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Chapter 2: Picturing Variation with Graphs

Section 2.1: Visualizing Variation in Numerical Data and Section 2.2: Summarizing Important Features of a Numerical Distribution

2.1 a. 11 are morbidly obese.

b. $\frac{11}{134} = 0.082$, or about 8%, which is much more than 3%.

2.2 a. 21 have levels above 240.

b. $\frac{21}{93} = 0.226$, or about 23%. That is a bit more than the 18% mentioned.

2.3 New vertical axis labels: $\frac{1}{25} = 0.04$, $\frac{2}{25} = 0.08$, $\frac{3}{25} = 0.12$, $\frac{4}{25} = 0.16$, $\frac{5}{25} = 0.20$, $\frac{6}{25} = 0.24$, $\frac{7}{25} = 0.28$.

2.4 a. $0.04 + 0.13 = 0.17$ and $0.17(24) = 4.08$, or about 4

b. The two modes are 7 and 8.

2.5 a. 1 (or 2) have no TVs

b. 9 TVs

c. Between 25 and 30

d. Around 6

e. $\frac{6}{90} = \frac{1}{15}$, or 0.0667

2.6 a. 18 or 19 hours

b. 8

c. About 5 or 6

d. $\frac{5}{50} = \frac{1}{10}$ or $\frac{6}{50} = \frac{3}{25}$ (or about 0.10 or 0.12)

2.7 a. Both dotplots are right-skewed. The dotplot for the females is also multimodal.

b. The females tend to have more pairs of shoes.

c. The numbers of pairs for the females are more spread out. The males' responses tend to be clustered at about 10 pairs or fewer.

2.8 a. Detroit

b. Seattle

c. Left-skewed

2.9 There will be a lot of people who have no tickets and maybe a few with 1, 2, 3, or more, so the distribution will be right-skewed.

2.10 This should be left-skewed with a lot of people reporting 7 and a few reporting various values less than 7.

2.11 It would be bimodal because men and women tend to have different heights and therefore different armspans.

2.12 It might be bimodal because private colleges and public colleges tend to differ in amount of tuition.

2.13 About 58 years (between 56 and 60)

2.14 The typical number of sleep hours is around 7 or 7.5 hours.

2.15 Riding the bus shows a larger typical value and also more variation.

2.16 a. Both graphs are bimodal with modes at about 100 and 200 dollars per month.

b. The women tend to spend a bit more.

c. The data for the women have more variation.

2.17 a. The distribution is multimodal with modes at 12 years (high school), 14 years (junior college), 16 years (bachelor's degree), and 18 years (possible master's degree). It is also left-skewed with numbers as low as 0.

b. Estimate: 300 + 50 + 100 + 40 + 50, or about 500 to 600, had 16 or more years.

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2.17 (continued)

c. Between $\frac{500}{2018}$, or about 25%, and $\frac{600}{2018}$, or about 30%, have a bachelor's degree or higher. This is very similar to the 27% given.

2.18 a. The distribution is right-skewed.

b. About 2 or 3

c. Between 80 and 100

d. $\frac{80}{2000} = 4\%$ or $\frac{100}{2000} = 5\%$

2.19 Both graphs go from about 0 to about 20 years of education, but the data for years of formal education for the respondents (compared to their mothers) include more with education above 12 years. For example, the bar at 16 (college bachelor's degree) is higher for the respondents than for the mothers, which shows that the respondents tend to have a bit more education than their mothers. Also, the bar at 12 is taller for the mothers, showing that the mothers were more likely to get only a high school diploma. Furthermore, the bar graph for the mothers includes more people (taller bars) at lower numbers of years, such as 0 and 3 and 6.

2.20 For men the data go from about 0 to about 90, and for women the data go from about 0 to about 80. There are more men who worked more than 40 hours. For example, the bars at 45, 50, 55, and 60 are taller for the men, showing that more men than women worked those numbers of hours.

