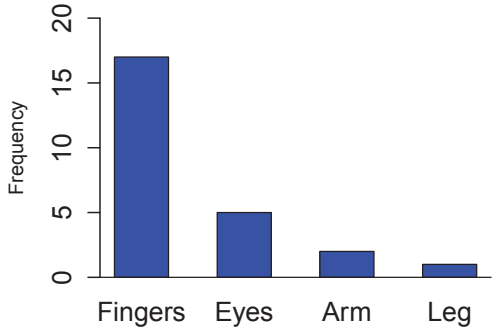
# *Miller and Freunds Probability and Statistics for Engineers 9th edition Johnson Solutions Manual*

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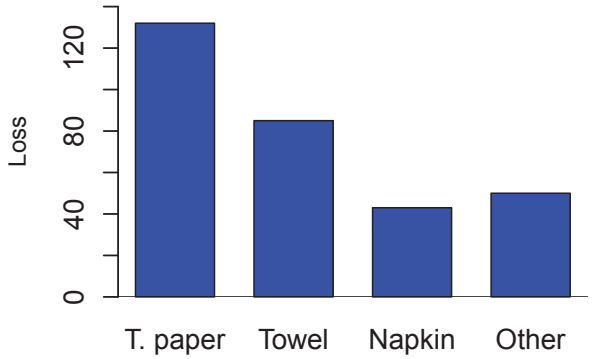
# Chapter 2

# ORGANIZATION AND DESCRIPTION OF DATA

2.1 Pareto chart of the accident data




2.2 a) Pareto chart of damage due to breakage (in thousands of dollars) is





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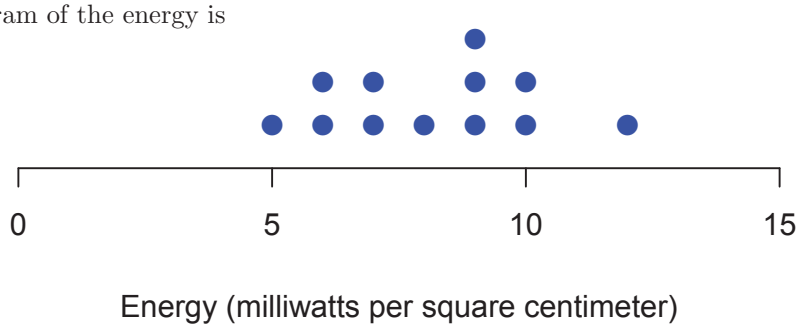
b) Percent of the loss that occurs in making toilet paper is

$$100 \cdot \frac{132}{132 + 85 + 43 + 50} = 100 \cdot \frac{132}{310} = 42.58\%.$$

c) Percent of the loss that occurs in making toilet paper or hand towels is

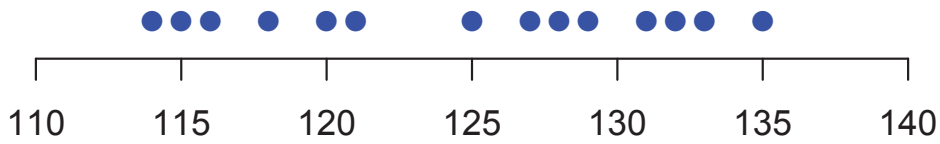
$$100 \cdot \frac{132 + 85}{310} = 100 \cdot \frac{217}{310} = 70\%.$$

2.3 The dot diagram of the energy is



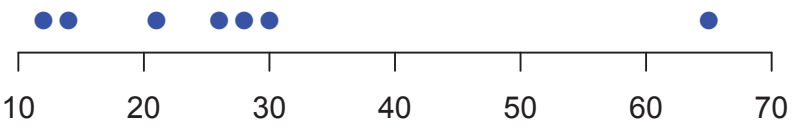

Energy (milliwatts per square centimeter)

2.4 The dot diagram of the paper strength data is




strength (pounds)

2.5 The dot diagram of the suspended solids data reveals that one reading, 65 ppm, is very large. Other readings taken at about the same time, but not given here, confirm that the water quality was bad at that time. That is, 65 is a reliable number for that day.

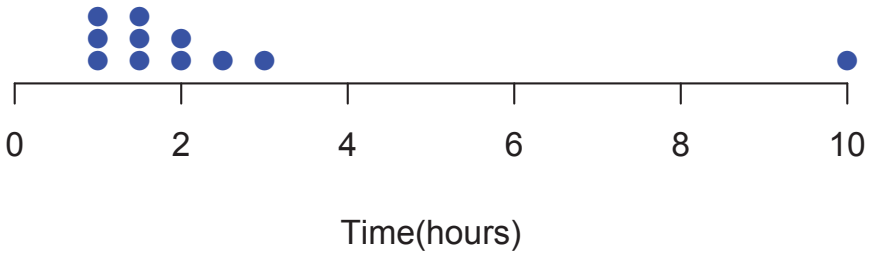



Suspended solids (ppm)

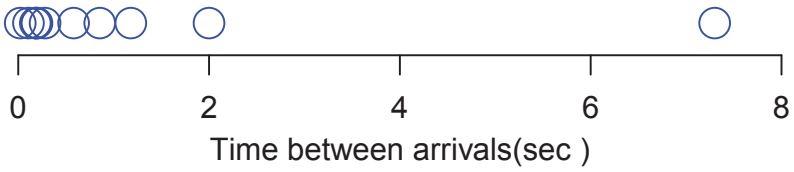
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2.6 The dot diagram of the times for the power outages shows one large value, 10.0 hours.




2.7 (a)




(b) The one extremely large gap between 2.0 and 7.3 seconds is an outlier. This could be due to neutrinos that were missed or the possibility that two explosions occurred.

2.8 (a) The class marks are 150.0, 170.0, 190.0, 210.0, 230.0 and 250.0.

(b) The class interval is 20.

2.9 (a) Yes. This is the number of observations in the class [140.0, 160.0).

(b) No. It is not possible to determine how many specimens have breaking strength 160.

(c) Yes. This is the total number of observations in the two classes [220.0, 240.0) and [240.0, 260.0).

(d) No. It is not possible to determine how many of the specimens have strength 240.

(e) No. It is not possible to determine how many of the specimens have strength 260.

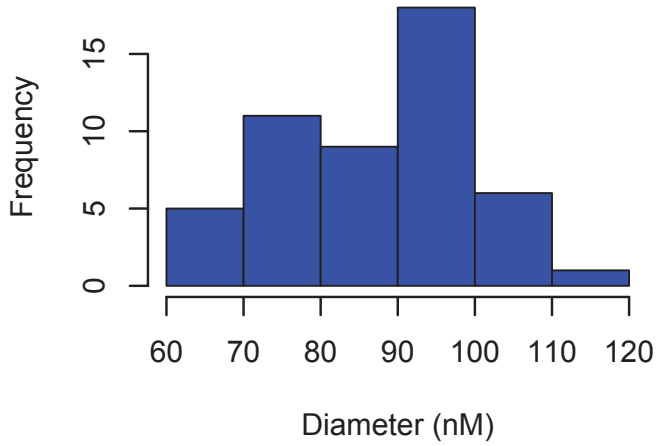
2.10 The frequency distribution is given in the table where the right-hand end point is included.

