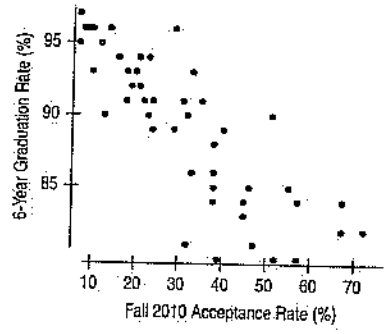
Exercises

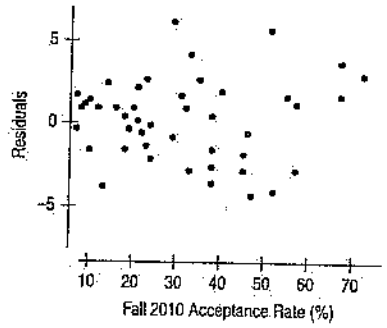
Section 23.2

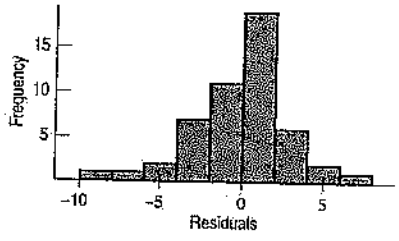
1. Graduation rates A prestigious college is interested in factors that might be associated with better graduation rates. The administrators wonder whether there is a relationship between acceptance rates and graduation rates. Before proceeding with their regression inference, what conditions and assumptions must be satisfied? Are they? (Source: *US News and World Report* National University Rankings October 2011. http://colleges.usnews.rankingsandreviews.com/best-colleges/rankings/national-universities/data/spp%2B50/page+1)

Dependent variable is 6-Year Graduation Rate
R-squared = 69.6%
s = 2.86 with 50 − 2 = 48 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	97.0663	0.84406	114.999	<0.0001
Acceptance Rate	−0.25101	0.023951	−10.480	<0.0001



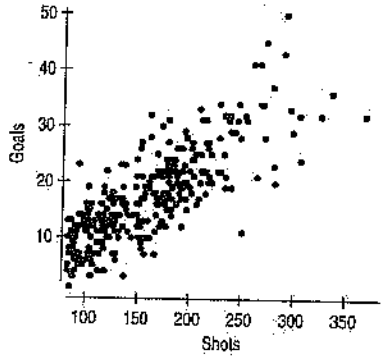


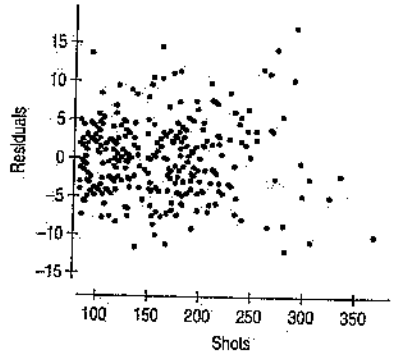


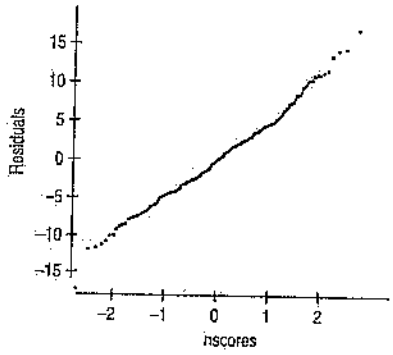
2. Shoot to score A college hockey coach collected data from the 2010–2011 National Hockey League season. He hopes to convince his players that the number of shots taken has an affect on the number of goals scored. The coach performed a preliminary analysis, using the scoring statistics from 293 offensive players who play professional hockey. He predicts *Goals* from number of *Shots* (taken for the season). Discuss each of the conditions and assumptions required for him to proceed with the regression analysis. (www.nhl.com)

Dependent variable is Goals
R-squared = 63.4%
s = 5.13 with 293 − 2 = 291 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	−1.77095	0.9087	−1.9488	0.052
Shots	0.11938	0.0053	22.460	<0.0001







Section 23.3

3. **Graduation rates, part II** Using the regression output in Exercise 1, identify the error standard deviation and explain what it means in the context of the problem.

4. **Shoot to score another one** Using the regression output from Exercise 2, identify the error standard deviation and explain its meaning with a sentence in context.

5. **Graduation rates, part III** Continuing with the regression of Exercise 1, write a sentence that explains the meaning of the standard error of the slope of the regression line, $SE(b_1) = 0.0240$.

6. **Shoot to score, hat trick** Returning to the results of Exercise 2, write a sentence to explain the meaning of the standard error of the slope of the regression line, $SE(b_1) = 0.0053$.

Section 23.4

7. **Graduation, part IV** The college administrators in Exercise 1 tested the hypotheses H_0: $\beta_1 = 0$ vs. H_A: $\beta_1 \neq 0$ and rejected the null hypothesis because the P-value was less than 0.0001. What can they conclude about the relationship between admission rates and graduation rates?

8. **Shoot to score, number four** What can the hockey coach in Exercise 2 conclude about shooting and scoring goals from the fact that the P-value < 0.0001 for the slope of the regression line? Write a sentence in context.

9. **Graduation, part V** The college administrators in Exercise 1 constructed a 95% confidence interval for the slope of their regression line. Interpret the meaning of their interval $(-0.299\%, -0.203\%)$ within the context of the problem.

10. **Shoot to score, overtime** The coach in Exercise 2 found a 95% confidence interval for the slope of his regression line. Recall that he is trying to predict total goals scored based on shots taken. Interpret with a sentence the meaning of the interval 0.12 ± 0.01.

Section 23.5

11. **Graduation, part VI** The college described in Exercise 1 admits about 33% of applicants each year. Which will be larger, the standard error of the predicted *6-Year Graduation Rate* of this college, or the standard error of the mean *6-Year Graduation Rate* of all colleges admitting 33% of their applicants? Explain briefly.

12. **Shoot to score, double overtime** One of the coach's best players has been in a slump, and the coach is trying to convince him to take more shots. Last year, the player took 104 shots. Would the standard error of the predicted number of goals he shot be larger or smaller than the standard error of the mean predicted number of all players who took 104 shots? Explain briefly.

Section 23.6

13. **Graduation, part VII** As in Exercise 11, the college described in Exercise 1 admits about 33% of applicants each year. Using their regression model, the administrators calculated a 95% confidence interval for the mean *6-Year Graduation Rate* for all top colleges who admit 33% of students. The interval was (87.96%, 89.60%). Interpret the meaning of this interval with a sentence.

14. **Shoot to score, triple overtime** As in Exercise 12, one of the coach's best players has been in a slump, and the coach is trying to convince him to take more shots. Last year, the player took 104 shots. The coach calculated a 95% confidence interval for the mean number of goals a player would score if 104 shots were taken. The interval turned out to be 9.8 to 11.5 goals. Summarize the interval with a sentence in context.

15. **Graduation, part VIII** The administrators from Exercise 1 also determined a 95% prediction interval for the graduation rate of a school admitting 33% of applicants to be (82.98%, 94.59%). Carefully explain what the 95% indicates for this interval.

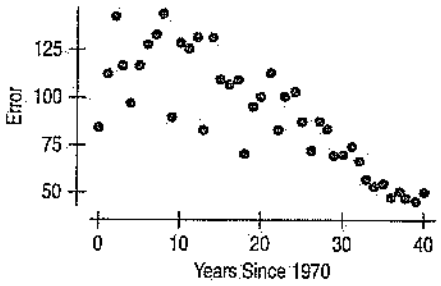
16. **Shoot to score, again** The coach, still working with his superstar from Exercise 12, went on to suggest the player shoot more. Hopeful for 150 shots for the season, he calculated a 95% prediction interval for the number of goals this player might score. If the prediction interval for goals scored was (6.03, 24.25), interpret the meaning of this interval with a sentence in context.

Chapter Exercises

17. **Graduation party** Would it be wise for the administrators at the college described in Exercise 1 to conclude that lowering their admission rate (i.e., making it harder to get in) would help to increase their graduation rates? Why or why not?

18. **Shoot to score, shootout** The coach from Exercise 2 called a team meeting to summarize the results from his study. Would it be a good strategy to tell the players that all they need to do is to shoot more and the goals will follow?

19. **Tracking hurricanes 2010** In Chapter 8, we looked at data from the National Oceanic and Atmospheric Administration about their success in predicting hurricane tracks. On the following page is a scatterplot of the error (in nautical miles) for predicting hurricane locations 24 hours in the future vs. the year in which the prediction (and the hurricane) occurred.



In Chapter 8, we could describe this relationship only in general terms. Now we can learn more. Here is the regression analysis:

Dependent variable is 24Error
R-squared = 68.7%
s = 16.44 with 41 − 2 = 39 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	132.3	5.043	26.2	≤0.0001
Years Since 1970	−2.01	0.217	−9.25	≤0.0001

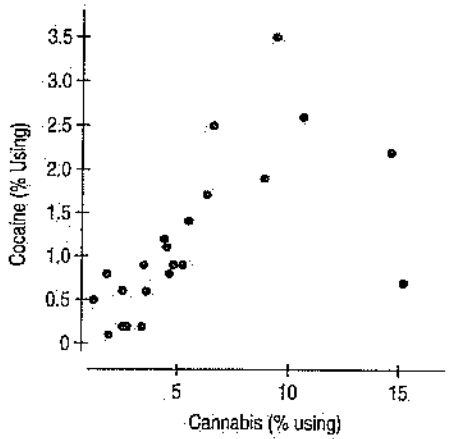
a) Explain in words and numbers what the regression says.

b) State the hypothesis about the slope (both numerically and in words) that describes how hurricane prediction quality has changed.

c) Assuming that the assumptions for inference are satisfied, perform the hypothesis test and state your conclusion. Be sure to state it in terms of prediction errors and years.

d) Explain what the R-squared means in terms of this regression.

20. Drug use. The *2011 World Drug Report* investigated the prevalence of drug use as a percentage of the population aged 15 to 64. Data from 22 European countries are shown in the following scatterplot and regression analysis. (Source: *World Drug Report*, 2011. www.unodc.org/unodc/en/data-and-analysis/WDR-2011.html)



Dependent variable is Cocaine
R-squared = 38.1%
s = 0.724 with 22 − 2 = 20 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	0.35707	0.2757	1.295	0.21
Cannabis%	0.14264	0.0406	3.512	0.002

a) Explain in context what the regression says.

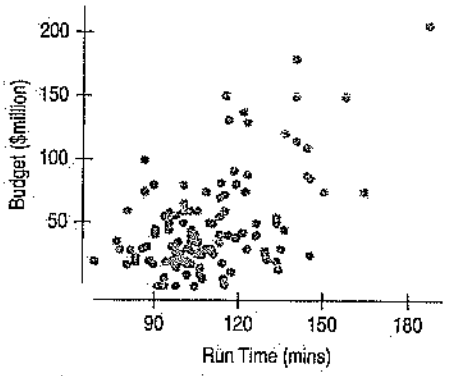
b) State the hypothesis about the slope (both numerically and in words) that describes how use of marijuana is associated with other drugs.

c) Assuming that the assumptions for inference are satisfied, perform the hypothesis test and state your conclusion in context.

d) Explain what R-squared means in context.

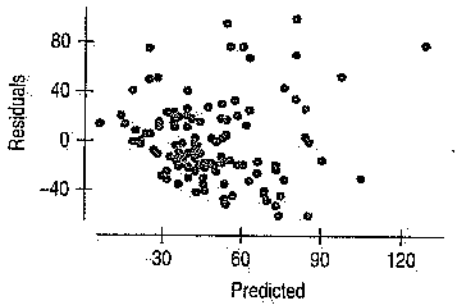
e) Do these results indicate that marijuana use leads to the use of harder drugs? Explain.

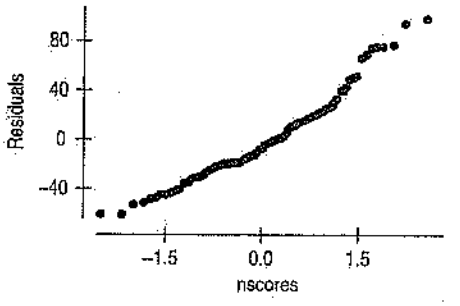
21. Movie budgets[13]. How does the cost of a movie depend on its length? Data on the cost (millions of dollars) and the running time (minutes) for major release films of 2005 are summarized in these plots and computer output:



Dependent variable is Budget($million)
R-squared = 27.3%
s = 32.95 with 120 − 2 = 118 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	−63.9981	17.12	−3.74	0.0003
Run Time	1.02648	0.1540	6.66	≤0.0001



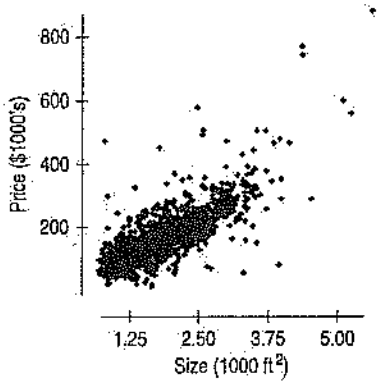


(continued)

[13]Data have been corrected since previous editions.

