be lessened by unreliability.

Chapter 8: Measures of Association: Ordinal and Nominal Variables

1. a. Members of religions: Protestant, Catholic, Jewish
       Nonmembers: agnostic, atheist
   b. Precipitation: rainy, snowy
       No precipitation: clear, cloudy

2. a. $\bar{X} = .347$, $s = .479$

3.

Political Party	Capital Punishment Approve	Disapprove	
Democrat	76	73	149
Republican	108	111	219
	184	184	368

Percentage difference 2%; phi .02; logit difference .07

4. Percentage difference: 43%; the difference between the percentage of women who smoke minus the percentage of men who smoke is 43%. Phi: .43; the correlation between gender and smoking is .43. This is a moderate to large correlation.
Logit difference: 1.86. The odds of a woman smoking are about six (the antilog of the logit difference) times greater than for a man in this sample.

5. Percentage difference = –39%; people over 30 are 39% less likely to agree than persons under 30.
Phi: –.32; the correlation between age and opinion is –.32. The correlation is moderate in size.
Logit difference: –1.66. The odds of a younger person agreeing are about five times more than an older person agreeing.

6. a.

Solitude	Intimacy Primary	Secondary	Public
Primary	28	20	34
Secondary	3	0	4
Public	69	80	62
	100	100	100

b.

Solitude	Intimacy Primary	Intimacy Secondary	Intimacy Public	
Primary	39	3	57	99
Secondary	43	0	57	100
Public	45	6	49	100

10. Rho equals –.571.

Chapter 9: Statistical Principles

1. a. nonrandom b. nonrandom c. nonrandom d. random
2. Although statistic p is unbiased, statistic q is to be preferred. Its standard error is so much smaller than q's that q is a better statistic.
5. a. yes b. k c. For k the standard error is 4.47 and for q the standard error is 5.00.
6. a. yes b. $\sqrt{1/(n-2)}$
9. It is more efficient.
11.

$\bar{X}$	*Frequency*
6.0	1
6.5	0
7.0	2
7.5	2
8.0	1
8.5	2
9.0	3
9.5	0
10.0	2
10.5	2
11.0	0
11.5	0
12.0	1

Mean of the random sampling distribution: 8.75; standard deviation: 1.58.

15. $$\frac{6!}{3!3!}\left(\frac{1}{6}\right)^3\left(\frac{5}{6}\right)^3 = .054$$

16. $$\frac{5!}{4!1!}\left(\frac{5}{36}\right)^4\left(\frac{31}{36}\right)^1 = .0016$$

Chapter 10: The Normal Distribution

1. a. .2794 b. .0438 c. .4115 − .1293 = .2822
   d. .5000 − .2642 = .2358

2. a. .3413 b. .4082 − .2486 = .1596 c. .5000 − .1293 = .3707

4. a. .412 b. −1.282

5. Percentile Ranks: 6, 17, 28, 39, 50, 61, 72, 83, 94
   Normalized ranks: −1.555, −.954, −.583, −.279, .000, .279, .583, .954, 1.555

7. The ranks are first transformed into percentile ranks. The percentile ranks for one through ten are 5, 15, 25, 35, 45, 55, 65, 75, 85, and 95, respectively. The normalized ranks for the ten cities are

	Trans.	*Econ.*	*Average*	*Ave. Rank*
Atlanta	−1.036	−.126	−.581	3.5
Boston	.126	−.385	−.130	5
Chicago	−.126	1.645	.760	7.5
Cincinnati	.674	.674	.674	8
Dallas	.385	−1.645	−.630	4
Denver	−.385	−1.036	−.710	3
New York	−1.645	.385	−.630	4
Phoenix	1.645	−.674	.486	6.5
Pittsburgh	1.036	1.036	1.036	9
San Francisco	−.674	.126	−.274	4.5

   Note that a lower score means that the city is ranked ahead of the other city. Now comparing the average rank (fourth column of numbers) to the average of the normalized ranks (third column of numbers), it is found that five cities' ranks do not change. The following changes do occur. First, using normalized ranks Cincinnati is ranked ahead of Chicago. Second, using normalized ranks both Dallas and New York are ranked ahead of Atlanta.