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| Class | Frequency |
|---|---|
| (60, 70] | 5 |
| (70, 80] | 11 |
| (80, 90] | 9 |
| (90, 100] | 18 |
| (100, 110] | 6 |
| (110, 120] | 1 |

The histogram is

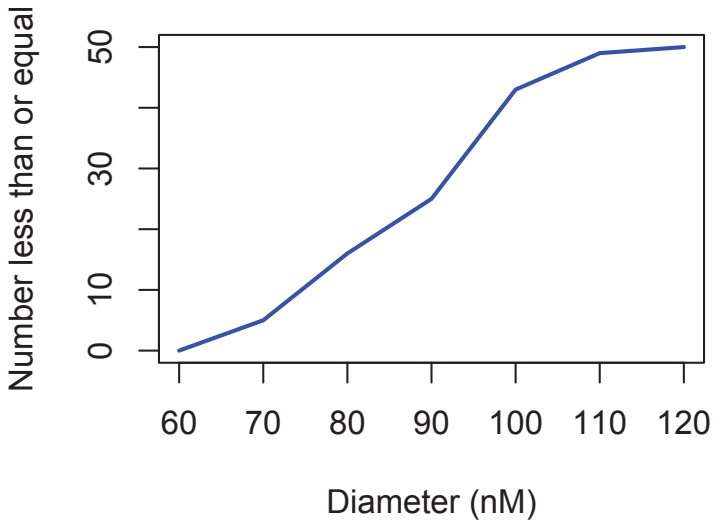



2.11 We first convert the data in the preceding exercise to a "less than or equal" distribution. The ogive is plotted below.

| x | No. less than or equal |
|---|---|
| 60.0 | 0 |
| 70.0 | 5 |
| 80.0 | 16 |
| 90.0 | 25 |
| 100.0 | 43 |
| 110.0 | 49 |
| 120.0 | 50 |

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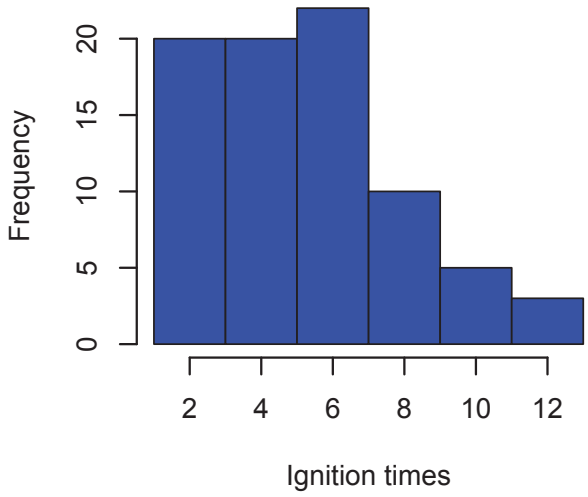
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2.12 These data can be grouped into the following frequency distribution where the right hand endpoint is excluded:

| Class limits | Frequency | Class limits | Frequency |
|---|---|---|---|
| [1.0, 2.0) | 10 | [7.0, 8.0) | 6 |
| [2.0, 3.0) | 10 | [8.0, 9.0) | 4 |
| [3.0, 4.0) | 9 | [9.0, 10.0) | 4 |
| [4.0, 5.0) | 11 | [10.0, 11.0) | 1 |
| [5.0, 6.0) | 12 | [11.0, 12.0) | 2 |
| [6.0, 7.0) | 10 | [12.0, 13.0) | 1 |

The histogram is



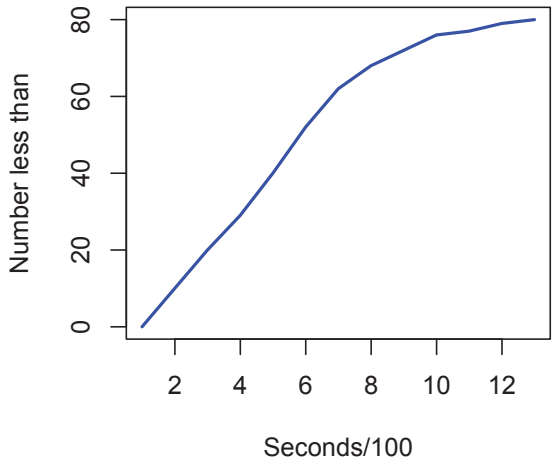

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2.13 We first convert the data in the preceding exercise to a "less than" distribution.

| x | No. less than | x | No. less than |
|---|---|---|---|
| 1.0 | 0 | 8.0 | 68 |
| 2.0 | 10 | 9.0 | 72 |
| 3.0 | 20 | 10.0 | 76 |
| 4.0 | 29 | 11.0 | 77 |
| 5.0 | 40 | 12.0 | 79 |
| 6.0 | 52 | 13.0 | 80 |
| 7.0 | 62 | | |

The ogive is



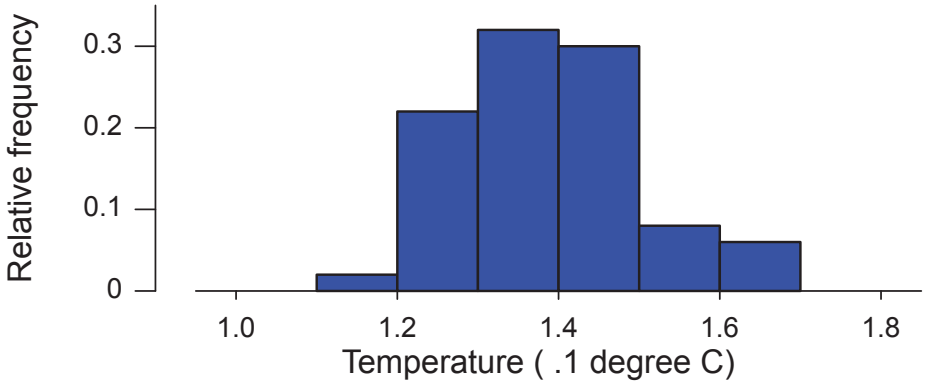

2.14 After ordering the data we obtain the frequency distribution.

| **Temperature (°C)** | **Frequency** |
|---|---|
| [1.10, 1.20) | 1 |
| [1.20, 1.30) | 11 |
| [1.30, 1.40) | 16 |
| [1.40, 1.50) | 15 |
| [1.50, 1.60) | 4 |
| [1.60, 1.70) | 3 |
| Total | 50 |

The relative frequency histogram is

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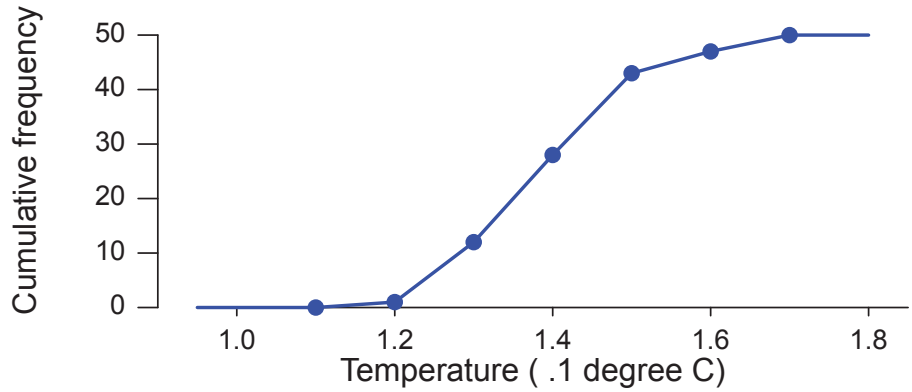
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2.15 The cumulative frequencies for less than the upper limit of the interval are

| Temperature (°C) | Cumulative Frequency |
|---|---|
| [1.10, 1.20) | 1 |
| [1.20, 1.30) | 12 |
| [1.30, 1.40) | 28 |
| [1.40, 1.50) | 43 |
| [1.50, 1.60) | 47 |
| [1.60, 1.70) | 50 |
| Total | 50 |

and the ogive is



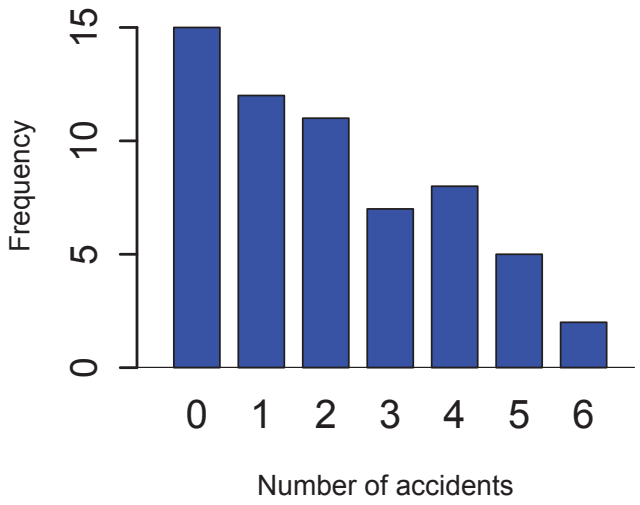

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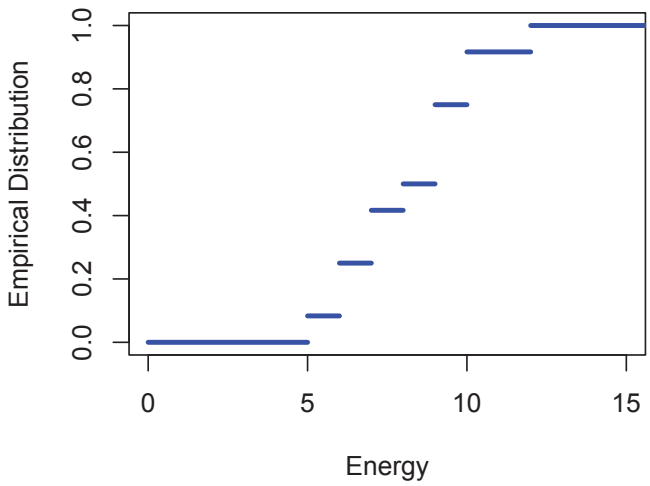
2.16 The frequency table is:

| Number of accidents | Frequency | Number of accidents | Frequency |
|---|---|---|---|
| 0 | 15 | 4 | 8 |
| 1 | 12 | 5 | 5 |
| 2 | 11 | 6 | 2 |
| 3 | 7 | | |

