21. Meat Processing. Compute a 95% calibration interval (using the graphical approach) for the time at which pH of steer carcasses should be 7.

22. Meat Processing (Sample Size Determination). The standard error of the estimated slope based on the 10 data points is 0.0344. Using the formula for SE in Section 7.3.4, and supposing that the spread of the X's and the estimate of σ will be about the same in a future study, calculate how large the sample size would have to be in order for the SE of the estimated slope to be 0.01.

23. Old Faithful. Old Faithful Geyser in Yellowstone National Park, Wyoming, derives its name and its considerable fame from the regularity (and beauty) of its eruptions. As they do with most geysers in the park, rangers post the predicted times of eruptions on signs nearby, and people gather beforehand to witness the show. R. A. Hutchinson, a park geologist, collected measurements of the eruption durations (X, in minutes) and the subsequent intervals before the next eruption (Y, in minutes) over an 8-day period. These data appear in Display 7.14. (Data from S. Weisberg, *Applied Linear*

Display 7.14 Durations (X, in minutes) of Old Faithful eruptions and intervals (Y, in minutes) until subsequent eruption, from August 1 to August 8, 1978

Date	X	Y	Date	X	Y	Date	X	Y	Date	X	Y
1	4.4	78	2	4.3	80	3	4.5	76	4	4.0	75
1	3.9	74	2	1.7	56	3	3.9	82	4	3.7	73
1	4.0	68	2	3.9	80	3	4.3	84	4	3.7	67
1	4.0	76	2	3.7	69	3	2.3	53	4	4.3	68
1	3.5	80	2	3.1	57	3	3.8	86	4	3.6	86
1	4.1	84	2	4.0	90	3	1.9	51	4	3.8	72
1	2.3	50	2	1.8	42	3	4.6	85	4	3.8	75
1	4.7	93	2	4.1	91	3	1.8	45	4	3.8	75
1	1.7	55	2	1.8	51	3	4.7	88	4	2.5	66
1	4.9	76	2	3.2	79	3	1.8	51	4	4.5	84
1	1.7	58	2	1.9	53	3	4.6	80	4	4.1	70
1	4.6	74	2	4.6	82	3	1.9	49	4	3.7	79
1	3.4	75	2	2.0	51	3	3.5	82	4	3.8	60
									4	3.4	86

Date	X	Y	Date	X	Y	Date	X	Y	Date	X	Y
5	4.0	71	6	1.8	55	7	3.5	81	8	4.2	77
5	2.3	67	6	4.6	75	7	2.0	53	8	4.4	73
5	4.4	81	6	3.5	73	7	4.3	89	8	4.1	70
5	4.1	76	6	4.0	70	7	1.8	44	8	4.1	88
5	4.3	83	6	3.7	83	7	4.1	78	8	4.0	75
5	3.3	76	6	1.7	50	7	1.8	61	8	4.1	83
5	2.0	55	6	4.6	95	7	4.7	73	8	2.7	61
5	4.3	73	6	1.7	51	7	4.2	75	8	4.6	78
5	2.9	56	6	4.0	82	7	3.9	73	8	1.9	61
5	4.6	83	6	1.8	54	7	4.3	76	8	4.5	81
5	1.9	57	6	4.4	83	7	1.8	55	8	2.0	51
5	3.6	71	6	1.9	51	7	4.5	86	8	4.8	80
5	3.7	72	6	4.6	80	7	2.0	48	8	4.1	79
5	3.7	77	6	2.9	78						

Regression, New York: John Wiley, 1985, p. 231.) Use them to obtain a method for predicting the interval between eruptions from the duration of the previous one. If possible with your statistical computer program, construct a 95% prediction band on a scatterplot of duration versus interval. Or construct 95% prediction intervals at each of several values for durations between 2 and 5 minutes.

24. Crab Claw Size and Force. As part of a study of the effects of predatory intertidal crab species on snail populations, researchers measured the mean closing forces and the propodus heights of the claws on several crabs of three species. Their data (read from their Figure 7) appear in Display 7.15. (Data from S. B. Yamada and E. G. Boulding, "Shell-breaking Efficiency of Predatory Crabs Influences the Distribution of an Intertidal Snail," Technical Report, Zoology Department, Oregon State University 1992.)

Display 7.15 Closing strengths and propodus heights in three predatory crab species

Hemigrapsus nudus ($n = 14$)		Lophopanopeus bellus ($n = 12$)		Cancer productus ($n = 12$)	
Force	Height	Force	Height	Force	Height
3.2	5.0	2.1	5.1	5.0	6.7
6.4	6.0	8.7	5.9	7.8	7.1
2.0	6.4	2.9	6.6	14.6	11.2
2.0	6.5	6.9	7.2	16.8	11.4
4.9	6.6	8.7	8.6	17.7	9.4
3.0	7.0	15.1	7.9	19.8	10.7
2.9	7.9	14.6	8.1	19.6	13.1
9.5	7.9	17.6	9.6	22.5	9.4
4.0	8.0	20.6	10.2	23.6	11.6
3.4	8.2	19.6	10.5	24.4	10.2
7.4	8.3	27.4	8.2	26.0	12.5
2.4	8.8	29.4	11.0	29.4	11.8
4.0	12.1				
5.2	12.2				

(a) Estimate the slope in the simple linear regression of log force on log height, separately for each crab species. Obtain the standard errors of the estimated slopes.