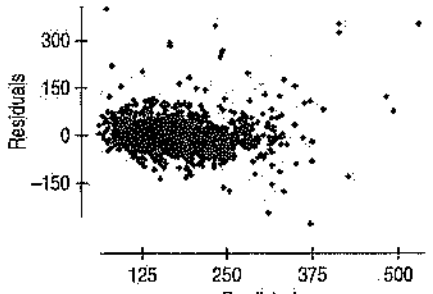
a) Explain in context what the regression says.
b) The intercept is negative. Discuss its value.
c) The output reports $s = 32.95$. Explain what that means in this context.
d) What's the value of the standard error of the slope of the regression line?
e) Explain what that means in this context.

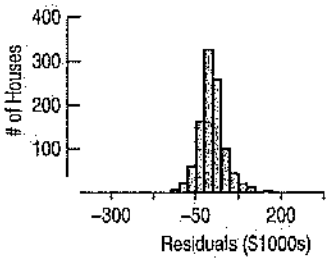
22. Saratoga house prices How does the price of a house depend on its size? Data from Saratoga, New York, on 1064 randomly selected houses that had been sold include data on price ($1000s) and size ($1000s ft^2), producing the following graphs and computer output:



Dependent variable is Price
R-squared = 59.5%
s = 53.79 with 1064 − 2 = 1062 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	−3.11686	4.688	−0.665	0.5063
Size	94.4539	2.393	39.5	≤0.0001





a) Explain in context what the regression says.
b) The intercept is negative. Discuss its value, taking note of its P-value.
c) The output reports $s = 53.79$. Explain what that means in this context.
d) What's the value of the standard error of the slope of the regression line?
e) Explain what that means in this context.

23. Movie budgets, the sequel Exercise 21 shows computer output examining the association between the length of a movie and its cost.
a) Check the assumptions and conditions for inference.
b) Find a 95% confidence interval for the slope and interpret it in context.

24. Second home Exercise 22 shows computer output examining the association between the sizes of houses and their sale prices.
a) Check the assumptions and conditions for inference.
b) Find a 95% confidence interval for the slope and interpret it in context.

25. Hot dogs Healthy eating probably doesn't include hot dogs, but if you are going to have one, you'd probably hope it's low in both calories and sodium. Recently, *Consumer Reports* listed the number of calories and sodium content (in milligrams) for 13 brands of all-beef hot dogs it tested. Examine the association, assuming that the data satisfy the conditions for inference.

Dependent variable is Sodium
R-squared = 60.5%
s = 59.66 with 13 − 2 = 11 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Constant	90.9783	77.69	1.17	0.2663
Calories	2.29959	0.5607	4.10	0.0018

a) State the appropriate hypotheses about the slope.
b) Test your hypotheses and state your conclusion in the proper context.

26. Cholesterol Does a person's cholesterol level tend to change with age? Data collected from 1406 adults aged 45 to 62 produced the regression analysis shown. Assuming that the data satisfy the conditions for inference, examine the association between age and cholesterol level.

Dependent variable is Chol
s = 46.16

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	194.232	13.55	14.3	≤0.0001
Age	0.771639	0.2574	3.00	0.0056

a) State the appropriate hypothesis for the slope.
b) Test your hypothesis and state your conclusion in the proper context.

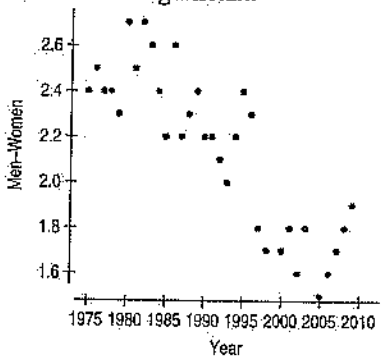
27. Second frank Look again at Exercise 25's regression output for the calorie and sodium content of hot dogs.
a) The output reports $s = 59.66$. Explain what that means in this context.
b) What's the value of the standard error of the slope of the regression line?
c) Explain what that means in this context.

3. **More cholesterol** Look again at Exercise 26's regression output for age and cholesterol level.
   a) The output reports $s = 46.16$. Explain what that means in this context.
   b) What's the value of the standard error of the slope of the regression line?
   c) Explain what that means in this context.

). **Last dog** Based on the regression output seen in Exercise 25, create a 95% confidence interval for the slope of the regression line and interpret your interval in context.

. **Cholesterol, finis** Based on the regression output seen in Exercise 26, create a 95% confidence interval for the slope of the regression line and interpret it in context.

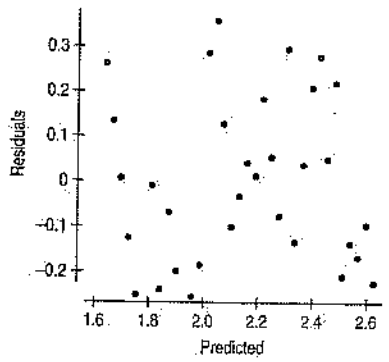
. **Marriage age 2010** The scatterplot suggests a decrease in the difference in ages at first marriage for men and women since 1975. We want to examine the regression to see if this decrease is significant.

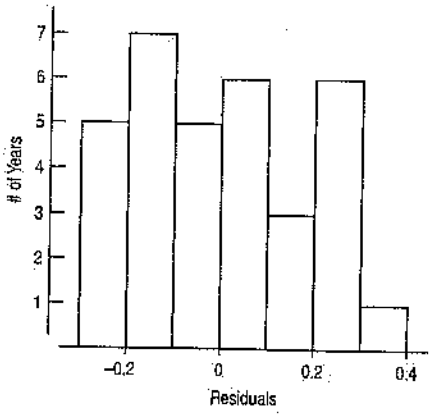


Dependent variable is Men–Women
R-squared = 72.6%
s = 0.186 with 33 − 2 = 31 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	60.055	6.396	9.39	≤0.0001
Year	−0.029	0.0032	−9.05	≤0.0001

a) Write appropriate hypotheses.
b) Here is the residuals plot and a histogram of the residuals. Do you think the conditions for inference are satisfied? Explain.





c) Test the hypothesis and state your conclusion about the trend in age at first marriage.

32. **Used cars 2010** Vehix.com offered several used Toyota Corollas for sale. Listed below are the ages of the cars and the advertised prices.

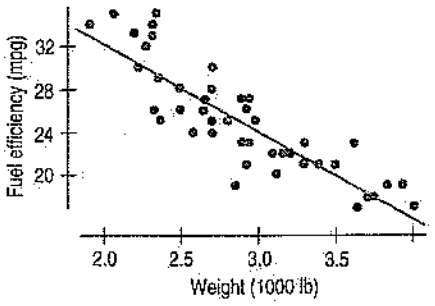
Age (yr)	Price ($)	Age (yr)	Price ($)
1	15988	6	9995
1	13988	6	11988
2	14488	7	8990
3	10995	8	9488
3	13998	8	8995
4	13622	9	5990
4	12810	10	4100
5	9988	12	2995

a) Make a scatterplot for these data.
b) Do you think a linear model is appropriate? Explain.
c) Find the equation of the regression line.
d) Check the residuals to see if the conditions for inference are met.

33. **Marriage age 2010, again** Based on the analysis of marriage ages since 1975 given in Exercise 31, find a 95% confidence interval for the rate at which the age gap is closing. Explain what your confidence interval means.

34. **Used cars 2010, again** Based on the analysis of used car prices you did for Exercise 32, create a 95% confidence interval for the slope of the regression line and explain what your interval means in context.

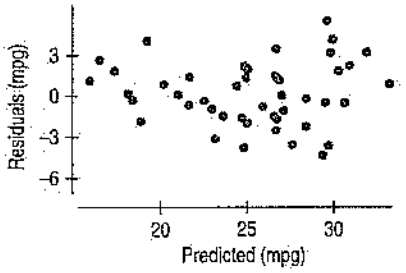
35. Fuel economy A consumer organization has reported test data for 50 car models. We will examine the association between the weight of the car (in thousands of pounds) and the fuel efficiency (in miles per gallon). Here are the scatterplot, summary statistics, and regression analysis:

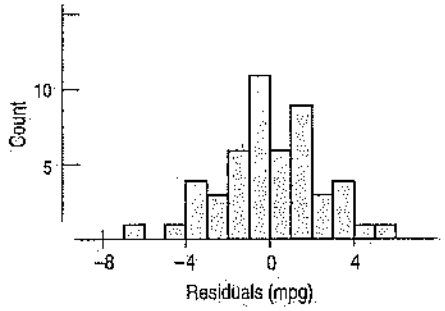


Variable	Count	Mean	StdDev
MPG	50	25.0200	4.83394
Wt(1000's)	50	2.88780	0.511656

Dependent variable is MPG
R-squared = 75.6%
s = 2.413 with 50 − 2 = 48 df

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	48.7393	1.976	24.7	≤0.0001
Weight	−8.2136	0.674	−12.2	≤0.0001





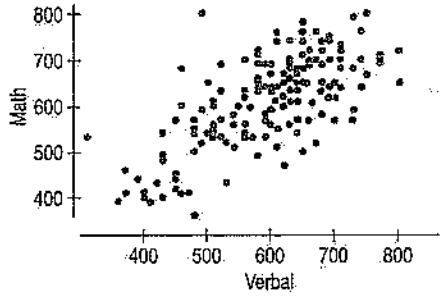
a) Is there strong evidence of an association between the weight of a car and its gas mileage? Write an appropriate hypothesis.
b) Are the assumptions for regression satisfied?
c) Test your hypothesis and state your conclusion.

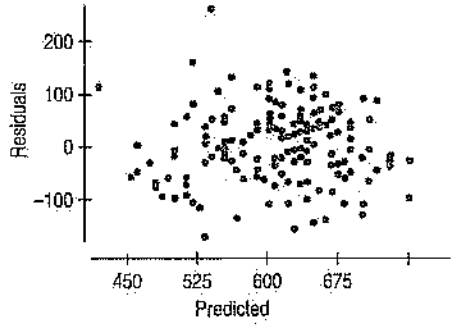
36. SAT scores How strong was the association between student scores on the Math and Verbal sections of the old SAT? Scores on each ranged from 200 to 800 and were widely used by college admissions offices. Here are summaries and plots of the scores for a graduating class at Ithaca High School:

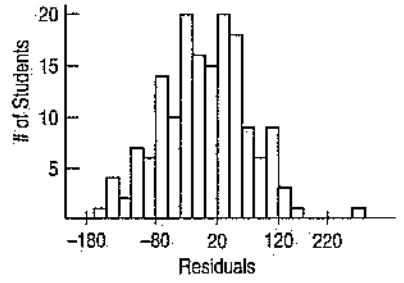
Variable	Count	Mean	Median	StdDev	Range	IntQRange
Verbal	162	596.296	610	99.5199	490	140
Math	162	612.099	630	98.1343	440	150

Dependent variable is Math
R-squared = 46.9%
s = 71.75 with 162 − 2 = 160 df

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	209.554	34.35	6.10	≤0.0001
Verbal	0.675	0.0568	11.9	≤0.0001







a) Is there evidence of an association between Math and Verbal scores? Write an appropriate hypothesis.
b) Discuss the assumptions for inference.
c) Test your hypothesis and state an appropriate conclusion.

37. Fuel economy, part II Consider again the data in Exercise 35 about the gas mileage and weights of cars.

a) Create a 95% confidence interval for the slope of the regression line.

b) Explain in this context what your confidence interval means.

38. SATs, part II Consider the high school SAT scores data from Exercise 36.

a) Find a 90% confidence interval for the slope of the true line describing the association between Math and Verbal scores.

b) Explain in this context what your confidence interval means.

39. Fuel economy, part III Consider again the data in Exercise 35 about the gas mileage and weights of cars.

a) Create a 95% confidence interval for the average fuel efficiency among cars weighing 2500 pounds, and explain what your interval means.

b) Create a 95% prediction interval for the gas mileage you might get driving your new 3450-pound SUV, and explain what that interval means.

40. SATs, again Consider the high school SAT scores data from Exercise 36 once more.

a) Find a 90% confidence interval for the mean SAT-Math score for all students with an SAT-Verbal score of 500.

b) Find a 90% prediction interval for the Math score of the senior class president if you know she scored 710 on the Verbal section.

41. Cereals A healthy cereal should be low in both calories and sodium. Data for 77 cereals were examined and judged acceptable for inference. The 77 cereals had between 50 and 160 calories per serving and between 0 and 320 mg of sodium per serving. Here's the regression analysis:

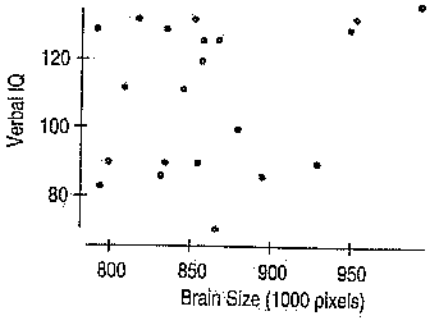
Dependent variable is Sodium
R-squared = 9.0%
$s = 80.49$ with $77 - 2 = 75$ degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	21.4143	51.47	0.416	0.6786
Calories	1.29357	0.4738	2.73	0.0079

a) Is there an association between the number of calories and the sodium content of cereals? Explain.

b) Do you think this association is strong enough to be useful? Explain.