The bar chart is



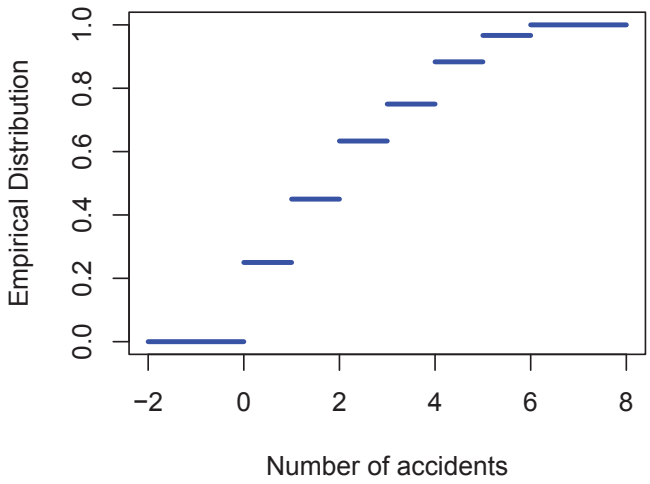

2.17 The empirical cumulative distribution function is




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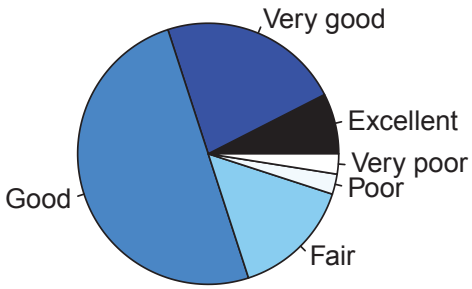
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2.18 The empirical cumulative distribution is:




2.19 No. We tend to compare areas visually. The area of the large sack is far more than double the area of the small sack. The large sack should be modified so that its area is slightly less than double that of the small sack.

2.20 The pie chart is

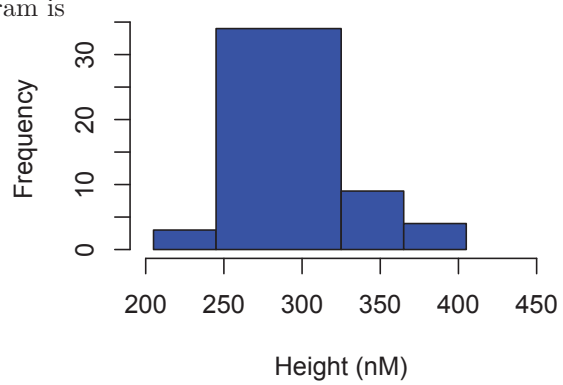



2.21 We first note that the classes are not of equal length. If the distribution of the data were uniform over a single interval covering all of the data, one would expect that longer classes would have higher counts. To correct for this, the area of each rectangle should be proportional to the proportion of observations in the class. Of course, when the class lengths are equal, plotting the height equal to the class frequency results in rectangles with area proportional to the corresponding class proportions.

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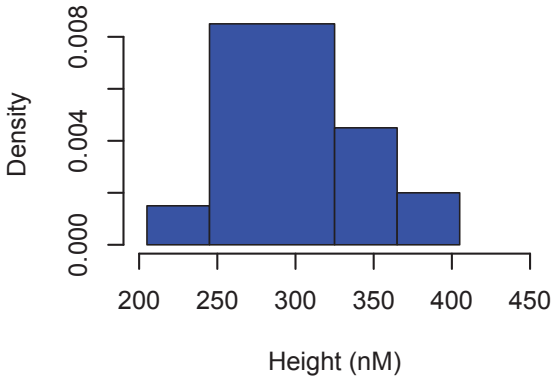
The incorrect histogram is




The correct histogram uses height = (relative frequency)/ width. The height of the first rectangle is

$$(\text{relative frequency})/\text{width} = (3/50)/40 = 0.0015.$$

This correct histogram is




2.22 The stem and leaf display is:

| | |
|---|---|
| 19* | 8 |
| 20* | 0 2 3 3 5 7 8 8 |
| 21* | 2 4 7 |
| 22* | 0 5 6 |
| 23* | |
| 24* | 3 |

2.23 The stem and leaf display is:

| | |
|---|---|
| 1** | |
| 2** | 67, 88, 95 |
| 3** | 17, 55, 70, 83, 91 |
| 4** | 05, 19, 34, 62 |
| 5** | 08, 40 |
| 6** | 12 |

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2.24 (a) The data are: 11, 12, 13, 14, 15, 17, 18.

(b) The data are: 230, 230, 231, 234, 236.

(c) The data are: 203, 218, 235, 257.

(d) The data are: 3.21, 3.23, 3.24, 3.24, 3.27.

2.25 The stem-and-leaf display is: Leaf Unit = 0.010

| | |
|---|---|
| 1.1 | 1 |
| 1.1 | |
| 1.2 | 1 1 1 3 4 |
| 1.2 | 5 5 7 7 8 9 |
| 1.3 | 1 1 1 2 4 4 |
| 1.3 | 5 6 6 6 6 6 6 6 7 9 |
| 1.4 | 0 1 2 2 2 2 3 3 3 4 4 4 |
| 1.4 | 7 8 8 |
| 1.5 | 0 0 |
| 1.5 | 6 6 |
| 1.6 | 0 0 |
| 1.6 | 8 |

2.26 (a) The stem-and-leaf display is:

| | |
|---|---|
| 10* | |
| 10t | |
| 10f | 4 |
| 10s | 6 6 6 7 |
| 10· | 8 8 8 9 9 9 |
| 11* | 0 0 1 1 |
| 11t | 2 2 |
| 11f | 5 |
| 11s | |
| 11· | |
| 12* | |
| 12t | |
| 12f | 5 |
| 12s | |
| 12· | 8 |

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(b) The data are:

534, 534, 534, 534, 535, 535, 536, 536, 536, 537, 538, 539, 541.

2.27 (a) Would like a high salary-outlier that is large.

(b) Would like a high score-outlier that is large.

(c) Near average.

2.28 (a) Would like finish early-outlier that is small.

(b) Near average.

2.29 Greater on the mean. It would not influence the median for sample size 3 or more.

2.30 Greater on the Range. It would influence the value of the range but not the interquartile range if the sample size is at least 5.

2.31 (a) $\overline{x} = (-6 + 1 - 4 - 3)/4 = -3$

(b)

$$s^2 = \frac{(-6-(-3))^2 \ + \ (1-(-3))^2 \ + \ (-4-(-3))^2 \ + \ (-3-(-3))^2}{4-1}$$

$$= (9 + 16 + 1 + 0)/3 = 8.667 \quad \text{so} \quad s = \sqrt{8.667} = 2.94.$$

(c) The mean of the observation minus specification is $-3$ so, on average, the observations are below the specification. On average, the holes are too small.