8. The sampling distribution of $\bar{X}$ with $n = 36$ has a mean of 50 and variance of 81/36. The standard error of $\bar{X}$ is 1.5. So the probability that $\bar{X}$ is between 50 and 51 equals the probability that Z is between zero and

(51 − 50)/1.5 or .67. This probability is .2486. Because the probability that $\bar{X}$ is between 49 and 50 is also .2486, the probability that $\bar{X}$ is between 49 and 51 is .4972.

12. a. .253 b. −.496 c. −.553

Chapter 11: Special Sampling Distributions

1. a. normal b. chi square c. t d. chi square
2. a. .70 b. 2.21
3. 64
5. a. .5000 − .3413 = .1587 b. .5000 − .4207 = .0793
8. First, because $t(df)^2 = F(1,df)$, then $t(\infty)^2 = F(1,\infty)$. Second, because $F(1,\infty) = \chi^2(1)$, then $t(\infty)^2 = \chi^2(1)$.

Chapter 12: Testing a Model

1. a. 3.055 b. 2.069 c. 3.435 (not 3.416, because one rounds down the df)
2. a. .20 b. .10 c. .01
3. $$t(8) = \frac{29.556 - 25}{12.72/\sqrt{9}} = 1.075$$

   This t with eight degrees of freedom is not statistically significant. There is then insufficient evidence to claim that the inmates score any differently from the national norm of 25.
4. $$t(5) = \frac{12.667 - 10}{3.011/\sqrt{6}} = 2.170$$

   This t with five degrees of freedom is marginally significant at the .10 level. Using the conventional .05 level of significance, there is not sufficient evidence to claim that the subjects are performing above chance.
5. a. 2.131 b. 2.004
6. A Type I error is concluding that the restricted model is false when in fact it is not. A Type II error is concluding that there is insufficient evidence to reject the restricted model when in fact the complete model is true.

8.
$$t(7) = \frac{112.125 - 100}{13.250/\sqrt{8}} = 2.588$$

This t with seven degrees of freedom is statistically significant at the .05 level. So the couples believe that they do significantly more than 100% of the housework.

9. The first model is the complete model and the second is the restricted model. The restriction is that the independent variable has no effect.

Chapter 13: The Two-Group Design

1. a. 2.056 b. 3.707 c. 1.684

2. The mean for method A is 19.40 and the mean for method B is 14.40. Method A is superior to method B. The test of whether this difference is statistically significant is $t(8) = 3.356$, which is statistically significant at the .01 level. (The pooled variance is 5.55.)

3. The six subjects lost an average of 8.5 pounds.

$$t(5) = \frac{-8.5}{7.007/\sqrt{6}} = -2.971$$

This t with five degrees of freedom is statistically significant at the .05 level. The weight loss then is statistically significant and cannot be explained by chance.

4. a. .59 b. .42

5. a. .33 b. .29 c. .99

6. The mean for the treatment group is 122.50 and the mean for the control group is 109.14. To test this difference a $t(13) = 2.846$ is obtained which is statistically significant at the .02 level. The program does significantly increase IQ. (The pooled variance is 82.220.)

8. The use of individual therapy as the control group would control for therapeutic experience because all subjects would receive some form of therapy. It would then contrast two different types of talk therapy. Its weakness is that it is a low power test because presumably both types of therapy are effective.

   Having a hypnosis control group would control for receiving some intervention that was attempting to reduce smoking. Because the two types of treatments are so very different, it would be difficult to determine why it is that one treatment is more effective than the other.

   The film condition would control for information and for the motivation to quit smoking. It would also provide the most powerful test. It would provide no evidence about why group therapy is effective.

13. The standard deviation of the treatment group is 8.06. The standard deviation of the control group is 4.75. Although the difference is large because the sample sizes are equal, the unequal variances should not have much effect on the p values.