42. Brain size Does your IQ depend on the size of your brain? A group of female college students took a test that measured their verbal IQs and also underwent an MRI scan to measure the size of their brains (in 1000s of pixels). The scatterplot and regression analysis are shown, and the assumptions for inference were satisfied.



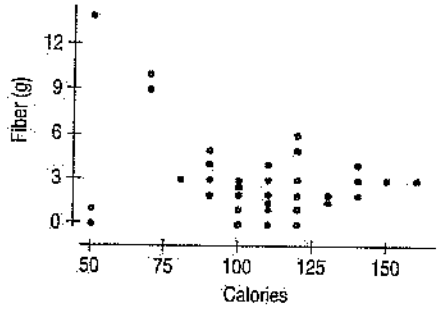
Dependent variable is IQ_Verbal
R-squared = 6.5%

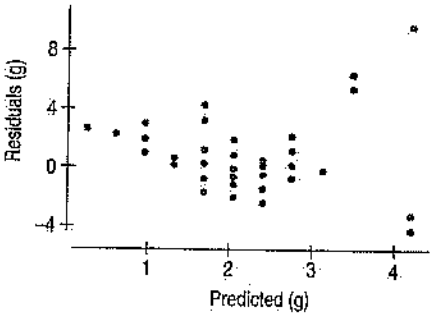
Variable	Coefficient	SE(Coeff)
Intercept	24.1835	76.38
Size	0.0988	0.088

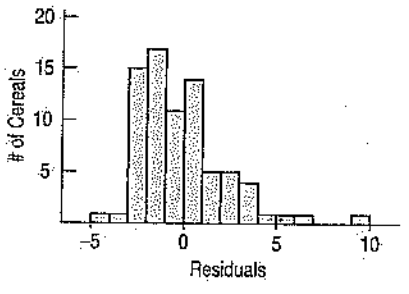
a) Test an appropriate hypothesis about the association between brain size and IQ.

b) State your conclusion about the strength of this association.

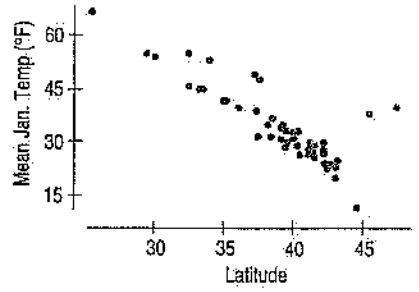
43. Cereals, part 2 Further analysis of the data for the breakfast cereals in Exercise 41 looked for an association between *Fiber* content and *Calories* by attempting to construct a linear model. Here are several graphs. Which of the assumptions for inference are violated? Explain.

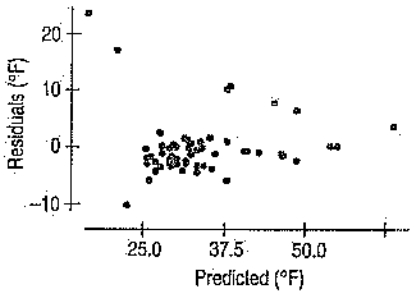


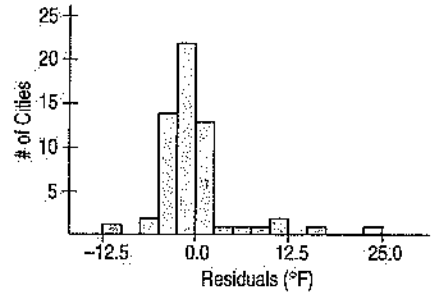




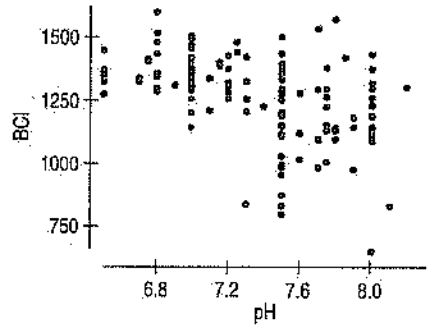
44. Winter The output shows an attempt to model the association between average *January Temperature* (in degrees Fahrenheit) and *Latitude* (in degrees north of the equator) for 59 U.S. cities. Which of the assumptions for inference do you think are violated? Explain.







45. Streams Biologists studying the effects of acid rain on wildlife collected data from 163 streams in the Adirondack Mountains. They recorded the *pH* (acidity) of the water and the *BCI*, a measure of biological diversity. Here's a scatterplot of *BCI* against *pH*:



And here is part of the regression analysis:

Dependent variable is BCI
R-squared = 27.1%
s = 140.4 with 163 − 2 = 161 degrees of freedom

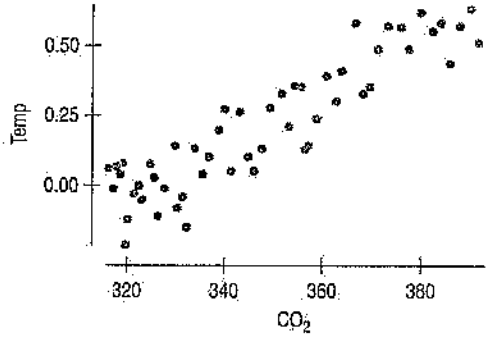
Variable	Coefficient	SE(Coeff)
Intercept	2733.37	187.9
pH	−197.694	25.57

a) State the null and alternative hypotheses under investigation.
b) Assuming that the assumptions for regression inference are reasonable, find the *t*- and P-values.
c) State your conclusion.

46. Climate change and CO_2 2011 Data collected from around the globe show that the earth is getting warmer. The most common theory relates climate change to an increase in atmospheric levels of carbon dioxide (CO_2), a greenhouse gas. The mean annual CO_2 concentration in the atmosphere (parts per million) is measured at the top of Mauna Loa in Hawaii (away from any local contaminants) and available at ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_annmean_mlo.tx

The mean surface air temperature is recorded as the change in °C relative to a base period of 1951 to 1980. It is available at data.giss.nasa.gov/gistemp/graphs_v3/

Here are a scatterplot and regression for the years from 1959 to 2011:



Dependent variable is Temp
R-squared = 82.3%
s = 0.0985 with 53 − 2 = 51 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	−2.98861	0.2086	−14.3	≤0.0001
CO_2	0.0092	0.0006	15.4	≤0.0001

a) Write the equation of the regression line.
b) Is there evidence of an association between CO_2 level and global temperature?
c) Do you think predictions made by this regression will be very accurate? Explain.
d) Does this regression prove that increasing CO_2 levels are causing global warming? Discuss.

47. Ozone The Environmental Protection Agency is examining the relationship between the ozone level (in parts per million) and the population (in millions) of U.S. cities. Part of the regression analysis is shown.

Dependent variable is Ozone
R-squared = 84.4%
s = 5.454 with 16 − 2 = 14 df

Variable	Coefficient	SE(Coeff)
Intercept	18.892	2.395
Pop	6.650	1.910

a) We suspect that the greater the population of a city, the higher its ozone level. Is the relationship statistically significant? Assuming the conditions for inference are satisfied, test an appropriate hypothesis and state your conclusion in context.

b) Do you think that the population of a city is a useful predictor of ozone level? Use the values of both R^2 and s in your explanation.

48. Sales and profits A business analyst was interested in the relationship between a company's sales and its profits. She collected data (in millions of dollars) from a random sample of Fortune 500 companies and created the regression analysis and summary statistics shown. The assumptions for regression inference appeared to be satisfied.

	Profits	Sales
Count	79	79
Mean	209.839	4178.29
Variance	635,172	49,163,000
Std Dev	796.977	7011.63

Dependent variable is Profits
R-squared = 66.2% s = 466.2

Variable	Coefficient	SE(Coeff)
Intercept	−176.644	61.16
Sales	0.092498	0.0075

a) Is there a statistically significant association between sales and profits? Test an appropriate hypothesis and state your conclusion in context.

b) Do you think that a company's sales serve as a useful predictor of its profits? Use the values of both R^2 and s in your explanation.

49. Ozone, again Consider again the relationship between the population and ozone level of U.S. cities that you analyzed in Exercise 47.

a) Give a 90% confidence interval for the approximate increase in ozone level associated with each additional million city inhabitants.

b) For the cities studied, the mean population was 1.7 million people. The population of Boston is approximately 0.6 million people. Predict the mean ozone level for cities of that size with an interval in which you have 90% confidence.

50. More sales and profits Consider again the relationship between the sales and profits of Fortune 500 companies that you analyzed in Exercise 48.

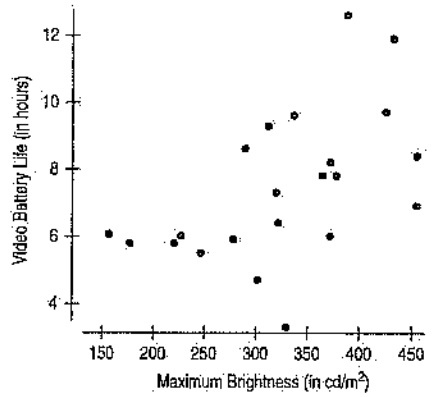
a) Find a 95% confidence interval for the slope of the regression line. Interpret your interval in context.

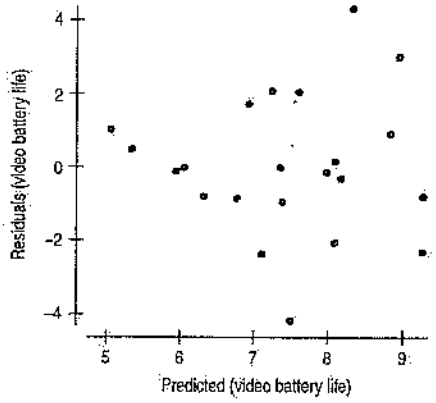
b) Last year, the drug manufacturer Eli Lilly, Inc., reported gross sales of $23 billion (that's $23,000 million). Create a 95% prediction interval for the company's profits, and interpret your interval in context.

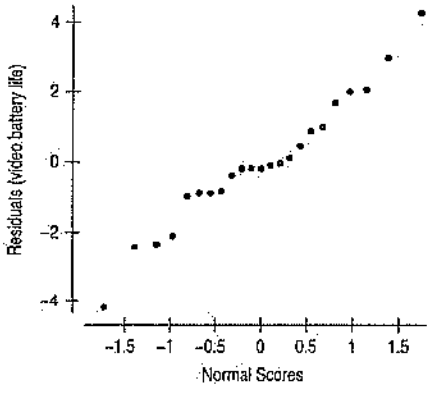
51. Tablet computers In October 2011, cnet.com listed the battery life (in hours) and luminous intensity (i.e., screen brightness, in cd/m^2) for a sample of tablet computers. We want to know if brighter screens drain the battery more quickly. (http://reviews.cnet.com/8301-19736_7-20080768-251/cnet-updates-tablet-test-results/?tag=contentBody;contentHighlights)

Dependent variable is Video battery life (in hours)
R-squared = 27.9%
s = 1.913 with 23 − 2 = 21 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	2.8467073	1.6628386	1.7119566	0.10163
Brightness	0.014080549	0.0049373503	2.851843	0.00955







(continued)

a) How many tablet computers were tested?
b) Are the conditions for inference satisfied? Explain.
c) Is there evidence of an association between maximum brightness of the screen and battery life? Test an appropriate hypothesis and state your conclusion.
d) Is the association strong? Explain.
e) What is the equation of the regression line?
f) Create a 90% confidence interval for the slope of the true line.
g) Interpret your interval in this context.

Crawling Researchers at the University of Denver Infant Study Center wondered whether temperature might influence the age at which babies learn to crawl. Perhaps the extra clothing that babies wear in cold weather would restrict movement and delay the age at which they started crawling. Data were collected on 208 boys and 206 girls. Parents reported the month of the baby's birth and the age (in weeks) at which their child first crawled. The table gives the average *Temperature* (°F) when the babies were 6 months old and average *Crawling Age* (in weeks) for each month of the year. Make the plots and compute the analyses necessary to answer the following questions.

Birth Month	6-Month Temperature	Average Crawling Age
Jan.	66	29.84
Feb.	73	30.52
Mar.	72	29.70
April	63	31.84
May	52	28.58
June	39	31.44
July	33	33.64
Aug.	30	32.82
Sept.	33	33.83
Oct.	37	33.35
Nov.	48	33.38
Dec.	57	32.32

a) Would this association appear to be weaker, stronger, or the same if data had been plotted for individual babies instead of using monthly averages? Explain.
b) Is there evidence of an association between *Temperature* and *Crawling Age*? Test an appropriate hypothesis and state your conclusion. Don't forget to check the assumptions.
c) Create and interpret a 95% confidence interval for the slope of the true relationship.

53. Body fat Do the data shown in the table below indicate an association between *Waist* size and *%Body Fat*?
a) Test an appropriate hypothesis and state your conclusion.
b) Give a 95% confidence interval for the mean *%Body Fat* found in people with a 40-inch *Waist*.