2.32 (a)

$$\overline{x} = \frac{366 \ + \ 381 \ + \ 442 \ + \ 452 \ + \ 484 \ + \ 492 \ + \ 508 \ + \ 601 \ + \ 828}{9}$$

$$= \frac{4554}{9} = 506 \quad \text{m}$$

(b)

$$\overline{x} = \frac{366 \ + \ 381 \ + \ 442 \ + \ 452 \ + \ 484 \ + \ 492 \ + \ 508 \ + \ 601}{8}$$

$$= \frac{3726}{8} = 465.75 \quad \text{m}$$

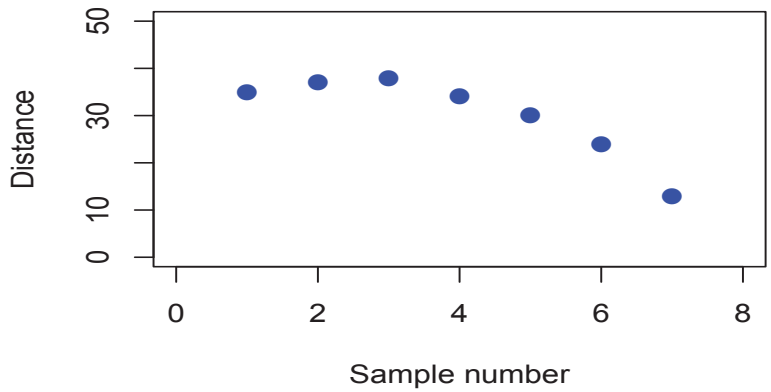
(c) The average drops by over 40 meters, about 8 %, when the one very tall building is excluded.

2.33 (a) $\overline{x} = (35 + 37 + 38 + 34 + 30 + 24 + 13)/7 = 211/7 = 30.14$ mm/min.

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(b) The mean does not provide a good summary. The most important feature is the drop in performance as illustrated in time order plot of distance versus sample number. It is likely the tip of the leg became covered with debris again. The early trials indicate what can be expected if this problem can be avoided.




2.34 (a) A computer calculation gives

```
N       MEAN    STDEV
29    1.4707   0.5235
```

You may verify the mean by first showing that $\sum x_i = 4265$.

(b) You may confirm the calculation of $s$ by showing that $\sum x_i^2 = 2041.54$ so

$$s^2 = \frac{29(2041.54) - (4265)^2}{29 \cdot 28} = .2740 \quad \text{or} \quad s = \sqrt{.2740} = .5235$$

2.35 No. The sum of the salaries must be equal to 3 ( 175,000) = 525,000 which is less than 550,000. This assumes that all salaries are non-negative. It is certainly possible if negative salaries are allowed.

2.36 The mean is indeed 85. But, we comment that $s = 15$ indicating considerable variation in average monthly temperature. The median is 86, also a comfortable temperature.

2.37 (a) The mean agreement is:

$$\frac{0.50 + 0.40 + 0.04 + 0.45 + 0.65 + 0.40 + 0.20 + 0.30 + 0.60 + 0.45}{10} = \frac{3.99}{10} = 0.399$$

(b)

$$s^2 = \frac{n\sum x_i^2 - (\sum x_i)^2}{n(n-1)} = \frac{10(1.8891) - (3.99)^2}{10 \times 9} = 0.0330$$

Consequently, $s = \sqrt{0.0330} = 0.1817$.

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2.38 (a) The following table gives the observations, the deviations, the squared deviations, and the sum of the squared deviations.

| Obs. | Deviation | Squared deviation | Obs. | Deviation | Squared deviation |
|---|---|---|---|---|---|
| .50 | .101 | .010201 | .40 | .001 | .000001 |
| .40 | .001 | .000001 | .20 | −.199 | .039601 |
| .04 | −.359 | .128881 | .30 | −.099 | .009801 |
| .45 | .051 | .002601 | .60 | .201 | .040401 |
| .65 | .251 | .063001 | .45 | .051 | .002601 |

Sum of Squared Deviations = .29709

Sample Variance $s^2 = .29709/9 = .03301$ and $s = .1817$.

(b) The squared observations are:

.2500 .1600 .0016 .2025 .4225 .1600 .0400 0900 .3600 .2025

The sum of these squares is 1.8891. Thus,

$$s^2 = \frac{\sum x_i^2 - (\sum x_i)^2/n}{n-1} = \frac{1.8891 - (3.99)^2/10}{9} = .03301$$

Thus, $s = .1817$

2.39 (a) The mean offensive smell is

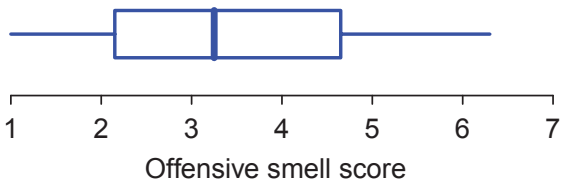
$$\overline{x} = \frac{\sum_{i=1}^{16} x_i}{16} = \frac{53.6}{16} = 3.35$$

(b) The ordered offensive smell scores are

```
1.0  1.0  1.7  1.9  2.4  2.6  2.7  3.2
3.3  3.8  3.9  4.3  5.0  5.2  5.3  6.3
```

The median = (3.2 + 3.3)/2 = 3.25.

(c) Since $16 \times (1/4) = 4$ is an integer, $Q_1 = (1.9 + 2.4)/2 = 2.15$ and $Q_3 = (4.3 + 5.0)/2 = 4.65$. The boxplot is




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2.40 (a) The table of data, deviation, and deviation squared is:

| | | | | |
|---|---|---|---|---|
| Data | −6 | 1 | −4 | −3 |
| Dev. | −3 | 4 | −1 | 0 |
| Sq. | 9 | 16 | 1 | 0 |

The sum of the squared deviations is 26. Thus,

$$s^2 = 26/3 = 8.667 \quad \text{and} \quad s = 2.94.$$

(b) The sum of the observations is 62. The sum of the observations squared is 144. Thus,

$$s^2 = (62 - 144/4)/3 = 8.667 \quad \text{and} \quad s = 2.94.$$

2.41 The mean is 30.91. The sorted data are:

29.6, 30.3, 30.4, 30.5, 30.7, 31.0, 31.2, 31.2, 32.0, 32.2

Since the number of observations is 10 (an even number), the median is the average of the 5th and 6th observations or $(30.7 + 31.0)/2 = 30.85$. The first quartile is the third observation, 30.4, and the third quartile is the eighth observation, 31.2.

2.42 The table of data, deviation, and deviation squared is:

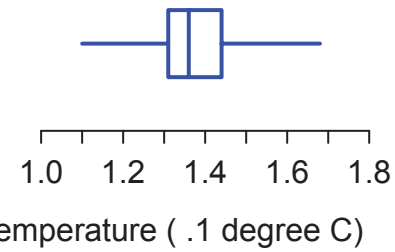
| | | | | |
|---|---|---|---|---|
| Data | 9 | 7 | 15 | 5 |
| Deviation | 0 | −2 | 6 | −4 |
| Squares | 0 | 4 | 36 | 16 |

(a) The deviations $(x_i - \bar{x})$ add to $0 + (-2) + 6 + (-4) = 0$.

(b) $\sum(x_i - \bar{x})^2 = 56$. Thus, $s^2 = 56/3 = 18.66$ and $s = 4.32$.

2.43 The boxplot is based on the five-number summary of the $n = 50$ temperatures.

| minimum | $Q_1$ | Median | $Q_3$ | maximum |
|---|---|---|---|---|
| 1.11 | 1.31 | 1.36 | 1.44 | 1.68 |




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2.44 (a) $\overline{x} = (.290 + .104 + .207 + .145 + .105 + .124)/6 = .974/6 = .1623$

(b) We first calculate $.290^2 + .104^2 + .207^2 + .145^2 + .105^2 + .124^2 = .18498$ and then

$$s^2 = \frac{n\sum x_i^2 - (\sum x_i)^2}{n(n-1)} = \frac{6(.18498) - (.974)^2}{6 \cdot 5} = .005373$$

Consequently, $s = \sqrt{.005373} = 0.0733$.

2.45 (a) For the non-leakers $\overline{x} = (.207 + .124 + .062 + .301 + .186 + .124)/6 = .16733$

(b) Also, $.207^2 + .124^2 + .062^2 + .301^2 + .186^2 + .124^2 = .20264$ so

$$s^2 = \frac{6(.20264) - (1.004)^2}{6 \cdot 5} = .006928 \qquad \text{so} \qquad s = \sqrt{.006928} = .0832$$

(c) The means are quite close to each other and so are the standard deviations. The size of gap does not seem to be connected to the existence of leaks.