2.21 1. Most psychology students would be younger, with a few older students: This is histogram C.
2. The number of psychology students should roughly the same for each year: This is histogram B.
3. Most students would eat breakfast every day: This is histogram A.

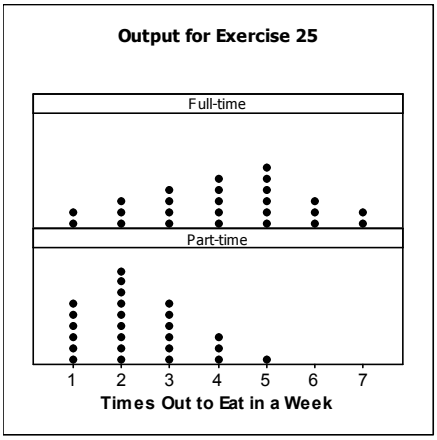
2.22 1. Most students would do well on an easy test: This is histogram A.
2. The number of hours of television watched would be left-skewed, with fewer people watching many hours of television: This is histogram B.
3. The heights of adults would be unimodal and roughly symmetrical: This is histogram C.

2.23 1. The heights of students would be bimodal and roughly symmetrical: This is histogram B.
2. The number of hours of sleep would be unimodal and roughly symmetrical, with any outliers more likely being fewer hours of sleep: This is histogram A.
3. The number of accidents would be left skewed, with most student being involved in no or a few accidents: This is histogram C.

2.24 1. The SAT scores would be unimodal and roughly symmetrical: This is histogram C.
2. The weights of men and women would be bimodal and roughly symmetrical, but with more variation that SAT scores: This is histogram A.
3. The ages of students would be left skewed, with most student being younger: This is histogram B.

2.25 The answers follow the steps given in the Guided Exercises.

1: See the dotplots. Histograms would also be good for visualizing the distributions. Stemplots would not work with these data sets because all the observed values have only one digit.
2: Full-time is a bit left-skewed, and part-time is a bit right-skewed.
3: Those with full-time jobs tend to go out to eat more than those with part-time jobs.
4: The full-time workers have a distribution that is more spread out; full-time goes from 1 to 7, whereas part-time goes only from 1 to 5.
5: There are no outliers—that is, no dots detached from the main group with an empty space between.



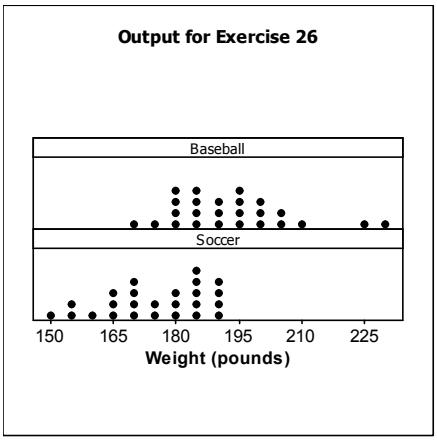
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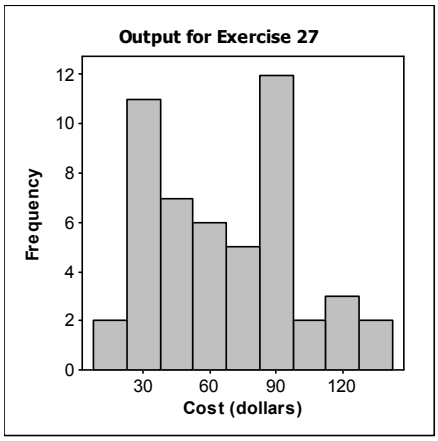
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2.25 (continued)

6. For the full-time workers the distribution is a little left-skewed, and for the part-time workers it is a little right-skewed. The full-time workers tend to go out to eat more, and their distribution is more spread out.