15. a. 32 b. 26

Chapter 14: One-Way Analysis of Variance

1. a. 4.49 b. 2.61 c. 3.23 d. 11.97

2.

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Factor A	140.0	4	35	3.5
Subjects within A (S/A)	380.0	38	10	
Total	520.0	42		

The $F(4,38) = 3.5$ is statistically significant at the .05 level.

3. The means for the three groups are 13.2, 9.8, and 10.4. The test that they are significantly different is $F(2,12) = 16.467/7.233 = 2.28$, which is not a significant difference. The value of ω^2 is .15, which is small to moderate in size.

4. a. One cannot do the Tukey lsd test because the overall F test is not statistically significant.
   b. The mean square for the constant equals $15(11.1333 - 10)^2 = 19.266$. The $F(1,12)$ is 2.66, which is not significant at the .05 level.

5. The result of the t test is $t(15) = 2.794$, which is statistically significant at the .02 level. The result of the one-way ANOVA is $F(1, 15) = 114.421/14.654 = 7.81$, which is significant at the .05 level. The mean for group I is 18.7 and for group II is 13.43. Note that 2.794^2 equals, within the level of rounding error, 7.81.

6. The contrast weights are 1, 1, −1, −1, and 0. (Also acceptable are −1, −1, 1, 1, and 0). Each mean is multiplied by twelve to obtain a group total: 24, 38.4, 49.2, 62.4, and 61.2. The mean square for the contrast is

$$\frac{(24 + 38.4 - 49.2 - 62.4)^2}{(12)(4)} = 50.43$$

7. $$\frac{55.33 - (3)(2.49)}{194.77 + 2.49} = .24$$

This indicates a moderate effect size.

Chapter 15: Two-Way Analysis of Variance

1.

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
A	6.3	3	2.1000	3.13
B	4.3	2	2.1500	3.21
A × B	6.0	6	1.0000	1.49
Subjects within AB (S/AB)	72.4	108	.6704	
Total	89.0	119		

The F tests for A and B are statistically significant at the .05 level while the F for A × B is not significant.

2.

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Meat (M)	105.8	1	105.8	3.04
Region (R)	57.8	1	57.8	1.66
M × R	1.8	1	1.8	.05
Pigs within MR (P/MR)	556.8	16	34.8	
Total	722.2	19		

None of the F tests is statistically significant at the .05 level. The main effect for meat is marginally significant at the .10 level. The fat content of bacon, 33.6, is higher than ham, 29.0.

3.

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
A	7.225	1	7.225	1.57
B	25.750	4	6.438	1.40
A × B	78.150	4	19.538	4.24
Subjects within AB (S/AB)	138.250	30	4.608	
Total	249.375	39		

The interaction is significant at the .05 level. The table of cells means is:

		B 1	2	3	4	5
A	1	6.75	3.25	6.75	4.75	2.50
	2	3.50	3.25	3.75	2.50	6.75

The A1 cell mean is higher than the A2 cell mean for B1, B3, and B4. However, the A2 cell mean is higher than the A1 cell mean for B5. Finally, the two cell means do not differ for B2.

5. There is evidence for a main effect of A. The A1 means are lower than the A2 means. There is also an indication of a main effect of B. The B3 means are the highest, then the B1 means, and finally the B2 means. There is little evidence for interaction because the A effect across levels of B is always about 3.0.

6.

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Day (D)	555.4	3	185.13	12.51
Subject (S)	664.8	4	166.20	
D × S	177.6	12	14.80	
Total	1397.8	19		

The effect for day is statistically significant at the .01 level of significance. Performance is highest at day 4 and lowest at day 1.

7.

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
A	124	2	62.000	23.25
B	25	3	8.333	3.12
C	48	1	48.000	18.00
A × B	12	6	2.000	.75
A × C	19	2	9.500	3.56
B × C	14	3	4.667	1.75
A × B × C	12	6	2.000	.75
S/ABC	64	24	2.667	
Total	318	47		

Significant results: A main effect, $p < .001$; B main effect, $p < .05$; C main effect, $p < .001$; A × C interaction, $p < .05$.

