Answers

15.1

a. b_1 = 4.14. This implies that, holding x_2 constant and increasing x_1 by one unit, the average y is estimated to increase by 4.14 units. b_2 = 8.72. This implies that, holding x_1 constant and increasing x_2 by one unit, the average y is estimated to increase by 8.72 units.

b. $\hat{y} = 12.67 + 4.14(4) + 8.72(9) = 107.71$

15.2

a. b_1 = -412. This implies that, holding the other independent variables constant and increasing the local unemployment rate by one percent, the average weekly sales is estimated to decrease by 412 dollars.
b_2 = 818. This implies that, holding the other independent variables constant and increasing the weekly average high temperature by one degree, the average weekly sales is estimated to increase by 818 dollars.
b_3 = -93. This implies that, holding the other independent variables constant and increasing the number of local activities by one, the average weekly sales is estimated to decrease by 93 dollars.
b_4 = -71. This implies that, holding the other independent variables constant and increasing the average gasoline price by one dollar, the average weekly sales is estimated to decrease by 71dollars.

b. $\hat{y} = 22{,}167 - 412(5.7) + 818(61) - 93(14) - 71(1.39) = 68{,}315.91$

15.3

a. $\hat{y}$ = 87.7897 – 0.9705x_1+ 0.0023x_2 – 8.7233x_3

b. F = 5.3276 > $F_{0.05}$ = 3.0725 (Using Excel's FINV) Also, p-value = .00689 < any reasonable alpha. . Therefore, reject H_0: $\beta_1 = \beta_2 = \beta_3 = 0$. At least some part of the model is statistically significant.

c. $R^2 = \dfrac{SSR}{SST} = \dfrac{16646.091}{38517.76} = 0.432$

d. x_1 (p-value = 0.1126 > α = 0.05 ➔ fail to reject H_0: $\beta_1 = 0$) and x_3 (p-value = 0.2576 > α = 0.05 ➔ fail to reject H_0: $\beta_3 = 0$) are not significant.

e. b_2 = 0.0023 ➔ $\hat{y}$ increases 0.0023 for each one unit increase of x_2.

b_3 = -8.7233 ➔ $\hat{y}$ decreases 8.7233 for each one unit increase of x_3.

f. The confidence intervals for β_1 and β_3 contain 0, This indicates that x_1 and x_3 are not statistically significantly different than 0 in this model.

15.4

The largest correlation that exists among these independent variables is 0.504.
From the previous problem, n = 25, so:

$$t = \frac{r}{\sqrt{\dfrac{1-r^2}{n-2}}} = \frac{0.502}{\sqrt{\dfrac{1-0.502^2}{25-2}}} = 2.78$$

This is significant at the .05 level but not at the .01 level. This is the only potential multicollinearity problem.

15.5

a. Minitab output:

Regression Analysis: yi versus x1, x2
The regression equation is
yi = 5.05 - 0.051 x1 + 0.888 x2

Predictor	Coef	SE Coef	T	P	VIF
Constant	5.045	8.698	0.58	0.580	
x1	-0.0513	0.2413	-0.21	0.838	1.1
x2	0.8880	0.1475	6.02	0.001	1.1

S = 6.82197 R-Sq = 84.5% R-Sq(adj) = 80.1%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	1775.12	887.56	19.07	0.001
Residual Error	7	325.78	46.54		
Total	9	2100.90			

The estimated regression equation is $\hat{y}$ = 5.05 – 0.0513x_1 + 0.888x_2

b. Minitab output:

Correlations: yi, x1, x2

	yi	x1
x1	0.206	
x2	0.919	0.257

Cell Contents: Pearson correlation

Using the steps from Chapter 14:

Step 1: Define the parameter of interest.

The parameter of interest is the population correlation coefficient between y and x_1, ρ;

Step 2: Formulate the appropriate null and alternative hypotheses.

H_O: ρ = 0 H_A: ρ ≠ 0

Step 3: Specify the level of significance.

α = 0.05

Step 4: Compute the test statistic.

$$t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}} = \frac{0.206}{\sqrt{\frac{1-0.206^2}{10-2}}} = 0.5954$$

Step 5: Construct the rejection region.

