Chapter 1

While some of these exercises are simple applications of ideas in the chapter, most are intended to stimulate thinking about issues under study and study design issues. In our own teaching we want our students to automatically begin to think about these types of things when presented with information. These exercises are a first step towards that goal. We are not after right or wrong answers. Many of these exercises work well for stimulating group discussion and there are often students in a class with some knowledge of the subject area who can contribute more informed and perceptive answers than the teachers. In the following we simply give a few sketch ideas.

Exercises for Section 1.1

1. We could take all members of the population in the country at the time who were entitled to vote in national elections. In New Zealand this would exclude the young, the illegal immigrants, those people in prisons and people legally committed to mental hospitals. It would include any other legal residents in New Zealand whether or not they were citizens, and citizens living overseas. You might want to be more, or less, restrictive. In practice, one would probably sample from something like the electoral rolls – that subset of people who fit the eligibility criteria for voting and who have registered to do so.

2. −**4.** These are entirely for you to draw on your own experience. Similar stories are given in the chapter.

5. The survey was self-selective and therefore not necessarily representative of N.Z. women. The reporter compared the statement"92% of incest cases reported in the survey are European" with "81% of the population is European" and claimed unusually high abuse. The reporter should have compared the statement "92% of incest cases reported in the survey are European" with the fact that "91% of those responding to the survey were European." Far from the figure of "92% of incest cases" being an abnormally high proportion, it is almost exactly what you would expect if incest and ethnicity were unrelated.

Exercises for Section 1.2

1. We would choose 10 rats at random to form the reward group. The remaining 10 form the punishment group. We might expect the first 10 rats caught to tend to be the slowest (and perhaps the most stupid!).

2. Product characteristics tend to vary over time, so it is possible that the two lengths chosen may differ in important ways from the other two. Another method would be to randomly choose two of the four rods available from each length for testing process 1 and the reminder for process 2. This would protect us from the possibility of systematic changes along the length of a rod. Alternatively we can use a systematic method: Choose rods 1 and 3 from each of the lengths for process 1, and rods 2 and 4 for process 2.

3. Important things are random selection and double blinding (cf. school milk story). The definition and measurement of intelligence is a thorny problem that has exercised psychologists for years. If one suspected that there would be an effect on a particular type of intelligence, that is the type that should be measured. Otherwise, you would probably just choose a standard broad-spectrum psychological test appropriate for the age group.

Exercises for Section 1.3

Note: In each of these these items there are other possible explanations besides the "obvious" one. Coming up with alternative possibilities is an important part of statistical thinking. Our answers are not the "right" answers. We have no particular expertise in the areas under discussion and just report a few ideas that occurred to us.

1. The "obvious" inference is that with the coming of electricity and the facilities it brings, there are more distractions, and birth rates fall. The observed differences in rates, however, may be related to economic issues, with people not yet having electricity tending to be poorer and less educated. There are probably rural/urban differences. Rural areas tend to be slower to get electricity, and there are practical reasons for rural people to want larger families.

2. The observed difference between the groups may be due to something that is associated with smoking but not caused by smoking. Perhaps people who choose to smoke tend not to work as hard on average, so that it is this and not the smoking that gives them the lower marks. Perhaps their average IQ is lower.

3. Not necessarily. Even long trips have a close-to-home portion. Most of our travelling experience is close to home, so we might expect more accidents close to home.

4. It could be the other way around. Maybe prolonged exposure to alcohol causes these chemical changes.

5. A host of factors may be at work here. Few would doubt that more men are involved in crime than women, so it is not surprising that more end up in jail. It is possible that mothers with dependent children are less likely to be sentenced to jail. The types of crime that men and women tend to commit may also differ.

6. A randomized experiment is not feasible. Subject choice affects the careers you can go into, for example. We cannot direct some randomly chosen people to head off in one direction and others in another. If the gender differences in mathematics scores disappear when we look just at people who also take physics, this would tend to support the "reinforcement" idea. A problem with this is that there may be gender differences in subject choice. Perhaps girls taking physics are better than boys on average because they are less likely to take the subject unless they know they are good at it. (This is easily investigated – how?) Any effect like this would bias the male-female comparison of mathematics scores confined to physics students.