Waist (in.)	Weight (lb)	Body Fat (%)	Waist (in.)	Weight (lb)	Body Fat (%)
32	175	6	33	188	10
36	181	21	40	240	20
38	200	15	36	175	22
33	159	6	32	168	9
39	196	22	44	246	38
40	192	31	33	160	10
41	205	32	41	215	27
35	173	21	34	159	12
38	187	25	34	146	10
38	188	30	44	219	28

54. Body fat, again Use the data from Exercise 53 to examine the association between *Weight* and *%Body Fat*.
a) Find a 90% confidence interval for the slope of the regression line of *%Body Fat* on *Weight*.
b) Interpret your interval in context.
c) Give a 95% prediction interval for the *%Body Fat* of an individual who weighs 165 pounds.

55. Grades The data set below shows midterm scores from an Introductory Statistics course.

First Name	Midterm 1	Midterm 2	Homework
Timothy	82	30	61
Karen	96	68	72
Verena	57	82	69
Jonathan	89	92	84
Elizabeth	88	86	84
Patrick	93	81	71
Julia	90	83	79
Thomas	83	21	51
Marshall	59	62	58
Justin	89	57	79
Alexandra	83	86	78
Christopher	95	75	77
Justin	81	66	66
Miguel	86	63	74
Brian	81	86	76
Gregory	81	87	75
Kristina	98	96	84
Timothy	50	27	20

First Name	Midterm 1	Midterm 2	Homework
Jason	91	83	71
Whitney	87	89	85
Alexis	90	91	68
Nicholas	95	82	68
Amandeep	91	37	54
Irena	93	81	82
Yvon	88	66	82
Sara	99	90	77
Annie	89	92	68
Benjamin	87	62	72
David	92	66	78
Josef	62	43	56
Rebecca	93	87	80
Joshua	95	93	87
Ian	93	65	66
Katharine	92	98	77
Emily	91	95	83
Brian	92	80	82
Shad	61	58	65
Michael	55	65	51
Israel	76	88	67
Iris	63	62	67
Mark	89	66	72
Peter	91	42	66
Catherine	90	85	78
Christina	75	62	72
Enrique	75	46	72
Sarah	91	65	77
Thomas	84	70	70
Sonya	94	92	81
Michael	93	78	72
Wesley	91	58	66
Mark	91	61	79
Adam	89	86	62
Jared	98	92	83
Michael	96	51	83
Kathryn	95	95	87
Nicole	98	89	77
Wayne	89	79	44
Elizabeth	93	89	73
John	74	64	72
Valentin	97	96	80
David	94	90	88
Marc	81	89	62
Samuel	94	85	76
Brooke	92	90	86

a) Fit a model predicting the second midterm score from the first.

b) Comment on the model you found, including a discussion of the assumptions and conditions for regression. Is the coefficient for the slope statistically significant?

c) A student comments that because the P-value for the slope is very small, Midterm 2 is very well predicted from Midterm 1. So, he reasons, next term the professor can give just one midterm. What do you think?

56. Grades? The professor teaching the Introductory Statistics class discussed in Exercise 55 wonders whether performance on homework can accurately predict midterm scores.

a) To investigate it, she fits a regression of the sum of the two midterms scores on homework scores. Fit the regression model.

b) Comment on the model including a discussion of the assumptions and conditions for regression. Is the coefficient for the slope "statistically significant"?

c) Do you think she can accurately judge a student's performance without giving the midterms? Explain.

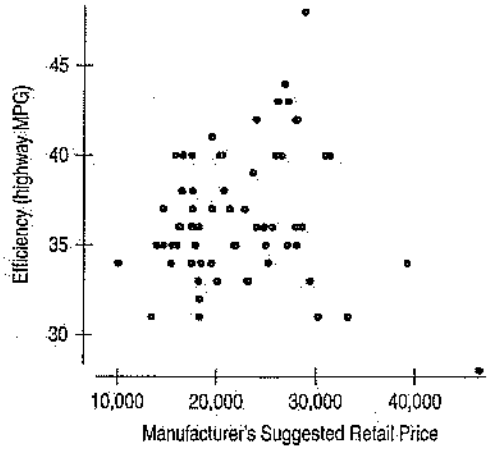
57. Strike two Remember the Little League instructional video discussed in Chapter 20? Ads claimed it would improve the performances of Little League pitchers. To test this claim, 20 Little Leaguers threw 50 pitches each, and we recorded the number of strikes. After the players participated in the training program, we repeated the test. The table shows the number of strikes each player threw before and after the training. A test of paired differences failed to show that this training improves ability to throw strikes. Is there any evidence that the effectiveness of the video (*After* − *Before*) depends on the player's initial ability to throw strikes (*Before*)? Test an appropriate hypothesis and state your conclusion. Propose an explanation for what you find.

Number of Strikes (out of 50)			
Before	After	Before	After
28	35	33	33
29	36	33	35
30	32	34	32
32	28	34	30
32	30	34	33
32	31	35	34
32	32	36	37
32	34	36	33
32	35	37	35
33	36	37	32

58. All the efficiency money can buy 2011 A sample of 84 model-2011 cars from an online information service was examined to see how fuel efficiency (as highway mpg) relates to the cost (Manufacturer's

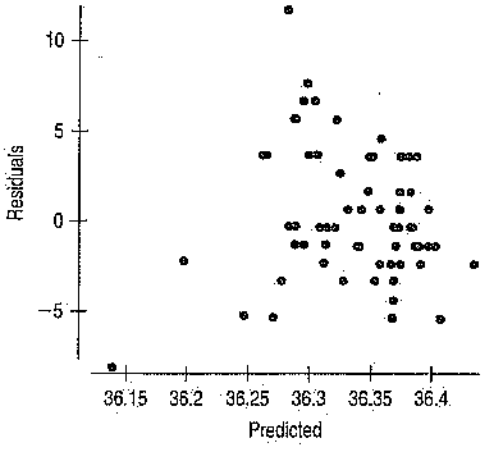
(*continued*)

Suggested Retail Price in dollars) of cars. Here are displays and computer output:



Dependent variable is MPG
R-squared = 0.0216%
s = 3.54

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	36.514	1.496	24.406	<0.0001
Slope	−8.089E−6	6.439E−5	−0.1256	0.900



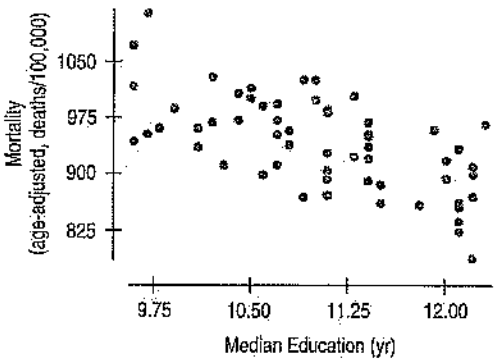
a) State what you want to know, identify the variables, and give the appropriate hypotheses.
b) Check the assumptions and conditions.
c) If the conditions are met, complete the analysis.

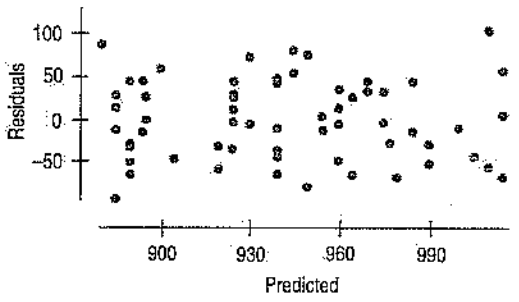
59. Education and mortality The following software output is based on the mortality rate (deaths per 100,000 people) and the education level (average number of years in school) for 58 U.S. cities.

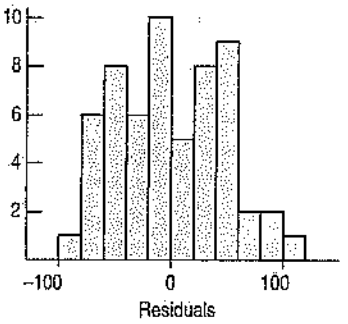
Variable	Count	Mean	StdDev
Mortality	58	942.501	61.8490
Education	58	11.0328	0.793480

Dependent variable is Mortality
R-squared = 41.0%
s = 47.92 with 58 − 2 = 56 degrees of freedom

Variable	Coefficient	SE(Coeff)
Intercept	1493.26	88.48
Education	−49.9202	8.000







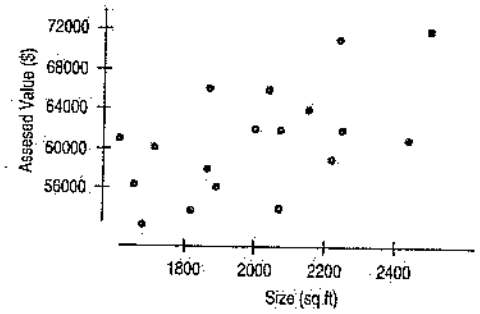
a) Comment on the assumptions for inference.
b) Is there evidence of a strong association between the level of *Education* in a city and the *Mortality* rate? Test an appropriate hypothesis and state your conclusion.
c) Can we conclude that getting more education is likely (on average) to prolong your life? Why or why not?
d) Find a 95% confidence interval for the slope of the true relationship.
e) Explain what your interval means.
f) Find a 95% confidence interval for the average *Mortality* rate in cities where the adult population completed an average of 12 years of school.

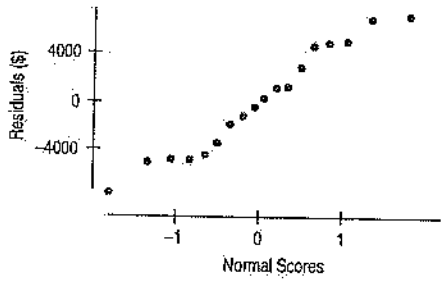
60. Property assessments The following software outputs provide information about the *Size* (in square feet) of 18 homes in Ithaca, New York, and the city's assessed *Value* of those homes.

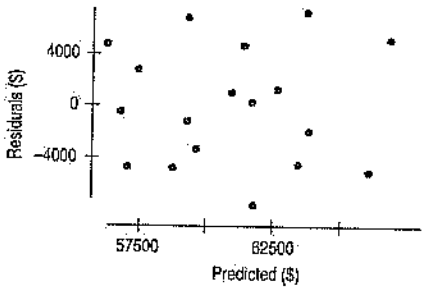
Variable	Count	Mean	StdDev	Range
Size	18	2003.39	264.727	890
Value	18	60946.7	5527.62	19710

Dependent variable is Value
R-squared = 32.5%
s = 4682 with 18 − 2 = 16 degrees of freedom

Variable	Coefficient	SE(Coeff)
Intercept	37108.8	8664
Size	11.8987	4.290







a) Explain why inference for linear regression is appropriate with these data.

b) Is there a significant association between the *Size* of a home and its assessed *Value*? Test an appropriate hypothesis and state your conclusion.

c) What percentage of the variability in assessed *Value* is explained by this regression?

d) Give a 90% confidence interval for the slope of the true regression line, and explain its meaning in the proper context.

e) From this analysis, can we conclude that adding a room to your house will increase its assessed *Value*? Why or why not?

f) The owner of a home measuring 2100 square feet files an appeal, claiming that the $70,200 assessed *Value* is too high. Do you agree? Explain your reasoning.

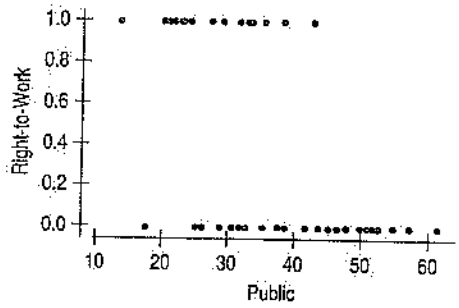
***61. Right-to-work laws** Are so-called "right-to-work" laws related to the percent of public sector employees in unions and the percent of private sector employees in unions? This data set looks at these percentages for the states in the United States in 1982. The dependent variable is whether the state had a right-to-work law or not. The computer output for the logistic regression is given here. (Source: N. M. Meltz, "Interstate and Interprovincial Differences in Union Density," *Industrial Relations*, 28:2 [Spring 1989], 142–158 by way of DASL.)

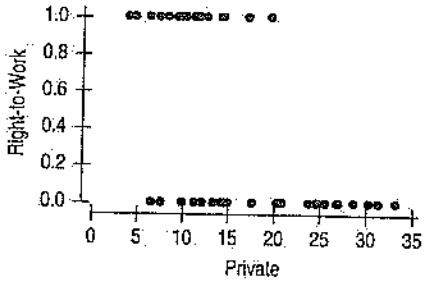
Logistic Regression Table

Predictor	Coeff	SE(Coeff)	Chisq	P
Intercept	6.1995	1.78724	12.04	0.001
pubf	−0.1062	0.0475	5.02	0.025
pvt	−0.2230	0.0811	7.56	0.006

a) Write out the estimated regression equation.

b) The following are scatterplots of the response variable against each of the explanatory variables. Does logistic regression seem appropriate here? Explain.





***62. Cost of higher education** Are there fundamental differences between liberal arts colleges and universities? In this case, we have information on the top 25 liberal arts colleges and the top 25 universities in the Unites States. We will consider the type of school as our response variable and will use the percent of students who were in the top 10% of their high school class and the amount of money spent per student by the college or university as our explanatory variables. The output from this logistic regression is given on the following page.