2.46 (a) $\sum x_i = 605$. Thus, $\bar{x} = 605/20 = 30.25$, and $\sum x_i^2 = 20,663$. Hence, $s^2 = (20 \cdot 21723 - 615^2)/(20 \cdot 19) = 124.303$. And $s = 11.15$.

(b) The class limits, marks, and frequencies are in the following table:

| Class limits | Class mark | Frequency |
|---|---|---|
| 10 - 19 | 14.5 | 3 |
| 20 - 29 | 24.5 | 8 |
| 30 - 39 | 34.5 | 5 |
| 40 - 49 | 44.5 | 3 |
| 50 - 59 | 54.5 | 1 |

Thus,

$\bar{x} = (3(14.5) + 8(24.5) + 5(34.5) + 3(44.5) + 54.5)/20 = 30.$

$\sum x_i f_i = 600$. $\sum x_i^2 f_i = 20,295$. Thus ,

$s^2 = (20 \cdot 20,295 - 600^2)/(20 \cdot 19) = 120.79$. So, $s = 10.99$.

2.47 The class marks and frequencies are:

| Class mark | Frequency |
|---|---|
| 65.0 | 5 |
| 75.0 | 11 |
| 85.0 | 9 |
| 95.0 | 18 |
| 105.0 | 6 |
| 115.0 | 1 |

Thus, $\sum x_i f_i = 4370$, $\sum x_i^2 f_i = 389,850$. The mean is $4370/50 = 87.40$, and $s^2 = (389,850 - 4370^2/50)/(49) = 161.47$.

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2.48 We use the class limits [1, 2), [2, 3), ... where the right-hand endpoint is excluded. The class marks and frequencies are:

| Class mark | Frequency |
|---|---|
| 1.5 | 10 |
| 2.5 | 10 |
| 3.5 | 9 |
| 4.5 | 11 |
| 5.5 | 12 |
| 6.5 | 10 |
| 7.5 | 6 |
| 8.5 | 4 |
| 9.5 | 4 |
| 10.5 | 1 |
| 11.5 | 2 |
| 12.5 | 1 |

Thus, $\sum x_i f_i = 415.0$, $\sum x_i^2 f_i = 2,722.0$. Therefore, the mean is $415.0/80 = 5.188$ and $s^2 = (80 \cdot 2,722.0 - 415.0^2)/(80 \cdot 79) = 7.2049$. The standard deviation is $s = 2.684$. The coefficient of variation is $v = 100\, s/\bar{x} = 51.0$ percent.

2.49 From Exercise 2.14 we have the intervals and frequencies. The last two columns give the calculations of the basic totals.

| **Interval** | $x_i$ | $f_i$ | $x_i\, f_i$ | $x_i^2\, f_i$ |
|---|---|---|---|---|
| [1.10, 1.20) | 1.15 | 1 | 1.15 | 1.3225 |
| [1.20, 1.30) | 1.25 | 11 | 13.75 | 17.1875 |
| [1.30, 1.40) | 1.35 | 16 | 21.60 | 29.1600 |
| [1.40, 1.50) | 1.45 | 15 | 21.75 | 31.5375 |
| [1.50, 1.60) | 1.55 | 4 | 6.20 | 9.6100 |
| [1.60, 1.70) | 1.65 | 3 | 4.95 | 8.1675 |
| | Total | 50 | 69.40 | 96.9850 |

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Substituting the totals into the appropriate formulas yields

$$\overline{x} = \frac{69.40}{50} = 1.388$$

and

$$s^2 = \frac{96.9850 - 69.40^2/50}{49} = 0.0134245 \quad \text{so} \quad s = 0.1159$$

The coefficient of variation is then

$$V = \frac{s}{\overline{x}} \times 100\% = \frac{0.1159}{1.388}\,100\% = 8.35\%$$

2.50

$$\sum_{i=1}^{n}(x_i - \bar{x}) = \sum_{i=1}^{n} x_i - \sum_{i=1}^{n} \bar{x} = \sum_{i=1}^{n} x_i - n\bar{x}.$$

But $\bar{x} = \sum_{i=1}^{n} x_i/n$, so,

$$\sum_{i=1}^{n}(x_i - \bar{x}) = \sum_{i=1}^{n} x_i - \sum_{i=1}^{n} x_i = 0.$$

2.51 The numerator

$$\sum_{i=1}^{n}(\,x_i - \bar{x}\,)^2 = \sum_{i=1}^{n}(\,x_i^2 - 2x_i\,\bar{x} + \bar{x}^2\,)$$

$$= \sum_{i=1}^{n} x_i^2 - 2\,\bar{x}\sum_{i=1}^{n} x_i + n\,\bar{x}^2$$

$$= \sum_{i=1}^{n} x_i^2 - 2\,(\sum_{i=1}^{n} x_i\,)^2/n + (\sum_{i=1}^{n} x_i)^2/n$$

$$= \sum_{i=1}^{n} x_i^2 - (\sum_{i=1}^{n} x_i\,)^2/n$$

2.52 Let $x_i = cu_i + a$. Then

$$\bar{x} = \sum_{i=1}^{n} x_i/n = \left(\sum_{i=1}^{n}(cu_i + a)\right)/n = c\sum_{i=1}^{n} u_i/n + na/n = c\bar{u} + a.$$

Now,

$$s_x^2 = \sum_{i=1}^{n}(x_i - \bar{x})^2/(n-1) = \sum_{i=1}^{n}(cu_i + a - c\bar{u} - a)^2/(n-1)$$

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$$= \sum_{i=1}^{n} (cu_i - c\bar{u})^2/(n-1) = c^2 \sum_{i=1}^{n} (u_i - \bar{u})^2/(n-1) = c^2 s_u^2.$$

Thus, $s_x = cs_u$.

2.53 (a) The median is the 50/2 th = the 25th largest observation. This occurs at the right-hand boundary so the median is 90. Applying the rule,

$$90 + \frac{0}{18} \times 10 = 90$$

(b) There are 80 observations. There are 40 observations in the first four classes, and 40 in the last four. Thus, the estimate for the median is the class boundary between the 4th and 5th class. We could use 5.0.

2.54 (a) We can estimate the mean and the median in this case since we know the class marks and frequencies for each class.

(b) We cannot estimate the mean in this case, since we do not know the class marks for the classes "less than 90" and "more than 119". We can estimate the median. It lies in the third class, and we proceed as before.

(c) Again, we cannot estimate the mean since we do not know the class mark for the class "110 or less". We also cannot estimate the median, as it also lies in the class "110 or less".

2.55 (a) There are 50 observations. $Q_1$ is in the second class and $Q_3$ is in the 4th class. The lower class boundary for the 2nd class is 245. There are 3 observations in the first class and 11 in the 2nd class. The class interval is 40. Thus, $Q_1$ is estimated by $40(50/4 - 3)/11 + 245 = 279.55$
Proceeding in a similar fashion gives $325 + 40(37.5 - 37)/9 = 327.22$ as the estimate of $Q_3$. Thus, the interquartile range is 47.67.

(b) There are 80 observations and $80/4 = 20$ which is on the boundary of the second and third classes so the estimate for $Q_1$ is 3.00 and for $Q_3$ it is $1((60 - 52)/10 + 6.00 = 6.80$.

2.56 (a) The average salary paid to the 30 executives is
$(4 \cdot 264{,}000 + 15 \cdot 272{,}000 + 11 \cdot 269{,}000)/(4 + 15 + 11) = 269{,}833.33$.

(b) The mean for the entire class is
$(22 \cdot 71 + 18 \cdot 78 + 10 \cdot 89)/(22 + 18 + 10) = 77.12$.

2.57 (a) The weighted average for the student is
$(69 + 75 + 56 + 72 + 4 \cdot 78)/8 = 73.0$.

(b) The combined percent increase for the average salaried worker is:
$(24 \cdot 60 + 33 \cdot 30 + 15 \cdot 40)/(24 + 33 + 15) = 42.08$ percent.

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2.58 Using MINITAB and the DESCRIBE command, we obtain $\overline{x}$ and $s$.