Review Exercises 1

1. **(a)** One definition would be anyone not in full-time paid employment who wants a job and is actively seeking one. This is problematic in that it excludes the long-term unemployed who are so discouraged that they have given up on finding a job.

(c) The definition of what it means to be unemployed differs between countries as does the way the data are collected, for example, surveys (with many differences in survey design) versus official registers of unemployed people.

2. Very few people bother to fill out such surveys and we cannot expect those that do to be representative. We would expect people who have complaints to be more likely to fill them out thus making the survey results look worse than the reality. The complaints one gets can identify the problems that needs fixing. Changes in the level of complaint (getting more or less) can help you see if your hotel is making progress or whether things are getting worse.

3. The experiences giving rise to anecdotal evidence are very small samples that may also have been resulted from a very biased "sampling" mechanism.

4. (Can the differences be explained by poverty?) We would like to see whether the ethnic differences went away if we confined our attention to people from the same socioeconomic class. (This would involve defining classes – broad definitions exist in sociology.)

(Is sentencing racist?) Since there may be ethnic differences in the types of crime typically committed, we would want to categorize crimes into classes by type and severity and then look for ethnic differences in imprisonment rates for people committing crimes in the same class.

5. (i) Big unrepresentative samples are still unrepresentative. (ii) This is fine so long as you see it as raising issues rather than representing popular opinion or experience. (iii) Pointing to other instances of unrepresentative research does not make your research any better.

6. We need some way of comparing their growth with how much they would have grown without the hormone. The closest we can get to that is to compare it to the growth of a *comparable* group who did not take the hormone. The most reliable method of obtaining two very similar groups for comparison is to take a set of people and randomly divide it into two groups; one group gets the hormone and the other serves as a control group. See Section 1.2 for the problems with other methods.

7. **(a)** There will be people with Celtic names but very little Celtic blood (e.g. a Celtic surname could have come from a sole Celtic male ancestor six generations ago). Similarly, there would be people who were predominently Celtic but have non-Celtic names.

(b) Including some non-Celts in with the Celtic group and some Celts in the non-Celtic group, would make the observed differences between the groups *smaller* than they should be.

(c) Psychiatric patients of the type that attended the particular hospital at that time.

(d) Anything that was special about the types of patients admitted and the conditions that they were exposed to.

8. **(a)** It is an experiment. The conditions experienced by the subjects are specified by the experimenter.

(b) People who often get headaches after drinking red wine.

(c) The wider question is whether aspirin is an effective treatment for preventing red-wine headaches in general. The experiment is addressing only one particular red wine, drunk in particular quatities, and there were probably things that are special about the way the subjects were obtained as well. The question then arises as to whether the results carry over to other red wines and other types of people who experience red-wine headaches.

(d) Some headaches, such as migraines, can be triggered by atmospheric conditions. Performing all the experiments on one condition (90 ml, no aspirin) one week and all on the other (180 ml, aspirin) a week later is a weakness. There is no mention of subjects being "blinded". We would have randomized the order in which the subjects experienced the treatments and introduced a placebo.

(e) We would next repeat the experiment with a different wine and a different group of people from a different area (state or country).

9. Fatalities per kilometer per car tell us how safe the road is for us to travel on. It tells us nothing, however, about the number of lives that we are likely to be able to save per dollar spent on highway improvement. Short stretches of road with many fatalities, like the bridge, may be good to target in this regard. Fatalities per kilometer of highway may give a reasonable approximate measure.

10. Heights are measurably smaller at the end of the day than at the beginning of the day as the spacings between vertebra settle. A person's height also begins to decrease with age. We need a way of comparing the heights of current 20-yearolds, say, with the heights of their parents when they were in their twenties.

11. Elevation, shading, steepness, and soil conditions are all factors to be considered. Laying out a grid of cells of equal area on a map of the area and randomly choosing cells to receive each of the three treatments is a reasonable way to proceed if practically feasible.