(*continued*)

Logistic Regression Table

Predictor	Coeff	SE(Coeff)	Chisq	P
Intercept	−13.1461	3.98629	10.89	0.001
Top 10%	0.0845	0.0396345	4.54	0.033
$/Student	0.0003	0.0000860	9.12	0.003

a) Write out the estimated regression equation.

b) Is percent of students in the top 10% of their high school class statistically significant in predicting whether or not the school is a university? Explain.

c) Is the amount of money spent per student statistically significant in predicting whether or not the school is a university? Explain.

Just Checking ANSWERS

1. A high t-ratio of 3.27 indicates that the slope is different from zero—that is, that there is a linear relationship between height and mouth size. The small P-value says that a slope this large would be very unlikely to occur by chance if, in fact, there was no linear relationship between the variables.

2. Not really. The R^2 for this regression is only 15.3%, so height doesn't account for very much of the variability in mouth size.

3. The value of s tells the standard deviation of the residuals. Mouth sizes have a mean of 60.3 cubic centimeters. A standard deviation of 15.7 in the residuals indicates that the errors made by this regression model can be quite large relative to what we are estimating. Errors of 15 to 30 cubic centimeters would be common.

Review of Part VI

Assessing Associations Between Variables

Quick Review

We now turn our focus to relationships between variables. This is where the effectiveness of Statistics becomes clear. Statistical inference about how variables are related is essential to science, social science, health, and business. In this part we have considered comparing groups with means and proportions, comparing groups that have a natural pairing, comparing proportions in several categories and between two categorical variables, and inferential decisions about linear regression. That may seem like a wide variety of ideas, but they are all held together by the central concept that by understanding the ways in which variables and groups relate to each other, we can understand how the world works. Here's a brief summary of the key concepts and skills:

- A confidence interval uses a sample statistic to estimate a range of possible values for the parameter of a population model.
- A hypothesis test proposes a model for the population, then examines the observed statistics to see if the model is plausible.
- Statistical inference procedures for comparing proportions are based on the Central Limit Theorem. We can make inferences about the difference of two proportions using Normal models.
- Statistical inference procedures for comparing means and for estimating regression coefficients are also based on the Central Limit Theorem, but we don't usually know the population standard deviation. Student's *t*-models take the additional uncertainty of independently estimating the standard deviation into account.
  - We can make inferences about the difference of two independent means, the mean of paired differences, or the intercept or slope of a linear regression using *t*-models.
  - No inference procedure is valid unless the underlying assumptions are true. Always think about the assumptions and check the conditions before proceeding. For regression, take care to check them in the right order.
  - Because *t*-models assume that samples are drawn from Normal populations, data in the sample (or, for regression, the residuals) should appear to be nearly Normal. Skewness and outliers are particularly problematic.
  - To identify the appropriate statistic for comparing the means of groups, you must think carefully about how the data were collected. You may use two-sample *t* procedures only if the groups are independent.
  - Unless there is some obvious reason to suspect that two independent populations have the same standard deviation, you should not pool the variances. It is never wrong to use unpooled *t* procedures.
  - If two groups are paired, the data are *not* from independent groups. You must use matched-pairs *t* procedures and test the mean difference rather than the difference in the means.
  - Linear regression inference is only valid if the relationship between the two variables is straight. Examine a scatterplot.
- Not all sampling distributions are unimodal, symmetric, or bell-shaped. Inferences about distributions of counts use chi-square models, which are unimodal but skewed to the high end. Nevertheless, the sampling distribution plays the same role in inference, helping us to translate between probabilities and values based on data.
  - To see if an observed distribution is consistent with a proposed model, use a chi-square goodness-of-fit test.
  - To see if two or more observed distributions could have arisen from populations with the same model, use a test of homogeneity.
  - To see if two categorical variables are independent, perform a chi-square test of independence.
- You can now use statistical inference to answer questions about means, proportions, distributions, associations, and linear regression models.
  - No inference procedure is valid unless the underlying assumptions are true. Always check the conditions before proceeding.
  - You can make inferences about the difference between two proportions using Normal models.
  - You can make inferences about the difference between two independent means, or about the mean of paired differences using *t*-models.
  - You can make inferences about distributions using chi-square models.
  - You can make inferences about association between categorical variables using chi-square models.
  - You can make inferences about the coefficients in a linear regression model using *t*-models.

Now for some opportunities to review these concepts. Be careful. You have a lot of thinking to do. These review exercises mix questions about proportions, means, chi square, and regression. You have to determine which of our inference procedures is appropriate in each situation. Then you have to check the proper assumptions and conditions. Keeping track of those can be difficult, so first we summarize the many procedures with their corresponding assumptions and conditions on the next page. Look them over carefully . . . then, on to the Exercises!

Assumptions for Inference	And the Conditions that Support or Override them
Proportions (z)	
*** One sample**	
1. Individuals are independent.	1. SRS and $n < 10\%$ of the population.
2. Sample is sufficiently large.	2. Successes and failures ≥ 10.
*** Two sample**	
1. Samples are independent.	1. (Think about how the data were collected.)
2. Data in each sample are independent.	2. Both are SRSs and $n < 10\%$ of populations OR random allocation.
3. Both samples are sufficiently large.	3. Successes and failures ≥ 10 for both.
Means (t)	
*** One sample** ($df = n - 1$)	
1. Individuals are independent.	1. SRS and $n < 10\%$ of the population.
2. Population has a Normal model.	2. Histogram is unimodal and symmetric.*
*** Two independent Samples** (df from technology)	
1. Samples are independent.	1. (Think about the design.)
2. Data in each sample are independent.	2. SRSs and $n < 10\%$ OR random allocation.
3. Both populations are Normal.	3. Both histograms are unimodal and symmetric.*
*** Matched pairs** ($df = n - 1$)	
1. Data are matched; n pairs.	1. (Think about the design.)
2. Individuals are independent.	2. SRSs and $n < 10\%$ OR random allocation.
3. Population of differences is Normal.	3. Histogram of differences is unimodal and symmetric.
Distributions/Association (χ^2)	
*** Goodness of fit** [df = # of cells -1; one variable, one sample compared with population model]	
1. Data are counts.	1. (Are they?)
2. Data in sample are independent.	2. SRS and $n < 10\%$ of the population.
3. Sample is sufficiently large.	3. All expected counts ≥ 5.
*** Homogeneity** [$df = (r - 1)(c - 1)$; samples from many populations compared on one variable]	
1. Data are counts.	1. (Are they?)
2. Data in samples are independent.	2. SRSs and $n < 10\%$ OR random allocation.
3. Groups are sufficiently large.	3. All expected counts ≥ 5.
*** Independence** [$df = (r - 1)(c - 1)$; sample from one population classified on two variables]	
1. Data are counts.	1. (Are they?)
2. Data are independent.	2. SRSs and $n < 10\%$ of the population.
3. Group is sufficiently large.	3. All expected counts ≥ 5.
Regression with One Quantitative Predictor (t, $df = n-2$)	
1. Form of relationship is linear.	1. Scatterplot of y against x is straight enough. Scatterplot of residuals against predicted values shows no special structure.
2. Errors are independent.	2. No apparent pattern in plot of residuals against predicted values.
3. Variability of errors is constant.	3. Plot of residuals against predicted values has constant spread, doesn't "thicken."
4. Errors follow a Normal model.	4. Histogram of residuals is approximately unimodal and symmetric, or Normal probability plot is resonably straight.*

*Less critical as n increases

Review Exercises

1. **Herbal cancer** A report in the *New England Journal of Medicine* notes growing evidence that the herb *Aristolochia fangchi* can cause urinary tract cancer in those who take it. Suppose you are asked to design an experiment to study this claim. Imagine that you have data on urinary tract cancers in subjects who have used this herb and similar subjects who have not used it and that you can measure incidences of cancer and precancerous lesions in these subjects. State the null and alternative hypotheses you would use in your study.

2. **Birth days** During a 2-month period, 72 babies were born at the Tompkins Community Hospital in upstate New York. The table shows how many babies were born on each day of the week.

Day	Births
Mon.	7
Tues.	17
Wed.	8
Thurs.	12
Fri.	9
Sat.	10
Sun.	9

   a) If births are uniformly distributed across all days of the week, how many would you expect on each day?
   b) Test the hypothesis that babies are equally likely to be born on any of the days of the week.
   c) Given the results of part b, do you think that the 7 births on Monday and 17 births on Tuesday indicate that women might be less likely to give birth on Monday, or more likely to give birth on Tuesday?
   d) Can you think of any reasons why births may not occur completely at random?

3. **Surgery and germs** Joseph Lister (for whom Listerine is named!) was a British physician who was interested in the role of bacteria in human infections. He suspected that germs were involved in transmitting infection, so he tried using carbolic acid as an operating room disinfectant. In 75 amputations, he used carbolic acid 40 times. Of the 40 amputations using carbolic acid, 34 of the patients lived. Of the 35 amputations without carbolic acid, 19 patients lived. The question of interest is whether carbolic acid is effective in increasing the chances of surviving an amputation.
   a) What kind of a study is this?
   b) What do you conclude? Support your conclusion by testing an appropriate hypothesis.
   c) What reservations do you have about the design of the study?

4. **Free throws 2011** During the 2010–2011 NBA season, Stephen Curry led the league by making 212 of 227 free throws, for a success rate of 93.39%. But Chauncey Billups was close behind, with 384 of 419 (91.65%).
   a) Find a 95% confidence interval for the difference in their free throw percentages.
   b) Based on your confidence interval, is it certain that Curry is better than Billups at making free throws?

5. **Twins** There is some indication in medical literature that doctors may have become more aggressive in inducing labor or doing preterm cesarean sections when a woman is carrying twins. Records at a large hospital show that, of the 43 sets of twins born in 2000, 20 were delivered before the 37th week of pregnancy. In 2010, 26 of 48 sets of twins were born preterm. Does this indicate an increase in the incidence of early births of twins? Test an appropriate hypothesis and state your conclusion.

6. **Eclampsia** It's estimated that 50,000 pregnant women worldwide die each year of eclampsia, a condition involving elevated blood pressure and seizures. A research team from 175 hospitals in 33 countries investigated the effectiveness of magnesium sulfate in preventing the occurrence of eclampsia in at-risk patients. Results are summarized below. (Source: *Lancet*, June 1, 2002)

		Total Subjects	Reported Side Effects	Developed Eclampsia	Deaths
Treatment	Magnesium Sulfate	4999	1201	40	11
	Placebo	4993	228	96	20

   a) Write a 95% confidence interval for the increase in the proportion of women who may develop side effects from this treatment. Interpret your interval.
   b) Is there evidence that the treatment may be effective in preventing the development of eclampsia? Test an appropriate hypothesis and state your conclusion.

7. **Eclampsia deaths** Refer again to the research summarized in Exercise 6. Is there any evidence that when eclampsia does occur, the magnesium sulfide treatment may help prevent the woman's death?
   a) Write an appropriate hypothesis.
   b) Check the assumptions and conditions.
   c) Find the P-value of the test.
   d) What do you conclude about the magnesium sulfide treatment?
   e) If your conclusion is wrong, which type of error have you made?

f) Name two things you could do to increase the power of this test.
g) What are the advantages and disadvantages of those two options?

8. Perfect pitch A recent study of perfect pitch tested 2700 students in American music conservatories. It found that 7% of non-Asian and 32% of Asian students have perfect pitch. A test of the difference in proportions resulted in a P-value of < 0.0001.
a) What are the researchers' null and alternative hypotheses?
b) State your conclusion.
c) Explain in this context what the P-value means.
d) The researchers claimed that the data prove that genetic differences between the two populations cause a difference in the frequency of occurrence of perfect pitch. Do you agree? Why or why not?

9. More errors A corporation with a fleet of vehicles wanted to test the cost-effectiveness of using Motor Silk oil additive. For the study, 6100 delivery and passenger vehicles were tested for the same 3-month period in 2007 and then again in 2008. In 2007, the fleet was driven without Motor Silk. Then in 2008, Motor Silk was used according to the standard instructions. The average fuel economy increased from 18.97 mpg to 21.72 mpg.
a) What kind of a study is this?
b) Will they do a one-tailed or a two-tailed test?
c) Explain in this context what a Type I error would be.
d) Explain in this context what a Type II error would be.
e) Which type of error would the additive manufacturer consider more serious?
f) If the vehicles with the additive are indeed statistically significantly better, can the company conclude it is an effect of the additive? Can they generalize this result and recommend the additive for all cars? Explain.

10. Preemies Among 242 Cleveland-area children born prematurely at low birth weights between 1977 and 1979, only 74% graduated from high school. Among a comparison group of 233 children of normal birth weight, 83% were high school graduates. (Source: "Outcomes in Young Adulthood for Very-Low-Birth-Weight Infants," *New England Journal of Medicine,* 346, no. 3)
a) Create a 95% confidence interval for the difference in graduation rates between children of normal and children of very low birth weights. Be sure to check the appropriate assumptions and conditions.
b) Does this provide evidence that premature birth may be a risk factor for not finishing high school? Use your confidence interval to test an appropriate hypothesis.
c) Suppose your conclusion is incorrect. Which type of error did you make?