(a) For the decay times data

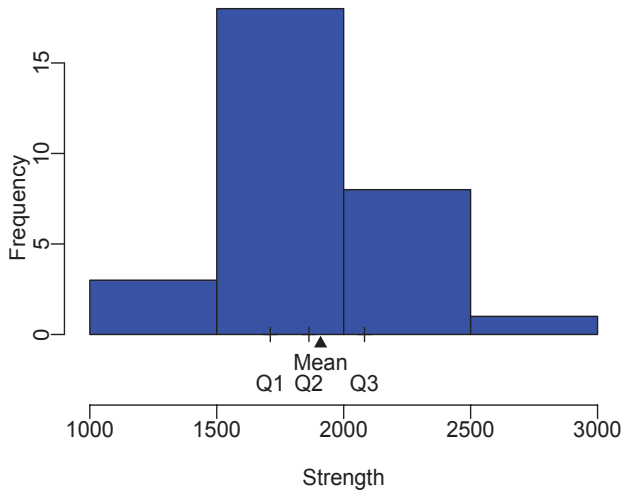
| | N | MEAN | MEDIAN | STDEV | MIN | MAX |
|---|---|---|---|---|---|---|
| C1 | 50 | 0.5495 | 0.2945 | 0.6242 | 0.0410 | 2.8630 |

(b) For the interrequest times

| | N | MEAN | MEDIAN | STDEV | MIN | MAX |
|---|---|---|---|---|---|---|
| C1 | 50 | 11795 | 6248 | 14056 | 995 | 78811 |

2.59 (a) From the ordered data, the first quartile $Q_1 = 1,712$, the median $Q_2 = 1,863$ and the third quartile $Q_3 = 2,061$.

(b) The histogram is




(c) For the aluminum data, we first sort the data.

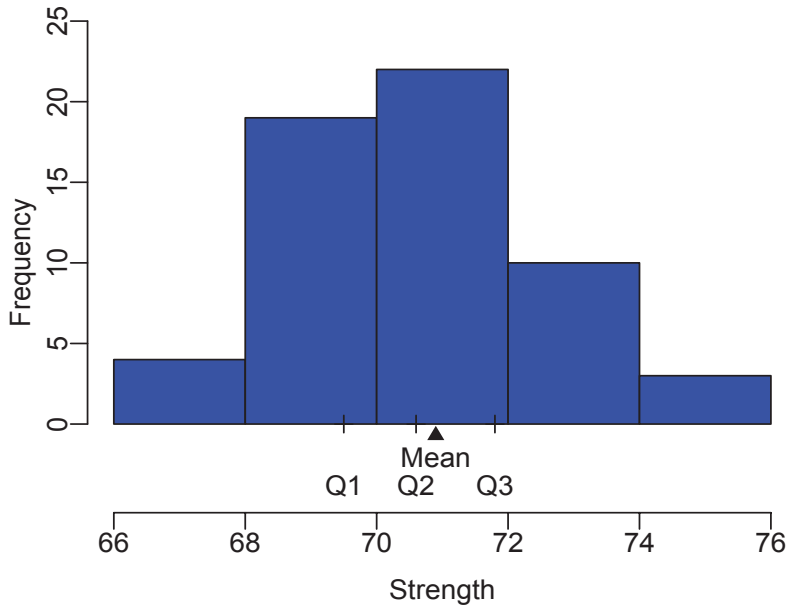
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 66.4 | 67.7 | 68.0 | 68.0 | 68.3 | 68.4 | 68.6 | 68.8 |
| 68.9 | 69.0 | 69.1 | 69.2 | 69.3 | 69.3 | 69.5 | 69.5 |

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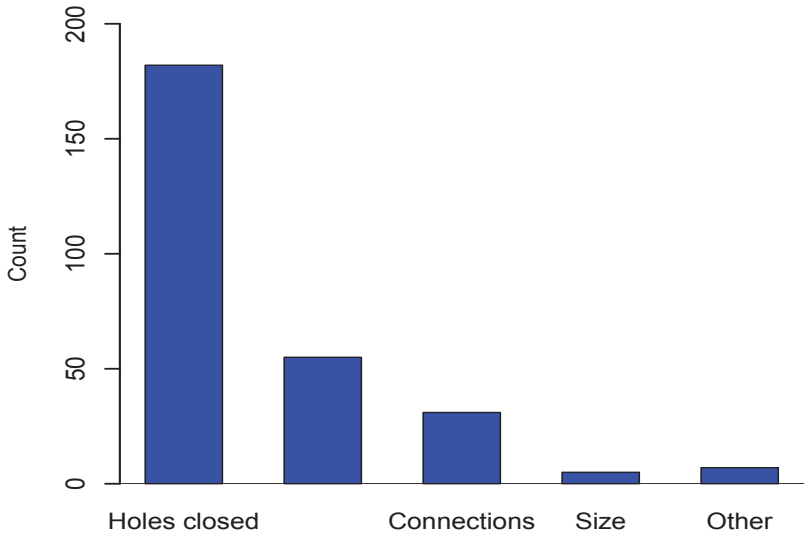
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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 69.6 | 69.7 | 69.8 | 69.8 | 69.9 | 70.0 | 70.0 | 70.1 |
| 70.2 | 70.3 | 70.3 | 70.4 | 70.5 | 70.6 | 70.6 | 70.8 |
| 70.9 | 71.0 | 71.1 | 71.2 | 71.3 | 71.3 | 71.5 | 71.6 |
| 71.6 | 71.7 | 71.8 | 71.8 | 71.9 | 72.1 | 72.2 | 72.3 |
| 72.4 | 72.6 | 72.7 | 72.9 | 73.1 | 73.3 | 73.5 | 74.2 |
| 74.5 | 75.3 | | | | | | |

The first quartile $Q_1 = 69.5$, the median $Q_2 = 70.55$ and the third quartile $Q_3 = 71.80$. The histogram is




2.60 The Pareto chart for computer chips defects is



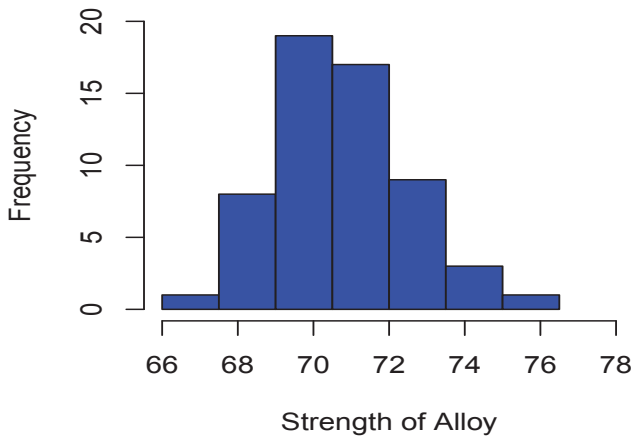

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2.61 (a) The frequency table of the aluminum alloy strength data (right-hand endpoint excluded) is

| Class limits | Frequency |
|---|---|
| [66.0, 67.5) | 1 |
| [67.5, 69.0) | 8 |
| [69.0, 70.5) | 19 |
| [70.5, 72.0) | 17 |
| [72.0, 73.5) | 9 |
| [73.5, 75.9) | 3 |
| [75.0, 76.5) | 1 |

(b) The histogram, using the frequency table in part (a), is




2.62 (a) Frequency table of the interrequest time data

| Class limits | Frequency | (Relative frequency)/width |
|---|---|---|
| [0, 2500) | 9 | 0.0036 |
| [2500, 5000) | 13 | 0.0052 |
| [5000, 10000) | 10 | 0.0020 |
| [10000, 20000) | 8 | 0.0008 |
| [20000, 40000) | 8 | 0.0004 |
| [40000, 60000) | 1 | 0.0001 |
| [60000, 80000) | 1 | 0.0001 |

(b) The histogram, using the frequency table in part (a), is given in Figure 2.1.