12. Total land area is different from land area that is usable for human habitation. A country may have a large land area but contain large deserts or very mountainous regions where very few people can live. Almost all will be living in the remaining areas where the population density may be very high. Extreme examples are the

Netherlands, a flat pastoral country where people can live anywhere, and Australia, but much of which is desert so that a majority of the people live in a narrow strip along the east coast.

13. Different places use different definitions. Reporting rates may also differ for a variety of reasons. We have to be a little suspicious that people with a point to prove may be very selective in what they report and how they report it!

14. The authors would want be more impressed if they knew that the study was conducted by someone independent and not a proponent of TM, and there some reassurance that the groups were comparable apart from TM use. For example, many of the types of health problems listed areas listed become more common with age so we would be concerned that the TM group might tend to be younger on average. Saying that TM practitioners encompass all ages is of no help in this regard. It is a matter of the relative proportions of people in each age group. TM practioners may also be more likely to be middle class, to live outside city centers, and have other characteristics that are associated with better health. It could be factors like these, not their practice of TM, that makes for better health statistics. We would want to be assured that factors such as the above had been taken into account in the analysis of the data.
The statement " 5-year study of US health insurance statistics" is ambiguous. It could mean the study took 5 years to complete or that it used 5 years of health data. We suspect the latter is what was meant.
We would want to see comparisons between people who do and do not practice TM within groups with the same sociological patterns. We would have most confidence in the results of properly-conducted controlled, randomized trials carried out by people who had no connection with the TM movement. The TM group are people who are doing something about their stress levels. We can see a range of questions: Does a regimen of regular periods of relaxation have health benefits? Is TM more effective in this regard than other methods of relaxation? What are the comparative benefits of regular relaxation versus regular exercise?

15. The paint surfaces that last longest at high temperatures may be different from the surfaces that last longest under normal operating conditions.

16. This is only a 10% response rate – the people who responded could be very unrepresentative. It could well be that the survey struck a responsive chord with stressed-out principals.

Chapter 2

Exercises for Section 2.1

2. Income (continuous), religion (categorical), ethnicity (categorical), distance (continuous), transport (categorical), household number (discrete), smoking (ordinal), cigarettes (discrete), political party (categorical), and percentage income (continuous, though if the data are sufficiently rounded to a few significant figures, it could be treated as discrete).

3. Patient 69 did not continue to smoke, had surgery for symptoms within one year, and was alive at last follow-up.

4. Patient 201 was aged 42 at admission, had DIAVOL = 329, was not taking beta blockers, and had a cholesterol score of 39.

5. Patient 203 was aged 54 at admission, had occlusion score 0, was not taking beta blockers, and had no cholesterol score recorded.

6. Only five patients continued to smoke. Only two had surgery for symptoms after five years. Thirty two were still alive at last follow-up.

Exercises for Section 2.2

Table 2.1 : Simplified World Gold Production Table
(in millions of troy ounces)

Year	World prod.	S. Afr.	U.S.	USSR	Aust.	Can.	China	Col.	Ghana	Phlp.	Mexico	Zaire
1972	45	29	1.4	–	0.8	2.1	–	0.2	0.7	0.6	0.1	0.1
1974	40	24	1.1	–	0.5	1.7	–	0.3	0.6	0.5	0.1	0.1
1975	38	23	1.1	–	0.5	1.7	–	0.3	0.5	0.5	0.1	0.1
1976	39	23	1.0	–	0.5	1.7	–	0.3	0.5	0.5	0.2	0.1
1977	39	23	1.1	–	0.6	1.7	–	0.3	0.5	0.6	0.2	0.1
1978	39	23	1.0	–	0.7	1.7	–	0.3	0.4	0.6	0.2	0.1
1979	39	23	1.0	–	0.6	1.6	–	0.3	0.4	0.5	0.2	0.1
1980	39	22	1.0	8.4	0.6	1.6	–	0.5	0.4	0.8	0.2	0.0
1982	43	21	1.5	8.6	0.9	2.1	1.8	0.5	0.3	0.8	0.2	0.1
1983	45	22	2.0	8.6	1.0	2.4	1.9	0.4	0.3	0.8	0.2	0.2
1984	46	22	2.1	8.7	1.3	2.7	1.9	0.8	0.3	0.8	0.3	0.1
1985	49	22	2.4	8.7	1.9	2.8	2.0	1.1	0.3	1.1	0.3	0.1
1986	52	21	3.7	8.9	2.4	3.4	2.1	1.3	0.3	1.3	0.3	0.2
1987	53	19	4.9	8.9	3.6	3.7	2.3	0.9	0.3	1.1	0.3	0.1
1988	58	20	6.5	9.0	4.9	4.1	2.5	0.9	0.4	1.1	0.3	0.1
1989	64	20	8.5	9.2	6.5	5.1	2.6	0.9	0.4	1.1	0.3	0.1
1990	68	19	9.3	9.7	7.9	5.4	3.2	0.9	0.5	0.8	0.3	0.1
1991	67	19	9.3	7.7	7.5	5.6	3.9	1.0	0.8	0.8	0.3	0.1