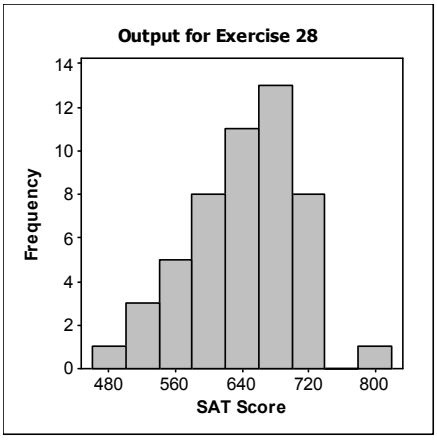
2.26 The figure shows dotplots of both groups. Histograms or stemplots would also be appropriate. The baseball players' weights are right-skewed with outliers at about 225 pounds or more. The soccer players' distribution of weights is left-skewed with no outliers. The baseball players tend to weigh more, and that data set is also more spread out. Both graphs appear bimodal with this grouping.

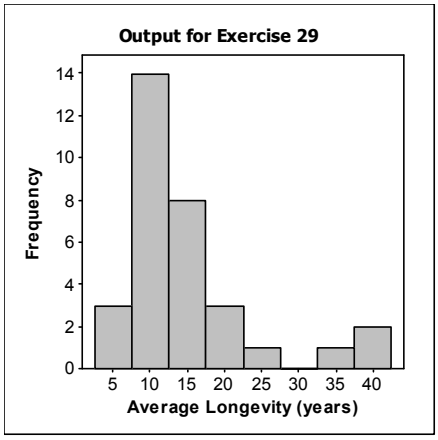




2.27 See histogram. The shape will depend on the binning used. The histogram is bimodal with modes at about \$30 and about \$90.

2.28 See histogram. The shape will depend on the binning used. The 800 score could be an outlier or not, and the graph could appear left-skewed or not.



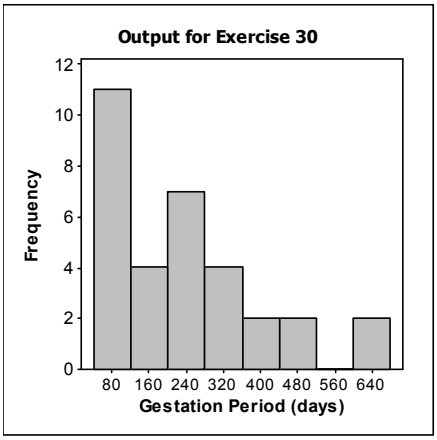


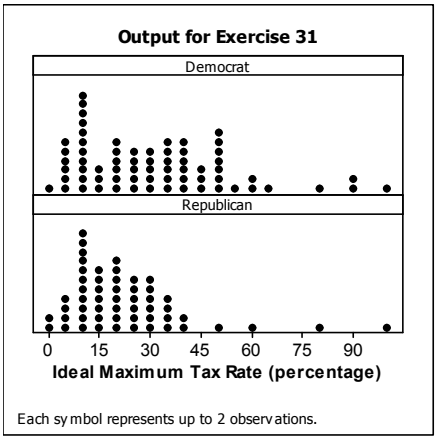
2.29 See histogram. The histogram is right-skewed. The typical value is around 12 (between 10 and 15) years, and there are three outliers: Asian elephant (40 years), African elephant (35 years), and hippo (41 years). Humans (75 years) would be way off to the right; they live much longer than other mammals.

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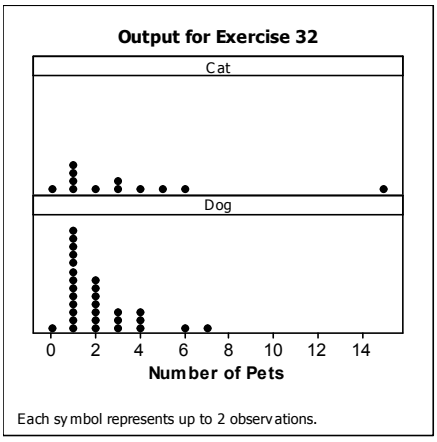
2.30 The histogram is right-skewed and also bimodal (at least with this grouping). The modes are at about 80 days and 240 days. The typical value is about 240 days (between 160 and 320 days). There are two outliers at more than 600 days, the Asian elephant and the African elephant. Humans (266 days) would be near the middle of the graph.