2.63 (a) The mean and standard deviation for the earth's density data are

$\bar{x} = 5.4835$ and $s = 0.19042$

(b) The ordered data are

5.10 5.27 5.29 5.29 5.30 5.34 5.34 5.36 5.39 5.42 5.44 5.46

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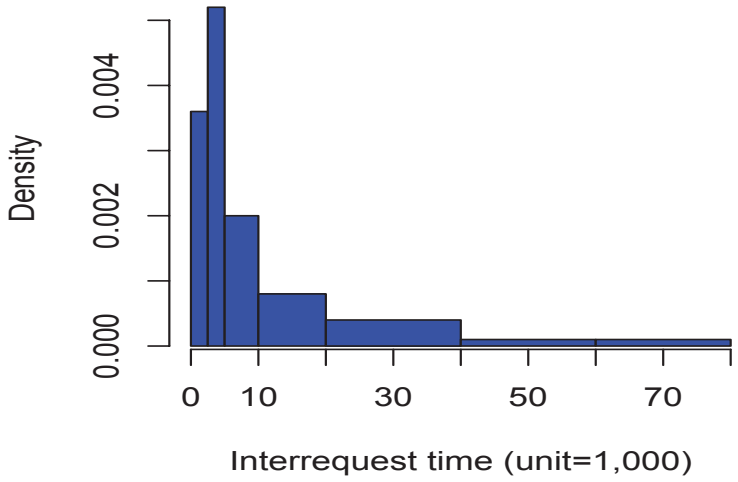
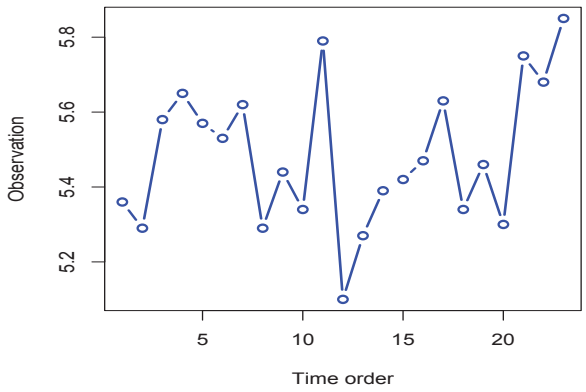



Figure 2.1: Histogram for Exercise 2.62

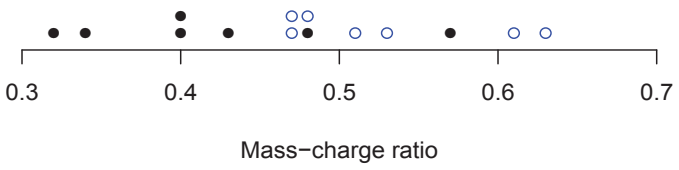
5.47 5.53 5.57 5.58 5.62 5.63 5.65 5.68 5.75 5.79 5.85

There are $n = 23$ observations. The median is the middle value, or 5.46. The must be at least 23/4=5.75 observations at or below $Q_1$ so $Q_1$ is the 6th larges value. $Q_1 = 5.34$. Similarly, there must be at least 3(23/4)=17.25 observations at or below $Q_3$ so $Q_3$ is the 18th largest observation. $Q_3 = 5.63$ .

(c) From the plot of the observations versus time order we see that there is no obvious trend although there is some suggestion of an increase over the last half of the observations.




2.64 (a) Dot diagram of Tube 1 and Tube 2 observations.




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(b) Mean and standard deviation for Tube 1 are $\bar{x}_1 = 0.42$ and $s_1 = 0.085049$

(c) Mean and standard deviation for Tube 2 are $\bar{x}_2 = 0.52857$ and $s_2 = 0.066440$

2.65 (a) The ordered data are

0.32 0.34 0.40 0.40 0.43 0.48 0.57

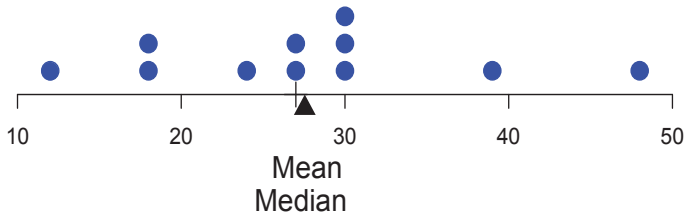
Since there are 7 observations, the median is the middle value. The median, maximum, minimum and range for the Tube 1 observations are:
Median = 0.40, maximum = 0.57, minimum = 0.32 and
range = maximum − minimum = 0.57 − 0.32 = 0.25.

(b) The ordered data are:

0.47 0.47 0.48 0.51 0.53 0.61 0.63

And the median, maximum, minimum and range for the Tube 2 observations are:
Median = 0.51, maximum = 0.63, minimum = 0.47 and
range = maximum − minimum = 0.63 − 0.47 = 0.16.

2.66 (a) Dot diagram for the velocity of light minus 299,700 km/s is




(b) The mean for the (velocity of light)−299,700 is equal to 27.545 and the median is equal to 27.

(c) The variance and the standard deviation are $s^2 = 100.47$ and $s = 10.024$

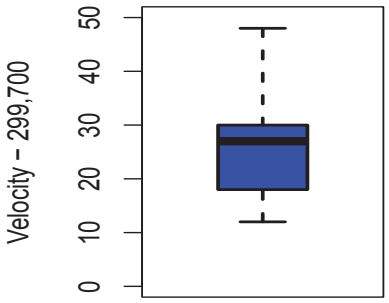
2.67 (a) Here, $11/4 = 2.25$ so $Q_1$ is the 3rd largest value. The quartiles for the velocity of light data are $Q_1 = 18.0$, $Q_2 = 27.0$, and $Q_3 = 30.0$

(b) The minimum, maximum, range and the interquartile range are
Minimum = 12, maximum = 48, range = maximum − minimum = 48 − 12 = 36 and
interquartile range = $Q_3 - Q_1 = 30.0 - 18.0 = 12.0$.

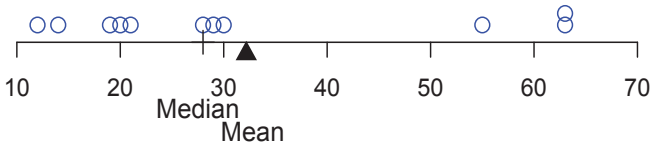
(c) The box-plot is

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2.68 (a) The dot diagram for the suspended solids data is




Suspended solids

(b) The median = 28.0 and the mean = 32.182.

(c) The variance and standard deviation are $s^2 = 363.76$ and $s = 19.073$.

2.69 (a) The ordered data are: 12 14 19 20 21 28 29 30 55 63 63

The quartiles for the suspended solids data are $Q_1 = 19$, $Q_2 = 28$, and $Q_3 = 55$.

(b) The minimum, maximum, range and the interquartile range are

Minimum = 12, maximum = 63, range = $63 - 12 = 51$ and

interquartile range = $Q_3 - Q_1 = 55 - 19 = 36$.

(c) The box plot is shown in Figure 2.2.

2.70 (a) The ordered data are given in the exercise. The minimum = 16.12 and the maximum = 19.00. Since $20/4 = 5$, to obtain the first quartile we average the 5th and 6th observations. The quartiles for the weight of meat data are $Q_1 = 16.975$, $Q_2 = 17.31$, and $Q_3 = 17.695$

(b) The minimum, maximum, range and the interquartile range are

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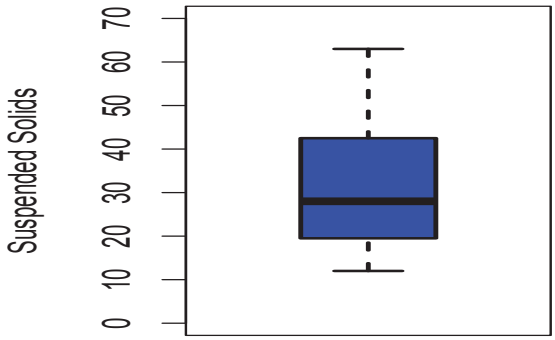
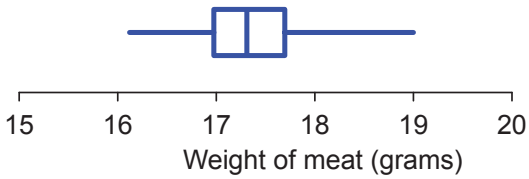


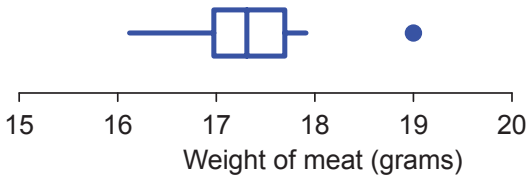

Figure 2.2: Box plot of suspended solids. Exercise 2.69.

Minimum = 16.12, maximum = 19.00, range = 19.00 − 16.12 = 2.88 and
interquartile range = (17.695 − 16.975) = .72.

(c) The 10th percentile is 16.82 and the 20th percentile is 16.935
which are obtained by taking the average of the 2nd and 3rd observations and the 4th and 5th observations, respectively.