1. (a) We have rounded severely and ordered the table by importance as a gold producer in the most recent year (1991) to get Table 2.1. We would have preferred to have years as columns and countries as rows as we are most interested in comparing countries. However, this would have forced us to use two pages to represent so

many columns, or to suppress some less important producers. We have left the world figures in column 1 so it is easier to compare the figures for the big producers with the world total. South Africa has been by far the biggest producer, but its production figures have been decreasing a little over time. Trends include a gradual increase in world production since 1980. The major increases in production have been in the United States, Australia, Canada, and China. Figures for the USSR start in 1980, but given the large production occurring then, we imagine that they must have been producing substantial amounts before this (similarly for China).

(b) (Using the original table) 1972: 0.65 (65%); 1980: 0.55 (55%); 1986: 0.4 (40%).

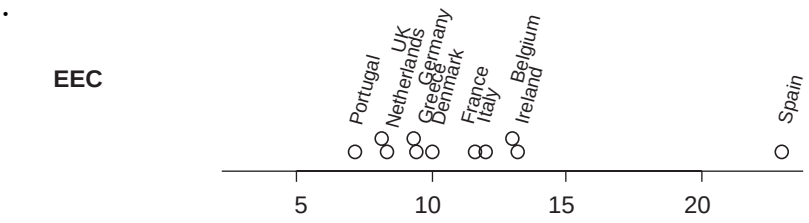
(c) (Using the original table) 1972: 3.2%; 1980: 2.5%; 1986: 7.3%; 1991: 13.9%.

(d) 1970s: Canada; 1980s: USSR; 1990s: U.S.

2. For the reader.

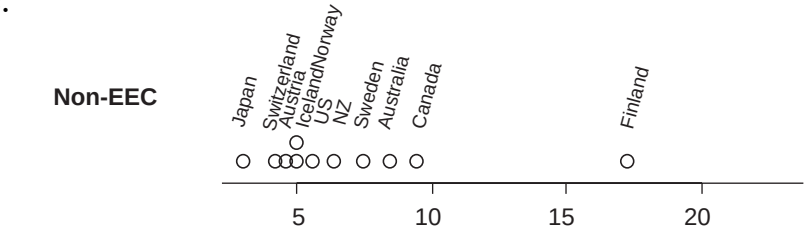
Exercises on Section 2.3.1

1.



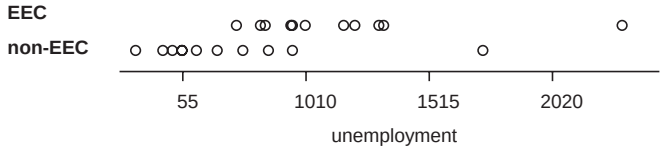
Spain stands out as a high-unemployment outlier.

2.



Finland stands out as a high-unemployment outlier.

3. Plotting against the same scale allows us to compare unemployment patterns of members and non-members. We see that EEC countries had higher unemployment on average than non-EEC members. The spreads are similar.



Exercises for Section 2.3.2

1. **(a)** (i) 1.54. (ii) 0.67. **(b)** (i) 154. (ii) 67. **(c)** (i) 0.00154. (ii) 0.00067.