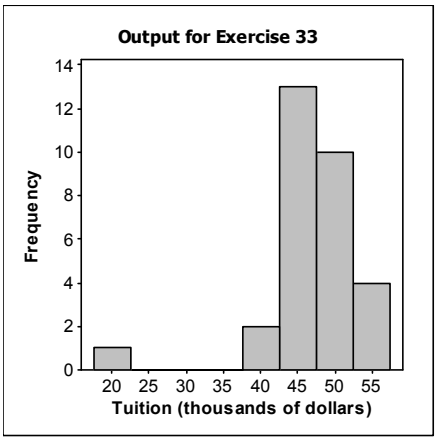




2.31 Both graphs are multimodal and right-skewed. The Democrats have a higher typical value, as shown by the fact that the center is roughly around 35 or 40%, while the center value for the Republicans is closer to 20 to 30%. Also note the much larger proportion of Democrats who think the rate should be 50% or higher. The distribution for the Democrats appears more spread out because the Democrats have more people responding with both lower and higher percentages.

2.32 Both distributions are right-skewed. A large outlier did represent a cat lover, but typically, cat lovers and dog lovers both seem to have about 2 pets, although there are a whole lot of dog lovers with one dog.



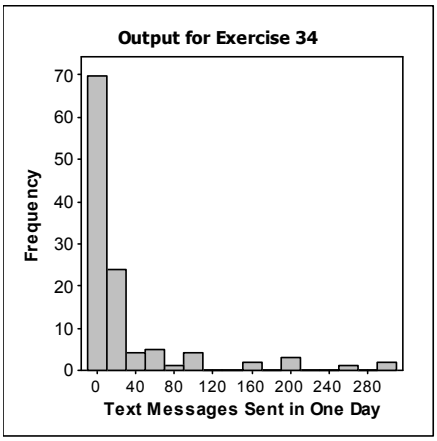


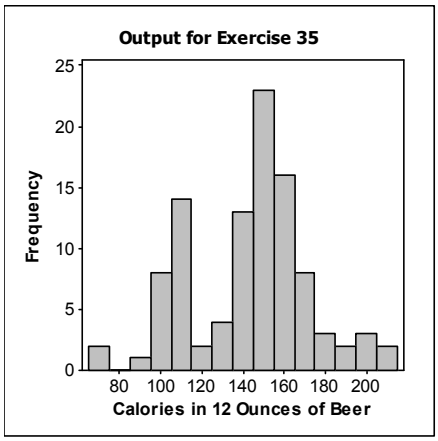
2.33 The distribution appears left-skewed because of the low-end outlier at about $20,000 (Brigham Young University).

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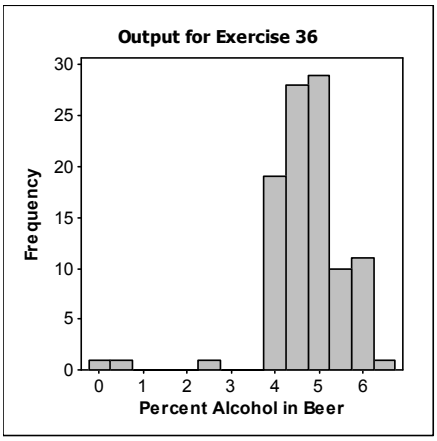
2.34 The histogram is strongly right-skewed, with outliers.





2.35 With this grouping the distribution appears bimodal with modes at about 110 and 150 calories. (With fewer—that is, wider—bins, it may not appear bimodal.) There is a low-end outlier at about 70 calories. There is a bit of left skew.