11. Crawling A study found that babies born at different times of the year may develop the ability to crawl at different ages. The author of the study suggested that these differences may be related to the temperature at the time the infant is 6 months old. (Source: Benson and Janette, *Infant Behavior and Development*)
a) The study found that 32 babies born in January crawled at an average age of 29.84 weeks, with a standard deviation of 7.08 weeks. Among 21 July babies, crawling ages averaged 33.64 weeks, with a standard deviation of 6.91 weeks. Is this difference significant?
b) For 26 babies born in April, the mean and standard deviation were 31.84 and 6.21 weeks, while for 44 October babies the mean and standard deviation of crawling ages were 33.35 and 7.29 weeks. Is this difference significant?
c) Are these results consistent with the researcher's claim?

12. Mazes and smells Can pleasant smells improve learning? Researchers timed 21 subjects as they tried to complete paper-and-pencil mazes. Each subject attempted a maze both with and without the presence of a floral aroma. Subjects were randomized with respect to whether they did the scented trial first or second. Some of the data collected are shown in the table. Is there any evidence that the floral scent improved the subjects' ability to complete the mazes? (Source: A. R. Hirsch and L. H. Johnston, "Odors and Learning." Chicago: Smell and Taste Treatment and Research Foundation)

Time to Complete the Maze (sec)

Unscented	Scented	Unscented	Scented
25.7	30.2	61.5	48.4
41.9	56.7	44.6	32.0
51.9	42.4	35.3	48.1
32.2	34.4	37.2	33.7
64.7	44.8	39.4	42.6
31.4	42.9	77.4	54.9
40.1	42.7	52.8	64.5
43.2	24.8	63.6	43.1
33.9	25.1	56.6	52.8
40.4	59.2	58.9	44.3
58.0	42.2		

13. Pottery Archaeologists can use the chemical composition of clay found in pottery artifacts to determine whether different sites were populated by the same ancient people. They collected five samples of Romano–British pottery from each of two sites in Great Britain—the Ashley Rails site and the New Forest site—and measured the percentage of aluminum oxide in each. Based on these data, do you think the same people used these two kiln sites? Base your conclusion on a 95% confidence interval for the difference in aluminum oxide content of pottery made at the

sites. (Source: A. Tubb, A. J. Parker, and G. Nickless, "The Analysis of Romano–British Pottery by Atomic Absorption Spectrophotometry." *Archaeometry*, 22[1980]:153–171)

Ashley Rails	19.1	14.8	16.7	18.3	17.7
New Forest	20.8	18.0	18.0	15.8	18.3

14. Grant writing Does race matter when applying for National Institutes of Health grants? A new study found that of 58,148 applications submitted by white researchers, 15,700 were accepted and funded by the NIH. Additionally, 198 of the 1164 applications submitted by black researchers were funded. (Source: *Science*, August 19, 2011)

a) Is there evidence that the chance for funding is higher for white researchers?

b) What kind of study is this? How does that affect the inference you made in part a?

15. Feeding fish In the midwestern United States, a large aquaculture industry raises largemouth bass. Researchers wanted to know whether the fish would grow better if fed a natural diet of fathead minnows or an artificial diet of food pellets. They stocked six ponds with bass fingerlings weighing about 8 grams. For one year, the fish in three of the ponds were fed minnows, and the others were fed the commercially prepared pellets. The fish were then harvested, weighed, and measured. The bass fed a natural food source had a higher average length (19.6 cm) and weight (95.9 g) than those fed the commercial fish food (17.3 cm and 72.0 g, respectively). The researchers reported P-values for both measurements to be less than 0.001.

a) Explain to someone who has not studied Statistics what the P-values mean here.

b) What advice should the researchers give the people who raise largemouth bass?

c) If that advice turns out to be incorrect, what type of error occurred?

16. Driving fatalities The U.S. Census compiled data from each state in 2009 to record the number of deaths per 100 million vehicle miles traveled. Wondering if the death rate is different in New England when compared to the Southwestern states, we hope to create a 95% confidence interval for the difference in death rates. Are these data appropriate for inference? If so, create the interval and make a concluding remark.

New England	0.7	1.1	0.6	0.9	1.0	1.0
Southwestern	1.3	1.3	1.4	1.2		

17. Age In a study of how depression may affect one's ability to survive a heart attack, the researchers reported the ages of the two groups they examined. The mean age of 2397 patients without cardiac disease was 69.8 years (SD = 8.7 years), while for the 450 patients with cardiac disease, the mean and standard deviation of the ages were 74.0 and 7.9, respectively.

a) Create a 95% confidence interval for the difference in mean ages of the two groups.

b) How might an age difference confound these research findings about the relationship between depression and ability to survive a heart attack?

18. Smoking In the depression and heart attack research described in Exercise 17, 32% of the diseased group were smokers, compared with only 23.7% of those free of heart disease.

a) Create a 95% confidence interval for the difference in the proportions of smokers in the two groups.

b) Is this evidence that the two groups in the study were different? Explain.

c) Could this be a problem in analyzing the results of the study? Explain.

19. Eating disorders A study conducted in the multicultural Spanish city of Ceuta investigated the relationship between religion and the prevalence of eating disorders. Students aged 12–20 were selected from three public schools. In the study, suppose there were 150 Muslim students and 46 were diagnosed with eating disorders. Of the 200 Christian students, 17% were diagnosed the same way.

a) Create a 95% confidence interval for the difference in eating disorder rates when comparing Muslims to Christians.

b) Based on your interval, are you convinced that there is a true difference when comparing rates between the religions? Explain.

20. Cesareans Some people fear that differences in insurance coverage can affect healthcare decisions. A survey of several randomly selected hospitals found that 16.6% of 223 recent births in Vermont involved cesarean deliveries, compared to 18.8% of 186 births in New Hampshire. Is this evidence that the rate of cesarean births in the two states is different?

21. Teach for America Several programs attempt to address the shortage of qualified teachers by placing uncertified instructors in schools with acute needs—often in inner cities. A study compared students taught by certified teachers to others taught by uncertified teachers in the same schools. Reading scores of the students of certified teachers averaged 35.62 points with standard deviation 9.31. The scores of students instructed by uncertified teachers had mean 32.48 points with standard deviation 9.43 points on the same test.

There were 44 students in each group. The appropriate t procedure has 86 degrees of freedom. Is there evidence of lower scores with uncertified teachers? Discuss. (Source: *The Effectiveness of "Teach for America" and Other Under-certified Teachers on Student Academic Achievement: A Case of Harmful Public Policy*. Education Policy Analysis Archives)

22. Legionnaires' disease In 1974, the Bellevue-Stratford Hotel in Philadelphia was the scene of an outbreak of what later became known as legionnaires' disease. The cause of the disease was finally discovered to be bacteria that thrived in the air-conditioning units of the hotel. Owners of the Rip Van Winkle Motel, hearing about the Bellevue-Stratford, replace their air-conditioning system. The following data are the bacteria counts in the air of eight rooms, before and after a new air-conditioning system was installed (measured in colonies per cubic foot of air). The objective is to find out whether the new system has succeeded in lowering the bacterial count. You are the statistician assigned to report to the hotel whether the strategy has worked. Base your analysis on a confidence interval. Be sure to list all your assumptions, methods, and conclusions.

Room Number	Before	After
121	11.8	10.1
163	8.2	7.2
125	7.1	3.8
264	14.0	12.0
233	10.8	8.3
218	10.1	10.5
324	14.6	12.1
325	14.0	13.7

23. Teach for America, part II The study described in Exercise 21 also looked at scores in mathematics and language. Here are software outputs for the appropriate tests. Explain what they show.

Mathematics

T-TEST OF Mu(1) − Mu(2) = 0
Mu(Cert) − Mu(NoCert) = 4.53 t (86) = 2.95 p = 0.002

Language

T-TEST OF Mu(1) − Mu(2) = 0
Mu(Cert) − Mu(NoCert) = 2.13 t (84) = 1.71 p = 0.045

24. Irises Can measurements of the petal length of flowers be of value when you need to determine the species of a certain flower? Here are the summary statistics from measurements of the petals of two species of irises. (Source: R. A. Fisher, "The Use of Multiple Measurements in Axonomic Problems." *Annals of Eugenics 7* [1936]:179–188)

	Species	
	Versicolor	Virginica
Count	50	50
Mean	55.52	43.22
Median	55.50	44.00
SD	5.519	5.362
Min	45	30
Max	69	56
Lower Quartile	51	40
Upper Quartile	59	47

a) Make parallel boxplots of petal lengths for the two species.
b) Describe the differences seen in the boxplots.
c) Write a 95% confidence interval for this difference.
d) Explain what your interval means.
e) Based on your confidence interval, is there evidence of a difference in petal length? Explain.

25. Insulin and diet A study published in the *Journal of the American Medical Association* examined people to see if they showed any signs of IRS (insulin resistance syndrome) involving major risk factors for Type 2 diabetes and heart disease. Among 102 subjects who consumed dairy products more than 35 times per week, 24 were identified with IRS. In comparison, IRS was identified in 85 of 190 individuals with the lowest dairy consumption, fewer than 10 times per week.

a) Is this strong evidence that IRS risk is different in people who frequently consume dairy products than in those who do not?
b) Does this prove that diary consumption influences the development of IRS? Explain.

26. Rainmakers? In an experiment to determine whether seeding clouds with silver iodide increases rainfall, 52 clouds were randomly assigned to be seeded or not. The amount of rain they generated was then measured (in acre-feet). Create a 95% confidence interval for the average amount of additional rain created by seeding clouds. Explain what your interval means.

	Unseeded Clouds	Seeded Clouds
Count	26	26
Mean	164.588	441.985
Median	44.200	221.600
SD	278.426	650.787
IntQRange	138.600	337.600
25 %ile	24.400	92.400
75 %ile	163	430

27. Genetics Two human traits controlled by a single gene are the ability to roll one's tongue and whether one's ear lobes are free or attached to the neck. Genetic theory says that people will have neither, one, or both of these traits in the ratio 1:3:3:9 (1 attached, noncurling; 3 attached, curling; 3 free, noncurling; 9 free, curling). An Introductory Biology class of 122 students collected the data shown. Are they consistent with the genetic theory? Test an appropriate hypothesis and state your conclusion.

	Trait			
	Attached, Noncurling	Attached, Curling	Free, Noncurling	Free, Curling
Count	10	22	31	59

28. Tableware Nambe Mills manufactures plates, bowls, and other tableware made from an alloy of several metals. Each item must go through several steps, including polishing. To better understand the production process and its impact on pricing, the company checked the polishing time (in minutes) and the retail price (in US$) of these items. The regression analysis is shown below. The scatterplot showed a linear pattern, and residuals were deemed suitable for inference.

Dependent variable is Price
R-squared = 84.5%
s = 20.50 with 59 − 2 = 57 degrees of freedom

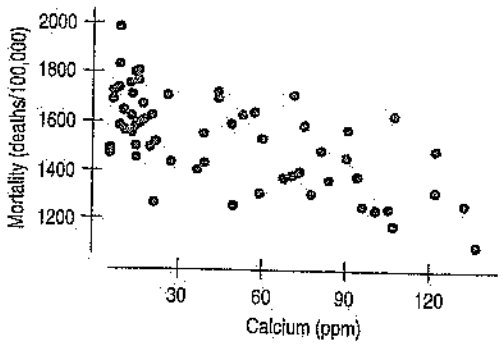
Variable	Coefficient	SE(Coeff)
Intercept	−2.89054	5.730
Time	2.49244	0.1416

a) How many different products were included in this analysis?
b) What fraction of the variation in retail price is explained by the polishing time?
c) Create a 95% confidence interval for the slope of this relationship.
d) Interpret your interval in this context.

29. Hard water In an investigation of environmental causes of disease, data were collected on the annual mortality rate (deaths per 100,000) for males in 61 large towns in England and Wales. In addition, the water hardness was recorded as the calcium concentration (parts per million, or ppm) in the drinking water. Here are the scatterplot and regression analysis of the relationship between mortality and calcium concentration.

Dependent variable is Mortality
R-squared = 43%
s = 143.0 with 61 − 2 = 59 degrees of freedom

Variable	Coefficient	SE(Coeff)
Intercept	1676	29.30
Calcium	−3.23	0.48



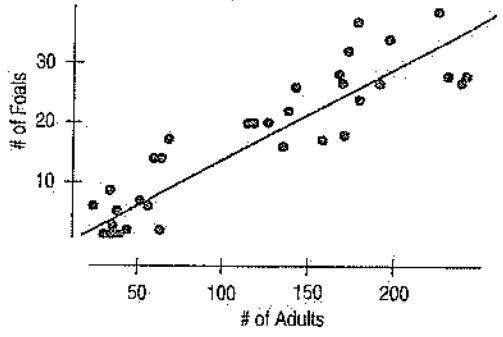
a) Is there an association between the hardness of the water and the mortality rate? Write the appropriate hypothesis.
b) Assuming the assumptions for regression inference are met, what do you conclude?
c) Create a 95% confidence interval for the slope of the true line relating calcium concentration and mortality.
d) Interpret your interval in context.