2. **(a)** $16|3 = 1.63\,\text{cm}$. **(b)** Round to two significant figures, i.e., $5|4 = 540\,\text{m}$. **(c)** Round to one decimal place, i.e., $16|3 = 16.3\,\text{m}$. **(d)** $166|3 = 1663\,\text{kg}$.

3. 5.4, 9.8, 10.1, 10.1, 10.3, ... , 25.6, 26.8.

4. `Units 0 | 9 = 90`

```
0 | 9
1 | 01122233333334444444
1 | 55555666666667779
2 | 0224
2 | 6
3 | 13
```

(a)

```
0 | 9
1 | 011
1 | 2223333333
1 | 444444455555
1 | 66666666777
1 | 9
2 | 0
2 | 22
2 | 4
2 | 6
2 |
3 | 1
3 | 3
```

(b)

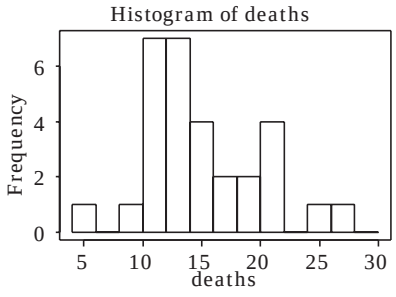
We see a positively skewed shape (long tail toward large values) with a mode at about 145.

6. A stem-and-leaf for position 7 is given, together with other plots, in Fig. 3.2.5 in the main text. The body of the plot is bimodal, and there is a group of three much smaller observations.

Exercises for Section 2.3.3

1.

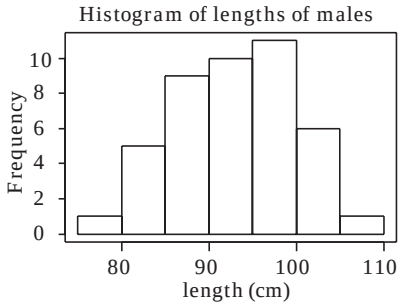
Interval		Freq.
4	6⁻	1
6	8⁻	0
8	10⁻	1
10	12⁻	7
12	14⁻	7
14	16⁻	4
16	18⁻	2
18	20⁻	2
20	22⁻	4
22	24⁻	0
24	26⁻	1
26	28⁻	1



The endpoints of the intervals are slightly different from the stem-and-leaf in Fig. 2.3.7(b), so the frequencies are not identical. The shapes are very similar, however.

2.

Interval		Freq.
75	80⁻	1
80	85⁻	5
85	90⁻	9
90	95⁻	10
95	100⁻	11
100	105⁻	6
105	110⁻	1



To compare the histograms we would place one histogram above the other and use the same scale. The histogram for the males is shifted to the right, indicating their greater lengths. The one for the females is more peaked.

3. 20/40, or 50%.