2.36 The distribution is left-skewed primarily because of the outliers at about 0% alcohol.



Section 2.3: Visualizing Variation in Categorical Variables and Section 2.4: Summarizing Categorical Distributions

2.37 No, the largest category is Wrong to Right, which suggests that changes tend to make the answers more likely to be right.

2.38 a. About 7.5 million
b. About 5 million
c. No, overweight and obesity do not result in the highest rate. That is from high blood pressure.
d. This is a Pareto chart.

2.39 a. 80 to 82%
b. Truth, since almost all observations are in the Top Fifth category.
c. Ideal, since these are almost uniformly spread across the five groups.
d. They underestimate the proportion of wealth held by the top 20%.

2.40 a. Oxnard tends to have more highly educated residents. Note that the bars for Oxnard are taller than the bars for Nyeland Acres for all the categories that show at least one year of college. Also note that the bars for Nyeland Acres are taller for the category with the least education.
b. Nyeland Acres has the least variation, because a substantially greater percentage of residents are in a single category (Less than HS). Oxnard also has residents in more categories, which suggests that it is more variable.

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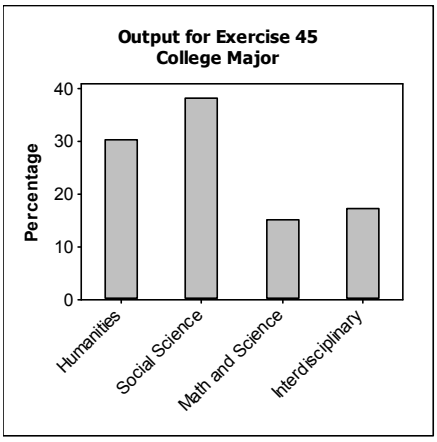
2.41 a. Dem (not strong)
b. Other. It is easier to pick out the second tallest bar in the bar chart. (Answers may vary.)

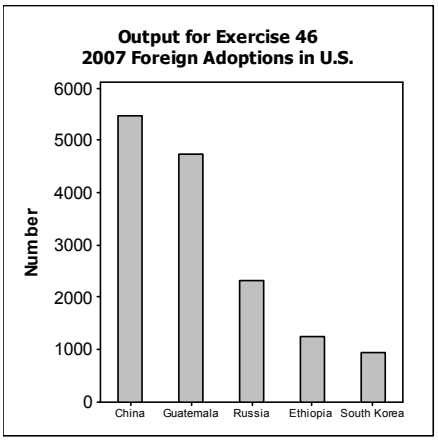
2.42 a. Dem (not strong)
b. Other. It is easier to pick out the second tallest bar in the bar chart.
c. There is no evidence of that. The percentage of men who are Democrats may even be larger than the percentage for women.

2.43 a. The percentage of old people is increasing, the percentage of those 25–64 is decreasing, and the percentage of those 24 and below is relatively constant.
b. The money for Social Security normally comes from those in a working age range (which includes those 25–64), and that group is decreasing in percentage. Also, the group receiving Social Security (those 65 and older) is becoming larger. This suggests that in the future, Social Security might not get enough money from the workers to support the old people.

2.44 a. Midsize
b. The percentage for small cars is going up, at least from 2000 to 2007.
c. The percentage for large cars went down between 1985 and 2000 but went part of the way back up in 2007.

2.45 A Pareto chart or pie chart would also be appropriate. Note that the mode is Social Science and that there is substantial variation. (Of course, individual majors such as chemistry were grouped into Math and Science.)





2.46 This is a Pareto chart, but a bar chart or pie chart would also be appropriate. The mode is China, but there is substantial variation.

Section 2.5: Interpreting Graphs

2.47 This is a histogram, which we can see because the bars touch. The software treated the values of the variable *Garage* as numbers. However, we wish them to be seen as categories. A bar graph or pie chart would be better for displaying the distribution.