Chapter 16: Testing Measures of Association

1. $$t(146) = \frac{.742\sqrt{146}}{\sqrt{1 - .742^2}} = 13.374$$

The positive correlation between age and susceptibility to glare is statistically significant at the .001 level.

2. a. −.1307 b. .0701 c. 1.5275 d. .9287

3. a. −.6963 b. −.4053 c. .7211 d. .0599

4. $$t(42) = \frac{.31\sqrt{31.93}}{\sqrt{\frac{22.41 - (.31^2)(31.93)}{42}}} = 2.581$$

The positive regression coefficient is statistically significant at the .02 level.

5. $$Z = \frac{.2342 - .5230}{\sqrt{\frac{1}{209} + \frac{1}{133}}} = -2.60$$

The difference between the two correlations is statistically significant at the .01 level.

6. $$t(82) = \frac{.39\sqrt{82}}{\sqrt{1 - .39^2}} = 3.835$$

The positive correlation is statistically significant at the .001 level.

8. a. $t(142) = 5.186$, $p < .001$ ($K = .563$)
   b. $Z = 3.00$, $p = .0026$ ($Q = .464$)

9. Test of the difference between slopes: $t(106) = -1.434$, which is not statistically significant. The pooled slope is .331 and its $t(104) = 4.529$, which is statistically significant at the .001 level. So the slopes do not differ, and the pooled slope does differ from zero.

10. The average of the four correlations yields a Fisher's z of 336.2733/480 = .7006, which when converted back to r is .6044. The test that the pooled correlation is different from zero yields $Z = .7006/\sqrt{1/480} = 15.35$, which is statistically significant at the .001 level. The test that the correlations differ is $\chi^2(3) = 8.79$, which is statistically significant at the .05 level. The four correlations differ significantly.

12. a. .06 b. .92

13. a. 384 b. 8

Chapter 17: Models for Nominal Dependent Variables

1. a. 3.84 b. 15.09 c. 16.27

2. Men are less likely to agree (29%) than women (52%). The test of independence yields a $\chi^2(2) = 15.48$, which is statistically significant at the .001 level.

3.

	Female	*Male*
Observed	212	246
Expected	238.16	219.84

$\chi^2(1) = 5.99$, which is statistically significant at the .02 level. So women are underrepresented in the juries of the county.

4. Persons are more likely to buy a product when they have seen the ad (54%) than when they have not seen the ad (21%). The test of independence yields a $\chi^2(1) = 94.28$, which is statistically significant at the .001 level.

5. Blacks prefer less to live in the North (47%) than whites (54%). The test of independence yields $\chi^2(1) = 38.18$, which is statistically significant at the .001 level. When the data are split by area of birth, the result reverses. Of persons who were born in the North, blacks are more likely to prefer the North (81%) than whites (73%). This difference is statistically significant $\chi^2(1) = 37.43$ at the .001 level. Of persons who were born in the South, blacks are more likely to prefer the North (28%) than whites (16%). This difference is statistically significant $\chi^2(1) = 68.41$ at the .001 level.

11. Fathers are less likely to recognize their infants' cries (22%) than are mothers (52%). To test this difference, McNemar's test is used. The result is $\chi^2(1) = (|9 - 1| - 1)^2/10 = 4.90$, which is statistically significant at the .05 level.

Chapter 18: Models for Ordinal Dependent Variables

1.
$$1 - \frac{(6)(146)}{(8)(63)} = -.738$$

This negative rank-order coefficient is statistically significant at the .05 level.

2. The sum of the ranks in group A is 70.5 and the value of U is $49 + 28 - 70.5 = 6.5$. This value of U with group sizes both equal to seven is

statistically significant at the .05 level. Using group B, the sum of the ranks is 34.5 and U is 42.5. This value of U is also significant at the .05 level, as it should be.

4.
$$H = \left[\frac{12}{(15)(16)}\right]\left[\frac{46.5^2 + 33^2 + 40.5^2}{5}\right] - (3)(16) = .915$$

A χ^2 test statistic of .915 with two degrees of freedom is not statistically significant. There is no evidence to conclude that the groups differ.