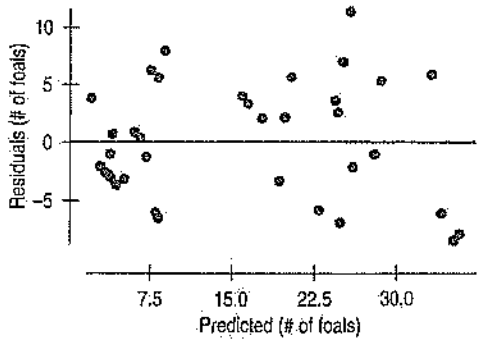
30. Wealth distribution The following table is based on a June 2011 Gallup Poll in which Americans were classified as high income (over $75,000), middle income ($30k–$75k), or low income (less than $30k). Those polled were asked for their views on redistributiug U.S. wealth by heavily taxing the rich. The data are summarized in the table below.

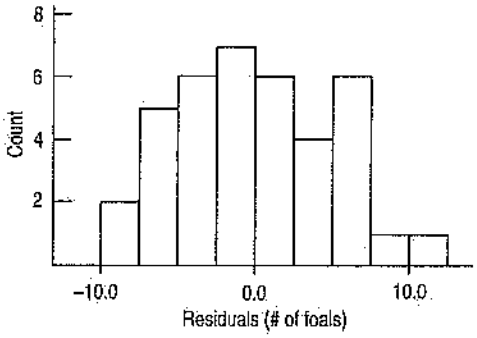
	Should Redistribute Wealth	Should Not	No Opinion
High Income	170	371	9
Middle Income	306	282	12
Low Income	362	184	29

Is there any evidence that income level is associated with feelings toward the wealth distribution in the United States? Test an appropriate hypothesis about this table, and state your conclusions.

31. Wild horses Large herds of wild horses can become a problem on some federal lands in the West. Researchers hoping to improve the management of these herds collected data to see if they could predict the number of foals that would be born based on the size of the current herd. Their attempt to model this herd growth is summarized in the output shown.







Variable	Count	Mean	StdDev
Adults	38	110.237	71.1809
Foals	38	15.3947	11.9945

Dependent variable is Foals
R-squared = 83.5%
s = 4.941 with 38 − 2 = 36 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	−1.57835	1.492	−1.06	0.2970
Adults	0.153969	0.0114	13.5	≤0.0001

a) How many herds of wild horses were studied?
b) Are the conditions necessary for inference satisfied? Explain.
c) Create a 95% confidence interval for the slope of this relationship.
d) Explain in this context what that slope means.
e) Suppose that a new herd with 80 adult horses is located. Estimate, with a 90% prediction interval, the number of foals that may be born.

32. Lefties and music In an experiment to see if left- and right-handed people have different abilities in music, subjects heard a tone and were then asked to identify which of several other tones matched the first. Of 76 right-handed subjects, 38 were successful in completing this test, compared with 33 of 53 lefties. Is this strong evidence of a difference in musical abilities based on handedness?

33. AP Statistics scores 2010 In 2010, almost 130,000 Statistics students nationwide took the Advanced Placement Examination in Statistics. The national distribution of scores and the results at Ithaca High School are shown in the table.

		Ithaca High School	
Score	National Distribution	Number of Boys	Number of Girls
5	12.8%	13	13
4	22.4%	21	15
3	23.5%	6	13
2	18.2%	7	3
1	23.1%	4	2

a) Is the distribution of scores at this high school significantly different from the national results?
b) Was there a significant different between the performances of boys and girls at this school?

34. Twins In 2000, the *Journal of the American Medical Association* published a study that examined a sample of pregnancies that resulted in the birth of twins. Births were classified as preterm with intervention (induced labor or cesarean), preterm without such procedures, or term or post-term. Researchers also classified the pregnancies by the level of prenatal medical care the mother received (inadequate, adequate, or intensive). The data, from the years 1995–1997, are summarized in the table below. Figures are in thousands of births. (Source: *JAMA* 284 [2000]: 335–341)

		Twin Births, 1995–1997 (in thousands)			
		Preterm (induced or cesarean)	Preterm (without procedures)	Term or Postterm	Total
Level of Prenatal Care	Intensive	18	15	28	61
	Adequate	46	43	65	154
	Inadequate	12	13	38	63
	Total	76	71	131	278

Is there evidence of an association between the duration of the pregnancy and the level of care received by the mother?

35. Twins, again After reading of the *JAMA* study in Exercise 34, a large city hospital examined their records of twin births for several years and found the data summarized in the table below. Is there evidence that the way the hospital deals with pregnancies involving twins may have changed?

Outcome of Pregnancy	2000	2005	2010
Preterm (induced or cesarean)	11	13	19
Preterm (without procedures)	13	14	18
Term or Postterm	27	26	32

36. Retirement planning According to the 2011 Retirement Confidence Survey, run by the Employee Benefit Research Institute, 37% of men reported being "a lot behind schedule" while 43% of women answered in the same way. Is this evidence that in general, more women are feeling this way when it comes to retirement planning? Assuming the study had 722 men and 701 women, run the appropriate hypothesis test.

37. Age and party 2011 The Pew Research Center conducted a representative telephone survey during 2011. Among the reported results was the following table concerning the preferred political party affiliation of respondents and their ages for white voters. Is there evidence of age-based differences in party affiliation in the United States for white voters?

	Leaning Republican	Leaning Democrat	Other	Total
18–29	274	216	36	526
30–49	888	581	146	1615
50–64	1173	962	211	2346
65+	1062	812	209	2083
Total	3397	2571	602	6570

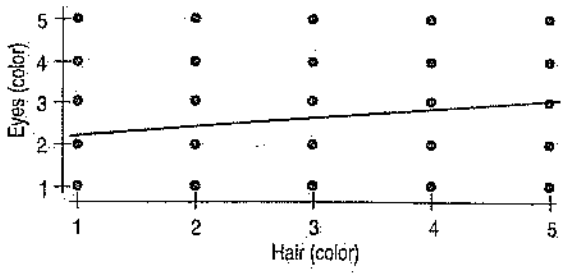
a) Will you conduct a test of homogeneity or independence? Why?
b) Test an appropriate hypothesis.
c) State your conclusion, including an analysis of differences you find (if any).

38. Eye and hair color A survey of 1021 school-age children was conducted by randomly selecting children from several large urban elementary schools. Two of the questions concerned eye and hair color. In the survey, the following codes were used:

Hair Color	Eye Color
1 = Blond	1 = Blue
2 = Brown	2 = Green
3 = Black	3 = Brown
4 = Red	4 = Grey
5 = Other	5 = Other

The Statistics students analyzing the data were asked to study the relationship between eye and hair color.

a) One group of students produced the output shown below. What kind of analysis is this? What are the null and alternative hypotheses? Is the analysis appropriate? If so, summarize the findings, being sure to include any assumptions you've made and/or limitations to the analysis. If it's not an appropriate analysis, state explicitly why not.



Dependent variable is Eyes
R-squared = 3.7%
s = 1.112 with 1021 − 2 = 1019 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	1.99541	0.08346	23.9	≤0.0001
Hair	0.211809	0.03372	0.28	≤0.0001

b) A second group of students used the same data to produce the output shown below. The table displays counts and standardized residuals in each cell. What kind of analysis is this? What are the null and alternative hypotheses? Is the analysis appropriate? If so, summarize the findings, being sure to include any assumptions you've made and/or limitations to the analysis. If it's not an appropriate analysis, state explicitly why not.

Hair Color \ Eye Color	1	2	3	4	5
1	143 7.67540	30 0.41799	58 −5.88169	15 −0.63925	12 −0.31451
2	90 −2.57141	45 0.29019	215 1.72235	30 0.49189	20 −0.08246
3	28 −5.39425	15 −2.34780	190 6.28154	10 −1.76376	10 −0.80382
4	30 2.06116	15 2.71589	10 −4.05540	10 2.37402	5 0.75993
5	10 −0.52195	5 0.33262	15 −0.94192	5 1.36326	5 2.07578

$$\sum \frac{(Observed - Expected)^2}{Expected} = 223.6 \quad \text{P-value} < 0.00001$$

39. Depression and the Internet The September 1998 issue of the *American Psychologist* published an article reporting on an experiment examining "the social and psychological impact of the Internet on 169 people in 73 households during their first 1 to 2 years online." In the experiment, a sample of households was offered free Internet access for one or two years in return for allowing their time and activity online to be tracked. The members of the households who participated in the study were also given a battery of tests at the beginning and again at the end of the study. One of the tests measured the subjects' levels of depression on a 4-point scale, with higher numbers meaning the person was more depressed. Internet usage was measured in average number of hours per week. The regression analysis examines the association between the subjects' depression levels and the amounts of Internet use. The conditions for inference were satisfied.

Dependent variable is Depression After
R-squared = 4.6%
s = 0.4563 with 162 − 2 = 160 degrees of freedom

Variable	Coefficient	SE(coeff)	t-Ratio	Prob
Constant	0.565485	0.0399	14.2	≤0.0001
Intr_use	0.019948	0.0072	2.76	0.0064

a) Do these data indicate that there is an association between Internet use and depression? Test an appropriate hypothesis and state your conclusion clearly.

b) One conclusion of the study was that those who spent more time online tended to be more depressed at the end of the experiment. News headlines said that too much time on the Internet can lead to depression. Does the study support this conclusion? Explain.

c) As noted, the subjects' depression levels were tested at both the beginning and the end of this study; higher scores indicated the person was more depressed. Results are summarized in the table. Is there evidence that the depression level of the subjects changed during this study?

Depression Level
162 subjects

Variable	Mean	StdDev
DeprBfore	0.730370	0.487817
DeprAfter	0.611914	0.461932
Difference	−0.118457	0.552417

40. Pregnancy A San Diego reproductive clinic reported 42 live births to 157 women under the age of 38, but only 7 successes for 89 clients aged 38 and older. Is this evidence of a difference in the effectiveness of the clinic's methods for older women?

a) Test the appropriate hypotheses, using the two-proportion z-procedure.

b) Repeat the analysis, using an appropriate chi-square procedure.

c) Explain how the two results are equivalent.

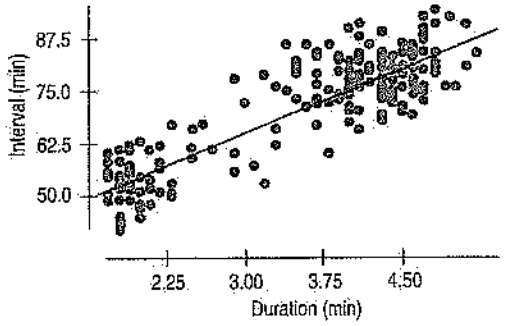
41. Family planning A 1954 study of 1438 pregnant women examined the association between the woman's education level and the occurrence of unplanned pregnancies, producing these data:

	Education Level		
	<3 Yr HS	3+ Yr HS	Some College
Number of Pregnancies	591	608	239
% Unplanned	66.2%	55.4%	42.7%

Do these data provide evidence of an association between family planning and education level? (Source: *Fertility Planning and Fertility Rates by Socio-Economic Status*, Social and Psychological Factors Affecting Fertility, 1954)

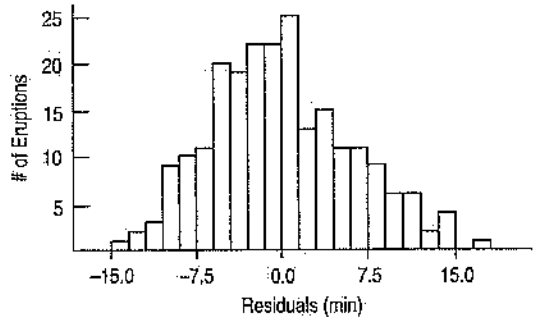
42. Old Faithful Old Faithful eruptions do not occur at uniform intervals and may vary greatly. Can we improve our chances of predicting the time of the next eruption if we know how long the previous eruption lasted?

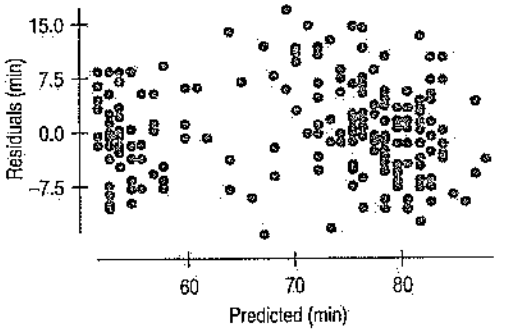
a) Describe what you see in this scatterplot.



b) Write an appropriate hypothesis.

c) Here are a histogram of the residuals and the residuals plot. Do you think the assumptions for inference are met? Explain.





d) State a conclusion based on this regression analysis:

Dependent variable is Interval
R-squared = 77.0%
s = 6.159 with 222 − 2 = 220 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	33.9668	1.428	23.8	≤0.0001
Duration	10.3582	0.3822	27.1	≤0.0001

Variable	Mean	StdDev
Duration	3.57613	1.08395
Interval	71.0090	12.7992

e) The second table shows the summary statistics for the two variables. Create a 95% confidence interval for the mean length of time that will elapse following a 2-minute eruption.

f) You arrive at Old Faithful just as an eruption ends. Witnesses say it lasted 4 minutes. Create a 95% prediction interval for the length of time you will wait to see the next eruption.