2.48 The graph is a histogram (the bars touch), and histograms are used for numerical data. But this data set is categorical, and the numbers (1, 2, and 3) represent categories. A more appropriate graph would be a bar graph or pie graph.

2.49 Hours of sleep is a numerical variable. A histogram or dotplot would better enable us to see the distribution of values. Because there are so many possible numerical values, this pie chart has so many "slices" that it is difficult to tell which is which.

2.50 a. This is a bar chart (or bar graph), as you can see by the separation between bars.
b. These numerical data would be better shown as a pair of histograms (with a common horizontal axis) or a pair of dotplots. Bar graphs are for categorical data.

2.51 Those who still play tended to have practiced more as teenagers, which we can see because the center of the distribution for those who still play is about 2 or 2.5 hours, compared to only about 1 or 1.5 hours for those who do not. The distribution could be displayed as a pair of histograms or a pair of dotplots.

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2.52 a. *Gender* is categorical and *Hours on Cell Phone* is also categorical.
b. Because in this data set both variables are categorical, the bar chart is appropriate.
c. You could make two histograms (or two dotplots) for the data because the time would be numerical. It would be ideal to use a common horizontal axis for easy comparison of the two graphs.
d. The distributions show that the women tend to talk more. (The mode for women is 4–8 hours, and the mode for the men is 0–4 hours.)

Chapter Review Exercises

2.53 Histograms would be appropriate: One for the males and one for the females would be appropriate. Dotplots or stemplots would also work for this numerical data set.

2.54 Bar graphs would allow comparison of men and women in one graph. If you chose pie charts, you would need two.

2.55 a. The diseases with higher rates for HRT were heart disease, stroke, pulmonary embolism, and breast cancer. The diseases with lower rates for HRT were endometrial cancer, colorectal cancer, and hip fracture.
b. Comparing the rates makes more sense than comparing just the numbers, in case there were more women in one group than in the other.

2.56 a. South Korea and the United States have the highest rate of access to the Internet.
b. China and Thailand have the highest percentage of music purchased over the Internet.

2.57 The vertical axis does not start at zero and exaggerates the differences. Make a graph for which the vertical axis starts at zero.

2.58 In histograms the bars should generally touch, and these don't touch. Also, we cannot see the top of the range because "More" is a poor label. Change the numbers on the horizontal axis and increase the width of the bins so as to make the bars touch.

2.59 The shapes are roughly bell-shaped and symmetric; the later period is warmer, but the spread is similar. This is consistent with theories on global warming. The difference is 57.9 – 56.7 = 1.2, so the difference is only a bit more than 1 degree Fahrenheit.

2.60 The typical percentage of students with jobs at the top schools is higher than the percentage for the bottom 91 schools. In other words, you are more likely to find a job if you went to a law school in the top half of the rankings. Both histograms are left-skewed. Also, the range for the bottom schools is wider, because it goes down to lower employment rates.

2.61 a. The graph shows that a greater percentage of people survived when lying prone (on their stomachs) than when lying supine (on their backs). This suggests that we should recommend that doctors ask these patients to lie prone.
b. Both variables (*Position* and *Outcome*) are categorical, so a bar chart is appropriate.

2.62 In 2012, more people thought global warming was happening than thought so in 2010.

2.63 The created 10-point dotplot will vary, but the dotplot for this exercise should be right-skewed.

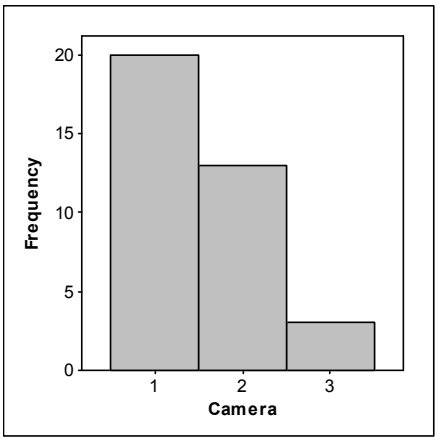
2.64 The created 10-point dotplot will vary, but the dotplot for this exercise should be not be skewed.