6. Eight values are higher in the after measure, three are lower, and one is tied. Using the sign test with $n = 11$, an eight is not significant.

7. Let heaviest have a rank of one, middle a rank of two, and lightest a rank of three. The sum of the ranks for the spherical condition is $3 + 2(9) + 3(8) = 45$; for the conical condition the sum is $5 + 2(4) + 3(11) = 46$; and for the cubical condition the sum is $12 + 2(7) + 3(1) = 29$. The Friedman test is

$$\left[\frac{12}{(20)(3)(4)}\right](45^2 + 46^2 + 29^2) - (3)(20)(4) = 9.1$$

A χ^2 with two degrees of freedom is statistically significant at the .02 level. The groups' distributions significantly differ.

8. The sum of the ranks in group B is 15.5 and the value of U is $25 + 15 - 15.5 = 24.5$. This value of U with group sizes both equal to five is statistically significant at the .02 level of significance. Using group A, the sum of the ranks is 39.5 and U is .5. This value of U is also significant at the .02 level, as it should be.

9. The sum of the ranks in control group is 34.5 and the value of U is $56 + 28 - 34.5 = 49.5$. This value of U with a control group n equal to seven and experimental group n equal to eight is statistically significant at the .02 level of significance. One cannot use the sum of the treated group ranks because the sample sizes of the two groups differ.

17. a.
$$U = (20)(25) + \frac{(21)(20)}{2} - 248 = 462$$

$$\frac{462 - (20)(25)/2}{\sqrt{(20)(25)(46)/12}} = 4.84$$

This value of Z is statistically significant at the .001 level.

18. a. $t(76) = -1.872$, $p < .10$
b. $t(40) = -3.187$, $p < .01$
c. $p < .02$
d. not statistically significant

statistically significant at the .05 level. Using group B, the sum of the ranks is 34.5 and U is 42.5. This value of U is also significant at the .05 level, as it should be.

4. $$H = \left[\frac{12}{(15)(16)}\right]\left[\frac{46.5^2 + 33^2 + 40.5^2}{5}\right] - (3)(16) = .915$$

A χ^2 test statistic of .915 with two degrees of freedom is not statistically significant. There is no evidence to conclude that the groups differ.

6. Eight values are higher in the after measure, three are lower, and one is tied. Using the sign test with $n = 11$, an eight is not significant.

7. Let heaviest have a rank of one, middle a rank of two, and lightest a rank of three. The sum of the ranks for the spherical condition is $3 + 2(9) + 3(8) = 45$; for the conical condition the sum is $5 + 2(4) + 3(11) = 46$; and for the cubical condition the sum is $12 + 2(7) + 3(1) = 29$. The Friedman test is

$$\left[\frac{12}{(20)(3)(4)}\right](45^2 + 46^2 + 29^2) - (3)(20)(4) = 9.1$$

A χ^2 with two degrees of freedom is statistically significant at the .02 level. The groups' distributions significantly differ.

8. The sum of the ranks in group B is 15.5 and the value of U is $25 + 15 - 15.5 = 24.5$. This value of U with group sizes both equal to five is statistically significant at the .02 level of significance. Using group A, the sum of the ranks is 39.5 and U is .5. This value of U is also significant at the .02 level, as it should be.

9. The sum of the ranks in control group is 34.5 and the value of U is $56 + 28 - 34.5 = 49.5$. This value of U with a control group n equal to seven and experimental group n equal to eight is statistically significant at the .02 level of significance. One cannot use the sum of the treated group ranks because the sample sizes of the two groups differ.

17. a. $$U = (20)(25) + \frac{(21)(20)}{2} - 248 = 462$$

$$\frac{462 - (20)(25)/2}{\sqrt{(20)(25)(46)/12}} = 4.84$$

This value of Z is statistically significant at the .001 level.

18. a. $t(76) = -1.872$, $p < .10$
    b. $t(40) = -3.187$, $p < .01$
    c. $p < .02$
    d. not statistically significant