(b) Use a t-test to compare the slopes for *C. productus* and *L. bellus*. Then compare the slopes for *C. productus* and *H. nudus*. The standard error for the difference in two slope estimates from independent samples is the following:

$$\mathrm{SE}[\hat{\beta}_{1(1)} - \hat{\beta}_{1(2)}] = \sqrt{[\mathrm{SE}(\hat{\beta}_{1(1)})]^2 + [\mathrm{SE}(\hat{\beta}_{1(2)})]^2},$$

where $\hat{\beta}_{1(j)}$ represents the estimate of slope from sample j. Use t-tests with the sum of the degrees of freedom associated with the two standard errors. What do you conclude? (*Note*: A better way to perform this test, using multiple regression, is described in Chapter 9.)

a summary of statistical findings, a graphical display, and a section detailing the methods used to answer the questions of interest.

Display 8.21 Wine consumption (liters per person per year) and heart disease mortality rates (deaths per 1,000) in 18 countries

Country	Wine consumption	Heart disease mortality
Norway	2.8	6.2
Scotland	3.2	9.0
England	3.2	7.1
Ireland	3.4	6.8
Finland	4.3	10.2
Canada	4.9	7.8
United States	5.1	9.3
Netherlands	5.2	5.9
New Zealand	5.9	8.9
Denmark	5.9	5.5
Sweden	6.6	7.1
Australia	8.3	9.1
Belgium	12.6	5.1
Germany	15.1	4.7
Austria	25.1	4.7
Switzerland	33.1	3.1
Italy	75.9	3.2
France	75.9	2.1

24. **Respiratory Rates for Children.** A high respiratory rate is a potential diagnostic indicator of respiratory infection in children. To judge whether a respiratory rate is truly "high," however, a physician must have a clear picture of the distribution of *normal* respiratory rates. To this end, Italian researchers measured the respiratory rates of 618 children between the ages of 15 days and 3 years. Display 8.22 shows a few rows of the data set. Analyze the data and provide a statistical summary. Include a useful plot or chart that a physician could use to assess a normal range of respiratory rate for children of any age between 0 and 3. (Data read from a graph in Rusconi *et al.*, "Reference values for respiratory rate in the first 3 years of life," *Pediatrics*, 94 (1994): 350–55.)

Display 8.22 Sketch of data on ages (months) and respiratory rates (breaths per minute) for 618 children

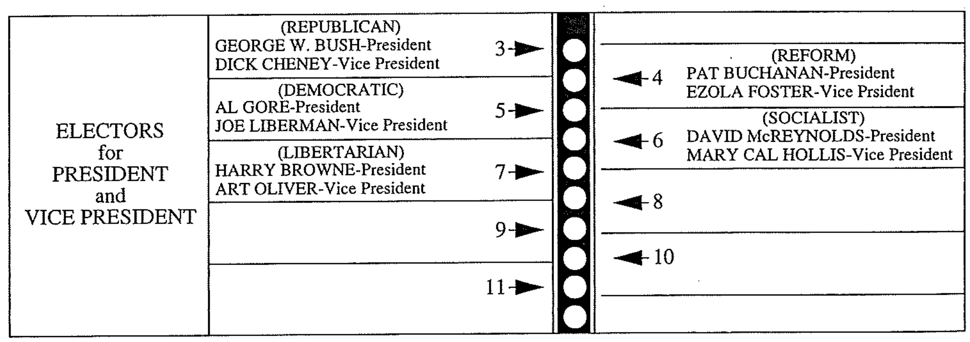
Child	1	2	3	4	5	6	...	618
Age:	.1	.2	.3	.3	.3	.4	...	36.0
Rate:	53	38	58	52	42	62	...	31

25. **The Dramatic U.S. Presidential Election of 2000.** The U.S. presidential election of November 7, 2000 was one of the closest in history. As returns were counted on election night it became clear that

the outcome in the state of Florida would determine the next president. At one point in the evening, television networks projected that the state was carried by the Democratic nominee, Al Gore, but a retraction of the projection followed a few hours later. Then, early in the morning of November 8, the networks projected that the Republican nominee, George W. Bush, had carried Florida and won the presidency. Gore called Bush to concede. While on route to his concession speech, though, the Florida count changed rapidly in his favor. The networks once again reversed their projection, and Gore called Bush to retract his concession. When the roughly 6 million Florida votes had been counted, Bush was shown to be leading by only 1,738, and the narrow margin triggered an automatic recount. The recount, completed in the evening of November 9, showed Bush's lead to be less than 400.

Meanwhile, angry Democratic voters in Palm Beach County complained that a confusing "butterfly" lay-out ballot caused them to accidentally vote for the Reform Party candidate Pat Buchanan instead of Gore. The ballot, as illustrated in Display 8.23, listed presidential candidates on both a left-hand and a right-hand page. Voters were to register their vote by punching the circle corresponding to their choice, from the column of circles between the pages. It was suspected that since Bush's name was listed first on the left-hand page, Bush voters likely selected the first circle. Since Gore's name was listed second on the left-hand side, many voters—who already knew who they wished to vote for—did not bother examining the right-hand side and consequently selected the second circle in the column; the one actually corresponding to Buchanan. Two pieces of evidence supported this claim: Buchanan had an unusually high percentage of the vote in that county, and an unusually large number of ballots (19,000) were discarded because voters had marked two circles (possibly by inadvertently voting for Buchanan and then trying to correct the mistake by then voting for Gore).

Display 8.23 Confusing ballot in Palm Beach County, Florida



Display 8.24 shows the first few rows of a data set containing the numbers of votes for Buchanan and Bush in all 67 counties in Florida. What evidence is there in the scatterplot of Display 8.25 that Buchanan received more votes than expected in Palm Beach County? Analyze the data without Palm Beach County results to obtain an equation for predicting Buchanan votes from Bush votes. Obtain a 95% prediction interval for the number of Buchanan votes in Palm Beach from this result—assuming the relationship is the same in this county as in the others. If it is assumed that Buchanan's actual count contains a number of votes intended for Gore, what can be said about the likely size of this number from the prediction interval? (Consider transformation.)