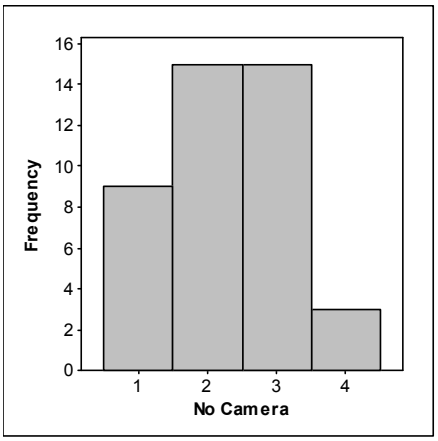
2.65 Graphs will vary. Histograms and dotplots are both appropriate. For the group without a camera the distribution is roughly symmetrical, and for the group with a camera it is right-skewed. Both are unimodal. The number of cars going through a yellow light tends to be less at intersections with cameras. Also, there is more variation in the intersections without cameras.

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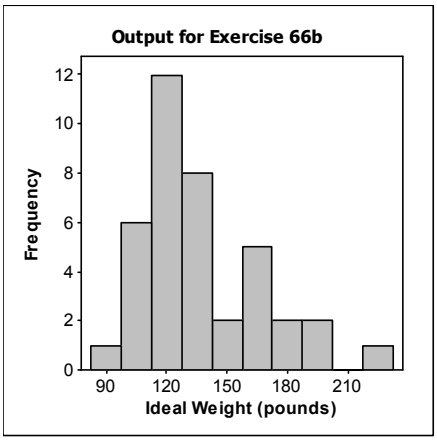
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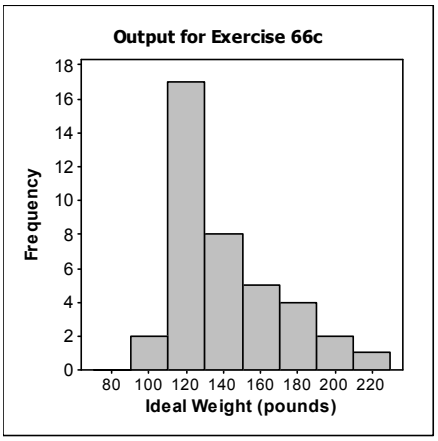




2.66 a. You might expect bimodality because men tend to have ideal weights that are larger than women's ideal weights.

b. and c.





Graphs may vary, depending on technology and the choice of bins for the second histogram. On the two graphs given here, the bin width for the first is 15 pounds and for the second is 20 pounds. The first distribution is bimodal and the second is not.

2.67 Both distributions are right-skewed. The typical speed for the men (a little above 100 mph) is a bit higher than the typical speed for the women (which appears to be closer to 90 mph). The spread for the men is larger primarily because of the outlier of 200 mph for the men.

2.68 Both graphs are relatively symmetric and unimodal. The center for the men is larger than the center for the women, showing that men tend to wear larger shoes than women. The spread is a bit more for women because their sizes range from about 5 to about 10 whereas the men's sizes range from about 8 to about 12. There are no outliers in either group.

2.69 The distribution should be right-skewed.

2.70 Since most of the physician's patients probably do not smoke and a few may be heavy smokers, the distribution should be right-skewed with lots of zeros and a few high numbers.

2.71 a. The tallest bar is Wrong to Right, which suggests that the instruction was correct.

b. For both instructors, the largest group is Wrong to Right, so it appears that changes made tend to raise the grades of the students.

2.72 a. The raw numbers would be affected by how many were in each group, and that might hide the rate. For example, because there are many more old women than old men, that information would hide the rates.

b. The males up to about 64 have a higher rate of visits to the ER. From 65 to 74 the rates are about the same, and for 75 and up the rates are higher for the women.

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