Exercises for Section 2.3.4

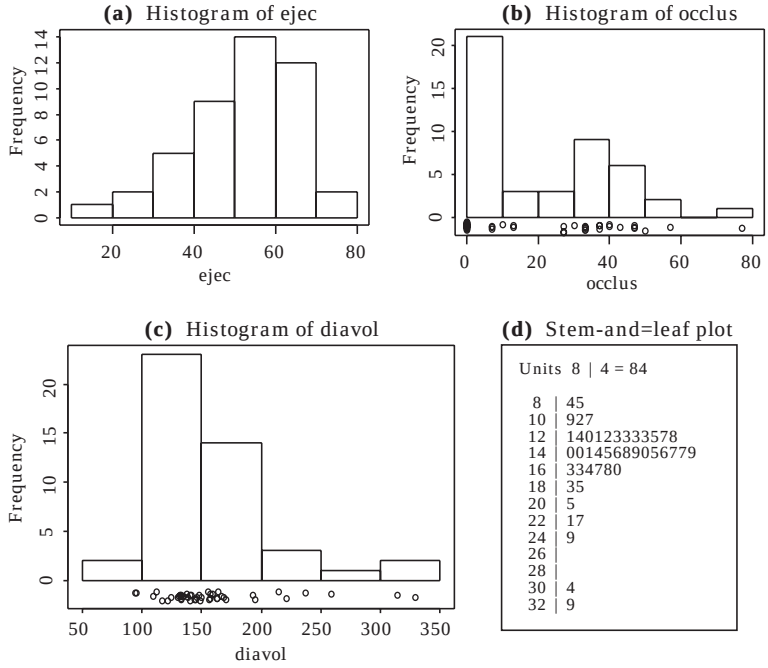


Figure 1 Plots for Exercises for Section 2.3.4

1. See Fig. 1(a). The shape is negatively skewed (long tail to the left).

2. See Fig. 1(b). The shape is bimodal with an outlier.

3. The stem-and-leaf plot given in Fig. 1(d) is very similar in shape to the histogram given in Fig. 1(c). The overall shape is positively skewed (long tail to the right) with possibly two outliers.

Note: In Figs 1(b,c) we have included the dot plot (not part of the histogram) just to reinforce how the data points are represented in the histogram and how the histogram represents relative density. Data points falling on a boundary are included in the class interval above them.]

Exercises on Section 2.4.1

1. **(a)** 7.5 [$(n+1)/2 = 3.5$, so midway between 3rd and 4th largest observations].

(b) 4 [$(n+1)/2 = 4$, so 4th largest observation)].

(c) 3.0 [$(n+1)/2 = 4.5$, so midway between 4th and 5th largest observations].

2. For the female coyotes, Mean = 89.24 and Median = 89.75 (original data) or 90 (stem-and leaf). Data from the stem-and-leaf plot are rounded. No.

3. For the male coyotes, Mean = 92.06 and Median = 92 (either original data or rounded data from a stem-and-leaf). From the samples, the average length of male coyotes is greater than that for the female coyotes.

4. Mean = 48.43. The stem-and-leaf plot for the ages of those with OUTCOME=0 and SURG=0 follows. There are 23 observations.

```
Units 4 | 5 = 45

  3 | 689
  4 | 23
  4 | 556777899
  5 | 11144
  5 | 7889
```

Taking the (23+1)/2 = 12th largest observation gives us Median = 48.

Exercises for Section 2.4.2

1. **(a)** (Min, Q_1, Med, Q_3, Max) = (1, 2, 8, 11.5, 14).

(b) (Min, Q_1, Med, Q_3, Max) = (1, 5, 10, 13, 20).

2. (6.8, 8.45, 8.75, 9.2, 10.4).

3. (36, 45, 48, 54, 59).

4. You would be moderately tall and thin.

Note: The quartiles given here apply the definitions given in the book exactly. Different computer packages use slightly different definitions and will give slightly different answers in some cases. The important thing about quartiles is the idea of a quartile, not fine differences in definitions.

Exercises for Section 2.4.3

1. There are eight of them with diastolic volumes 133, 138, 193, 149, 124, 167, 156, 195. These data have $\overline{x} = 156.875$, $s_X = 26.541$.

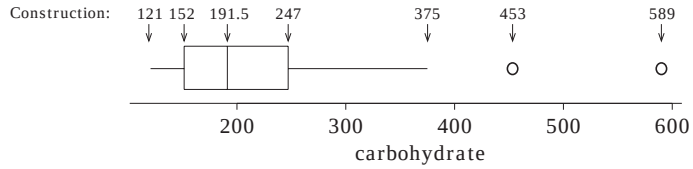
2. **(a)** $\overline{x} = 92.056$, $s_X = 6.696$. They are both larger for males. The male data set is slightly more variable. Although on *average* males are longer than females, when it comes to individual comparisons we could not be sure which one would be longer.

(b) (1 sd) $29/43 = 0.67$ of 67%, (2 sd) $42/43 = 0.98$ or 98%.

(c) Range $= 105 - 78 = 27$, IQR $= 96 - 87 = 9$. sd/IQR $= 0.744$, or almost exactly 75%.