The degrees of freedom are n – 2 = 8; the critical values are ± 2.306.

Step 6: Reach a decision.

Since -2.306 < t = 0.5954 < 2.306; we fail to reject $H_{O.}$

Step 7: Draw a conclusion.

The correlation with the dependent variable is not significant.

c. Step 1: The parameters of interest are the population coefficients of x_1 and x_2,

Step 2: H_O: $\beta_1 = \beta_2 = 0$, H_A: at least one $\beta_i \neq 0$

Step 3: α = 0.05

Step 4: $$F = \frac{\frac{SSR}{k}}{\frac{SSE}{n-k-1}} = \frac{\frac{1775.12}{2}}{\frac{325.78}{10-2-1}} = 19.07$$

Step 5: The numerator degrees of freedom are k = 2 and the denominator degrees of freedom are n – k – 1 = 10 – 2 – 1 = 7; the critical value = 4.737.

Step 6: Since F = 19.07 > 4.737, reject $H_{O.}$;

Step 7: The overall model is significant.

d. Minitab output:

Predictor	Coef	SE Coef	T	P	VIF
Constant	5.045	8.698	0.58	0.580	
x1	-0.0513	0.2413	-0.21	0.838	1.1
x2	0.8880	0.1475	6.02	0.001	1.1

S = 6.82197 R-Sq = 84.5% R-Sq(adj) = 80.1%

A VIF < 5 for a given independent variable indicates that this independent variable is not correlated with the remaining independent variables in the model. Both x_1 and x_2 have VIFs equal to 1.1. Therefore, neither of the independent variable is correlated with the other independent variable. Multicollinearity does not exist between the two independent variables.

15.14

a. $\hat{y} = 24.1 + 5.8x_1 + 7.9(1) = (24.1 + 7.9) + 5.8x_1 = 32 + 5.8x_1$

b. $\hat{y} = 24.1 + 5.8(10) + 7.9(1) = 32 + 5.8(10) = 90$

c. $\hat{y} = 24.1 + 5.8\,x_1 + 7.9(0) = 24.1 + 5.8x_1$

d. $\hat{y} = 24.1 + 5.8(30) + 7.9(0) = 198.1$

15.15

a. Since the apartment is in the town center, $x_2 = 1$ which implies $\hat{y} = 145 + 1.2(1500) + 300(1) = 2245$.

b. Since the apartment is not in the town center, $x_2 = 0$ which implies $\hat{y} = 145 + 1.2(1500) + 300(0) = 1945$.

c. The difference between the answers in part a. and b. (2245 -1945 = 300) equals the value of b_2. Therefore, b_2 indicates the average premium paid for living in the city's town center.

15.18

a. Minitab output:

Regression Analysis: Price versus Sq Footage, Type

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The regression equation is
Price = 69631 + 90.4 Sq Footage - 3630 Type


Predictor     Coef  SE Coef      T      P
Constant     69631    53986   1.29  0.214
Sq Footage   90.37    29.53   3.06  0.007
Type         -3630    15891  -0.23  0.822


S = 32186.4   R-Sq = 40.6%   R-Sq(adj) = 33.7%


Analysis of Variance

Source          DF           SS          MS     F      P
Regression       2  12062286443  6031143222  5.82  0.012
Residual Error  17  17611399057  1035964650
Total           19  29673685500
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$\hat{y} = 69631 + 90.4x_1 - 3630x_2$

b. β_1 = the average change in the selling price of a residence (for both condominiums and single family residences) when the square footage of the residence is increased by one square foot. β_2 = the difference in the average selling price of a residence for a specified square footage between condominiums and single family residences.

c. The equation that describes the relationship between the selling price and the square footage for condominiums is $\hat{y} = 69631 + 90.4x_1 - 3630(1) = 66001 + 90.4x_1$, and for single family homes $\hat{y} = 69631 + 90.4x_1 - 3630(0) = 69631 + 90.4x_1$.

d.

Since $-2.1098 < t = -0.23 < 2.1098$, we fail to reject H_O There is sufficient evidence to conclude that the relationship between the selling price and the square footage is not different between condominiums and single family homes.