2.71 The box plot and modified box plot are




2.72 The stem-and-leaf display of the aluminum data

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| | |
|---|---|
| 66 | 4 |
| 67 | 7 |
| 68 | 0 0 3 4 6 8 9 |
| 69 | 0 1 2 3 3 5 5 6 7 8 8 9 |
| 70 | 0 0 1 2 3 3 4 5 6 6 8 9 |
| 71 | 0 1 2 3 3 5 6 6 7 8 8 9 |
| 72 | 1 2 3 4 6 7 9 |
| 73 | 1 3 5 |
| 74 | 2 5 |
| 75 | 3 |

Note the leaf unit is 0.10, that is for instance, the number in the first row should be read as 66.4.

2.73 (a) $\overline{x} = 2.929/12 = .2441$

(b)
$$s^2 = \frac{\sum x_i^2 - (\sum x_i)^2/n}{n-1} = \frac{.715063 - (2.929)^2/12}{11} = .00001299$$

so $s = \sqrt{.00001299} = .0036$

(c) The coefficient of variation is
$$\frac{.0036}{.2441} \cdot 100 = 1.47 \text{ percent.}$$

(d) For the large disk, the coefficient of variation is
$$\frac{.05}{.28} \cdot 100 = 17.9 \text{ percent.}$$

Thus, the values for the larger hard disk are relatively less consistent.

2.74 (a) From the SAS output, we identify the mean to be 1908.76667 and the standard deviation to be 327.115047. These answers seem to be more precise than the ones given in Exercise 2.51, which are the rounding of these answers.

(b) The software program R treats 2,983 as an outlier and only extends the line to the second largest observation 2,403. The boxplot is shown in Figure 2.3.

2.75 (a) The ordered observations are

389.1 390.8 392.4 400.1 425.9 429.1 448.4 461.6
479.1 480.8 482.9 497.2 505.8 516.5 517.5 547.5
550.9 563.7 567.7 572.2 572.5 575.6 595.5 602.0
606.7 611.9 618.9 626.9 634.9 644.0 657.6 679.3
698.6 718.5 738.0 743.3 752.6 760.6 794.8 817.2
833.9 889.0 895.8 904.7 986.4 1146.0 1156.0

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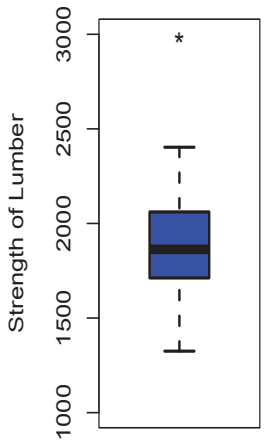
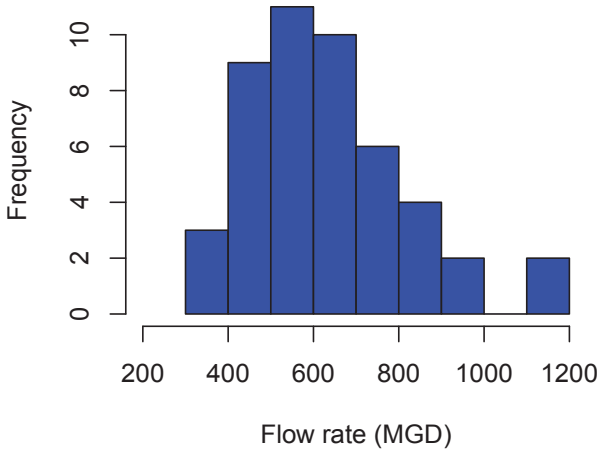



Figure 2.3: Box plot for Exercise 2.74.

The first quartile is the 12th observation, 497.2, the median is the 24th observation, 602.0, and the third quartile is the 36th observation, 743.3.

(b) Since $47(.90) = 42.3$, the 90th percentile is the 43rd observation, 895.8.

(c) The histogram is



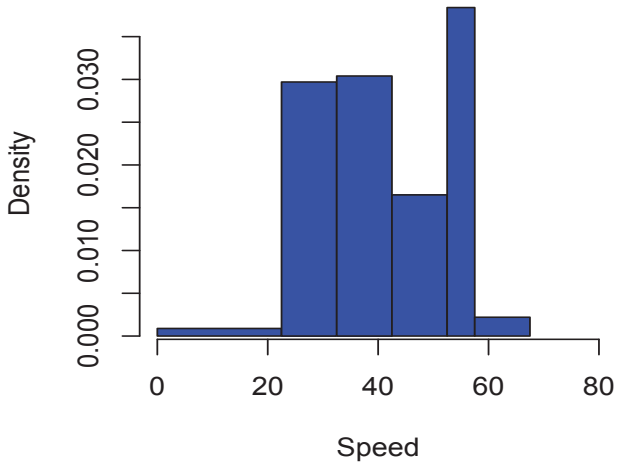

2.76 (a) We certainly cannot conclude that it is safer to drive at high speeds. The great majority of driving is city driving where speeds in the ranges 25 *or* 30, or 35 *or* 40 are the most common. That is, the majority of traffic volume is in these ranges so those are the speeds where most accidents occur. Traffic volume at the given speeds must be taken into account.

(b) As explained above, the majority of traffic volume moves at these speeds.

(c) The density histogram is

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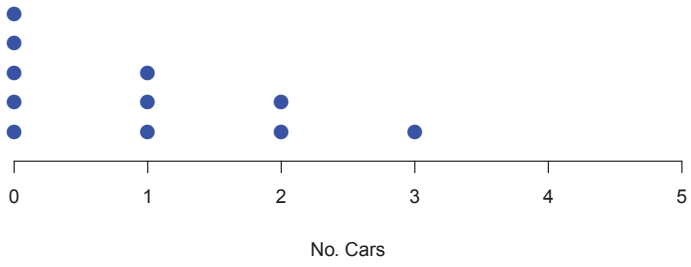
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2.77 No. To be an outlier, the minimum or maximum must be quite separated from the next few closest observations.

2.78 Yes because, from the stem-and-leaf display, you can determine at least two of the leading digits. Usually there are stems with no leaves after the smallest observations or before the largest.

2.79 (a) The dot diagram has a long right hand tail.




(b) The ordered data are

$$0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1 \quad 1 \quad 2 \quad 2 \quad 3$$

The median is the middle value, 1 car, and $\overline{x} = 10/11 = .909$ car, which is smaller than the median.

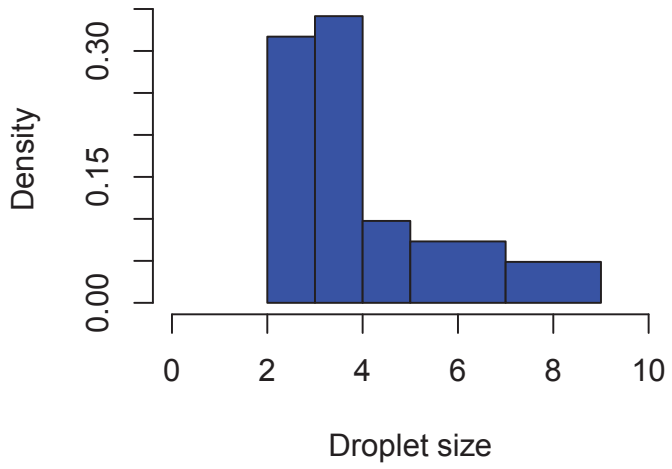
2.80 (a) The frequency distribution is given in the table where the left-hand end point is included.

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| Class | Frequency |
|---|---|
| $[2, 3)$ | 13 |
| $[3, 4)$ | 14 |
| $[4, 5)$ | 4 |
| $[5, 7)$ | 6 |
| $[7, 9)$ | 4 |
| Total | 41 |

(b) The density histogram has a long right hand tail.




(c) A computer calculation gives

$$\overline{x} = \frac{162.6}{41} = 3.97 \qquad s^2 = \frac{\sum x_i^2 - (\sum x_i)^2/n}{n-1} = \frac{761.06 - (162.6)^2/41}{40} = 2.905$$

so $s = 1.70$

(d) The data are already ordered. For the first quartile, $41/4 = 10.25$ is increased to the 11th position so $Q_1 = 2.9$ Continuing $Q_2 = 3.4$ and $Q_3 = 4.9$

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