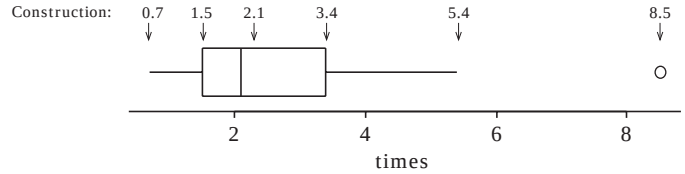
Exercises for Section 2.4.4

1.



The data are positively skewed (long tail to the right) with two outside values (453, 589).

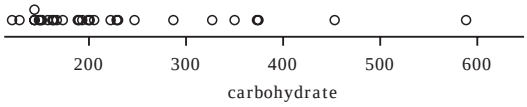
2.



The data are positively skewed with one outside value (8.5).

Notes:

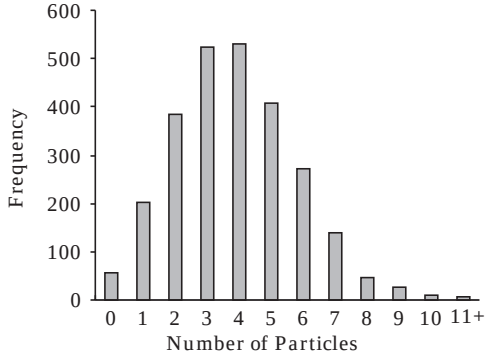
1. In each box plot in Fig. 2.5, the numbers used in the construction of the box plot have been represented just above the plot. The plots have been constructed using the definitions (including the definitions of quartiles) exactly as given in the text. Different computer packages use slightly different definitions so you will often see minor differences in the plots produced by different packages.
2. The rules defining what values are to be plotted as outside values were worked out assuming a Normal distribution (which has a symmetric bell shape). With skewed data, we often see some scattered outside values on the long-tailed side of the distribution. Very often, as here, they are not outliers in the sense that they are so discrepant that we expect they are wrong. They are just part of the skewed shape as the following dot plot of the data in question 1 shows.



Exercises for Section 2.5.1

1. **(a)** Mean $= \frac{0\times57+1\times203+2\times383+\ldots+11\times6}{2608}$ $= 3.870$.

(b) The bar graph as given:



(c) The table is now:

No. of Particles	Freq	Prop.	Percent	Cum. Percent
0	57	0.022	2.2	2.2
1	203	0.078	7.8	10.0
2	383	0.147	14.7	24.7
3	525	0.201	20.1	44.8
4	532	0.204	20.4	65.2
5	408	0.156	15.6	80.8
6	273	0.105	10.5	91.3
7	139	0.053	5.3	96.6
8	45	0.017	1.7	98.3
9	27	0.010	1.0	99.3
10	10	0.004	0.4	99.7
11+	6	0.002	0.2	99.9
Total	2608	0.999	99.9	

(d) 20.4% **(e)** 65.2% **(f)** 6.

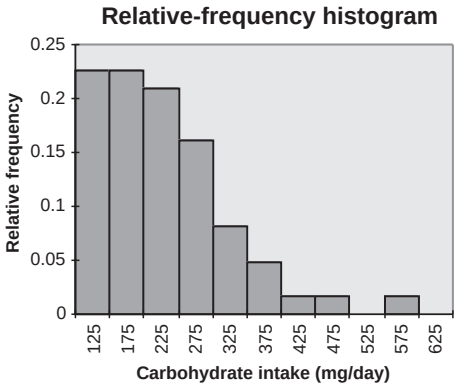
2. They don't make much sense. For example, how would we define a median? Of the observations, 44.8% are smaller than 4, 20.4% are equal to 4, and 34.7% are bigger than 4.

Exercises for Section 2.5.2

1. Mean= $\frac{125\times14 + 175\times14 + 225\times13 + \ldots + 575\times1}{62}$ = 227.42 and sd = 94.27 (computer). These answers are fairly close to the answers for the ungrouped data.

2.

From	To	Midpt	Freq.	Rel. Freq.
100	150	125	14	0.2258
150	200	175	14	0.2258
200	250	225	13	0.2097
250	300	275	10	0.1613
300	350	325	5	0.0806
350	400	375	3	0.0484
400	450	425	1	0.0161
450	500	475	1	0.0161
500	550	525	0	0.0000
550	600	575	1	0.0161
		Total	62	1



The shape looks like the right half of a bell. **(a)** 51/62. **(b)** 9/62. **(c)** 2/62.