43. Togetherness Are good grades in high school associated with family togetherness? A simple random sample of 142 high-school students was asked how many meals per week their families ate together. Their responses produced a mean of 3.78 meals per week, with a standard deviation of 2.2. Researchers then matched these responses against the students' grade point averages. The scatterplot appeared to be reasonably linear, so they went ahead with the regression analysis, seen below. No apparent pattern emerged in the residuals plot.

Dependent variable is GPA
R-squared = 11.0%
s = 0.6682 with 142 − 2 = 140 df

Variable	Coefficient	SE(Coeff)
Intercept	2.7288	0.1148
Meals/wk	0.1093	0.0263

a) Is there evidence of an association? Test an appropriate hypothesis and state your conclusion.

b) Do you think this association would be useful in predicting a student's grade point average? Explain.

c) Are your answers to parts a and b contradictory? Explain.

44. Learning math Developers of a new math curriculum called "Accelerated Math" compared performances of students taught by their system with control groups of students in the same schools who were taught using traditional instructional methods and materials. Statistics about pretest and posttest scores are shown in the table. (Source: J. Ysseldyke and S. Tardrew, *Differentiating Math Instruction*, Renaissance Learning)

a) Did the groups differ in average math score at the start of this study?

b) Did the group taught using the Accelerated Math program show a significant improvement in test scores?

c) Did the control group show a significant improvement in test scores?

d) Were gains significantly higher for the Accelerated Math group than for the control group?

		Instructional Method	
	Number of Students	Acc. Math 231	Control 245
Pretest	Mean	560.01	549.65
	St. Dev	84.29	74.68
Posttest	Mean	637.55	588.76
	St. Dev	82.9	83.24
Individual Gain	Mean	77.53	39.11
	St. Dev.	78.01	66.25

45. Juvenile offenders According to a 2011 article in the *Journal of Consulting and Clinical Psychology*, Charles Borduin pioneered a treatment called Multisystemic Therapy (MST) as a way to prevent serious mental health problems in adolescents. The therapy involves a total support network including family and community, rather than the more common individual therapy (e.g., visits to a therapist). After a 22-year-long study, one notable fact was that while 15.5% of juveniles who received individual therapy were arrested for a violent felony, only 4.3% of the juveniles treated with MST had done so.

a) Suppose the results are based on sample sizes of 125 juveniles in each group. Create a 99% confidence interval for the reduction in violent felony rate when comparing MST to the traditional individual therapy.

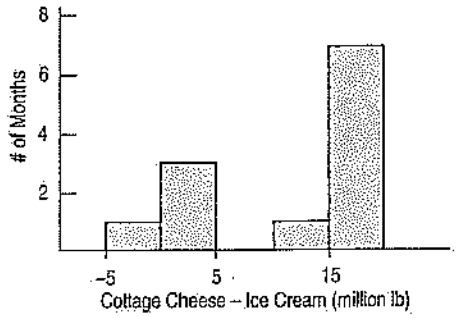
b) Using your interval, is there evidence of a true reduction for the whole population? Which population is the study investigating?

46. Dairy sales Peninsula Creameries sells both cottage cheese and ice cream. The CEO recently noticed that in months when the company sells more cottage cheese, it seems to sell more ice cream as well. Two of his aides were assigned to test whether this is true or not. The first aide's plot and analysis of sales data for the past 12 months (in millions of pounds for cottage cheese and for ice cream) appear below.

Dependent variable is Ice cream
R-squared = 36.9%
s = 8.320 with 12 − 2 = 10 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	−26.5306	37.68	−0.704	0.4975
Cottage C...	1.19334	0.4936	2.42	0.0362

The other aide looked at the differences in sales of ice cream and cottage cheese for each month and created the following output:



Cottage Cheese − Ice Cream

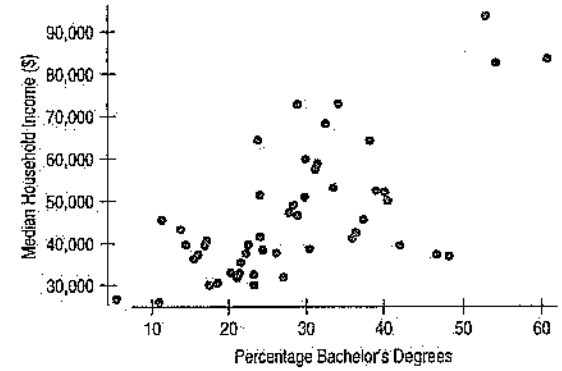
Count	12
Mean	11.8000
Median	15.3500
StdDev	7.99386
IntQRange	14.3000
25th %tile	3.20000
75th %tile	17.5000

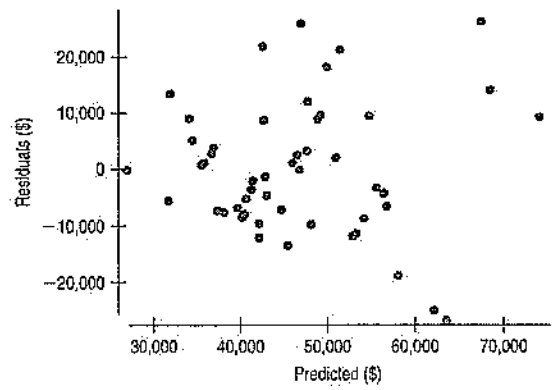
Test H_0: $\mu(CC - IC) = 0$ vs H_a: $\mu(CC - IC) \neq 0$
Sample Mean = 11.800000 t-Statistic = 5.113 w/11 df
Prob = 0.0003
Lower 95% bound = 6.7209429
Upper 95% bound = 16.879057

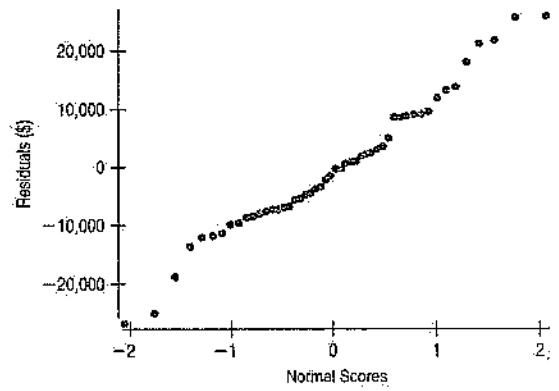
a) Which analysis would you use to answer the CEO's question? Why?
b) What would you tell the CEO?
c) Which analysis would you use to test whether the company sells more cottage cheese or ice cream in a typical year? Why?
d) What would you tell the CEO about this other result?
e) What assumptions are you making in the analysis you chose in part a? What assumptions are you making in the analysis in part c?
f) Next month's cottage cheese sales are 82 million pounds. Ice cream sales are not yet available. How much ice cream do you predict Peninsula Creameries will sell?
g) Give a 95% confidence interval for the true slope of the regression equation of ice cream sales by cottage cheese sales.
h) Explain what your interval means.

47. Infliximab In an article appearing in the journal *The Lancet*, medical researchers reported on the experimental use of the arthritis drug infliximab in treating Crohn's disease. In a trial, 573 patients were given initial 5-mg injections of the drug. Two weeks later, 335 had responded positively. These patients were then randomly assigned to three groups. Group I received continued injections of a placebo, Group II continued with 5 mg of infliximab, and Group III received 10 mg of the drug. After 30 weeks, 23 of 110 Group I patients were in remission, compared with 44 of 113 Group II and 50 of 112 Group III patients. Do these data indicate that continued treatment with infliximab is of value for Crohn's disease patients who exhibit a positive initial response to the drug?

48. Education vs. income 2009 The information below examines the median income and education level (percent of population with at least a Bachelor's degree) for several large U.S. cities in 2009.







Summary Statistics:

Column	n	Mean	Std. Dev.
Median Household Income	50	46521.22	15455.175
Percentage Bachelor's Degrees	50	28.402	11.756

Dependent variable is Median Household Income
R-squared = 42.1%
s = 11,881.87 with 50 − 2 = 48 degrees of freedom

Variable	Coefficient	SE(Coeff)	t-Ratio	P-Value
Intercept	22294.24	4431.67	5.03	<0.0001
Percentage Bachelor's Degrees	853.00	144.38	5.91	<0.0001

a) Do you think the assumptions for inference are met? Explain.
b) Does there appear to be an association between education and income levels in these cities?
c) Would this association appear to be weaker, stronger, or the same if data were plotted for individual people rather than for cities in aggregate? Explain.
d) Create and interpret a 95% confidence interval for the slope of the true line that describes the association between income and education.
e) Predict the median household income for cities where an average of 25% of residents have at least a Bachelor's degree. Describe your estimate with a 90% confidence interval, and interpret that result.

49. Diet Thirteen overweight women volunteered for a study to determine whether eating specially prepared crackers before a meal could help them lose weight. The subjects were randomly assigned to eat crackers with different types of fiber (bran fiber, gum fiber, both, and a control cracker). Unfortunately, some of the women developed uncomfortable bloating and upset stomachs. Researchers suspected that some of the crackers might be at fault. The contingency table of "Cracker" versus "Bloat" shows the relationship between the four different types of crackers and the reported bloating. The study was paid for by the manufacturers of the gum fiber. What would you recommend to them about the prospects for marketing their new diet cracker?

		Bloat	
		Little/None	Moderate/Severe
Cracker	Bran	11	2
	Gum	4	9
	Combo	7	6
	Control	8	4

50. Cramming Students in two basic Spanish classes were required to learn 50 new vocabulary words. One group of 45 students received the list on Monday and studied the words all week. Statistics summarizing this group's scores on Friday's quiz are given. The other group of 25 students did not get the vocabulary list until Thursday. They also took the quiz on Friday, after "cramming" Thursday night. Then, when they returned to class the following Monday, they were retested—without advance warning. Both sets of test scores for these students are shown.

Group 1
Fri.
Number of students = 45
Mean = 43.2 (of 50)
StDev = 3.4
Students passing (score ≥ 40) = 33%

Group 2

Fri.	Mon.	Fri.	Mon.
42	36	50	47
44	44	34	34
45	46	38	31
48	38	43	40
44	40	39	41
43	38	46	32
41	37	37	36
35	31	40	31
43	32	41	32
48	37	48	39
43	41	37	31
45	32	36	41
47	44		

a) Did the week-long study group have a mean score significantly higher than that of the overnight crammers?
b) Was there a significant difference in the percentages of students who passed the quiz on Friday?
c) Is there any evidence that when students cram for a test, their "learning" does not last for 3 days?
d) Use a 95% confidence interval to estimate the mean number of words that might be forgotten by crammers.
e) Is there any evidence that how much students forget depends on how much they "learned" to begin with?

51. Hearing Fitting someone for a hearing aid requires assessing the patient's hearing ability. In one method of assessment, the patient listens to a tape of 50 English words. The tape is played at low volume, and the patient is asked to repeat the words. The patient's hearing ability score is the number of words perceived correctly. Four tapes of equivalent difficulty are available so that each ear can be tested with more than one hearing aid. These lists were created to be equally difficult to perceive in silence, but hearing aids must work in the presence of background noise. Researchers had 24 subjects with normal hearing

compare two of the tapes when a background noise was present, with the order of the tapes randomized. Is it reasonable to assume that the two lists are still equivalent for purposes of the hearing test when there is background noise? Base your decision on a confidence interval for the mean difference in the number of words people might misunderstand. (Source: Faith Loven, *A Study of the Interlist Equivalency of the CID W-22 Word List Presented in Quiet and in Noise*. University of Iowa [1981])

Subject	List A	List B
1	24	26
2	32	24
3	20	22
4	14	18
5	32	24
6	22	30
7	20	22
8	26	28
9	26	30
10	38	16
11	30	18
12	16	34
13	36	32
14	32	34
15	38	32
16	14	18
17	26	20
18	14	20
19	38	40
20	20	26
21	14	14
22	18	14
23	22	30
24	34	42

52. Newspapers Who reads the newspaper more, men or women? Eurostat, an agency of the European Union (EU), conducts surveys on several aspects of daily life in EU countries. Recently, the agency asked samples of 1000 respondents in each of 14 European countries whether they read the newspaper on a daily basis. Below are the data by country and gender.

	% Reading a Newspaper Daily	
Country	Men	Women
Belgium	56.3	45.5
Denmark	76.8	70.3
Germany	79.9	76.8
Greece	22.5	17.2
Spain	46.2	24.8
Ireland	58.0	54.0
Italy	50.2	29.8
Luxembourg	71.0	67.0
Netherlands	71.3	63.0
Austria	78.2	74.1
Portugal	58.3	24.1
Finland	93.0	90.0
Sweden	89.0	88.0
U.K.	32.6	30.4

a) Examine the differences in the percentages for each country. Which of these countries seem to be outliers? What do they have in common?

b) After eliminating the outliers, is there evidence that in Europe men are more likely than women to read the newspaper?