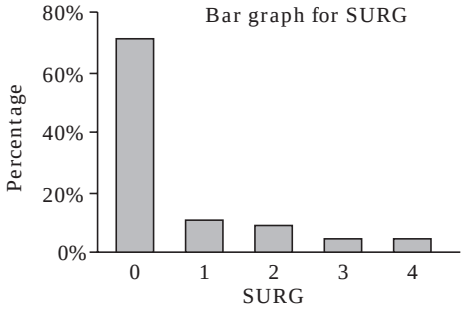
3. The height of the rectangle above the interval 400–600 would be $3/(4 \times 62)$.

Exercises for Section 2.6

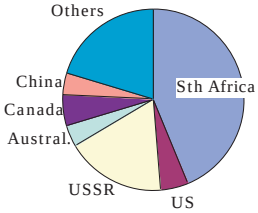
1. The table and graph follow:

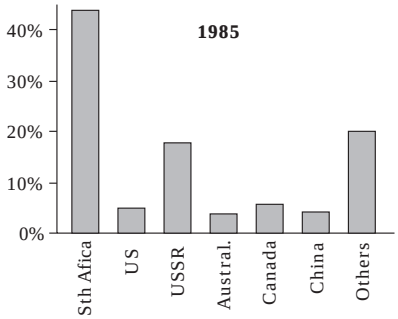
Frequency Table for SURG

SURG	Freq	Percent	Cum. %
0	32	71.111	71.11
1	5	11.111	82.22
2	4	8.889	91.11
3	2	4.444	95.56
4	2	4.444	100.00
	45	100	



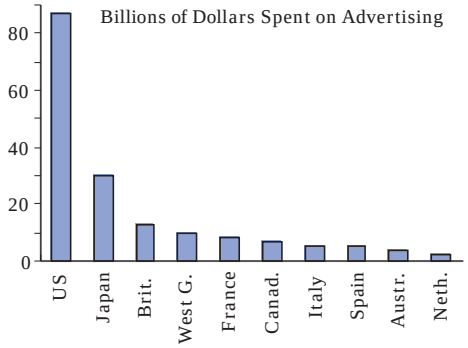
2.



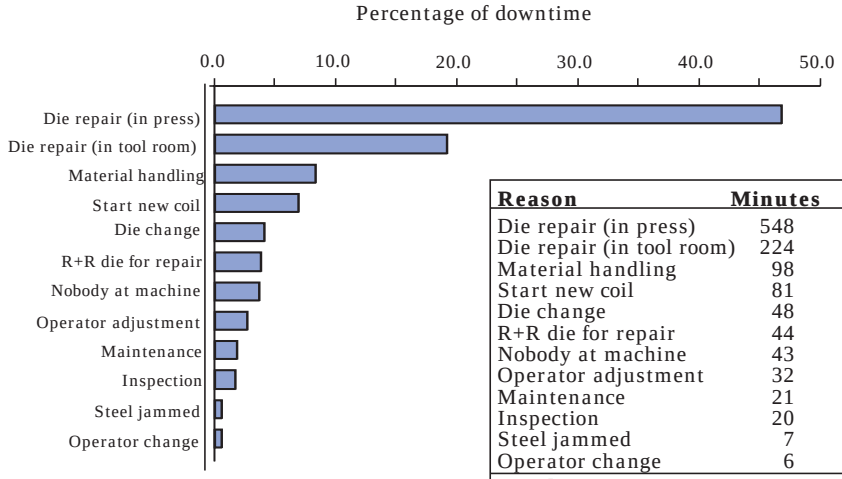


The biggest changes are the reduction in the South African share, and the growth in the US and Australian shares between 1985 and 1991.

3. We use a "decreasing" bar graph.



4. We have used percentage of total downtime as our measure, and ordered by descending percentage. We decided to turn this graph on its side because this is good for displaying long labels. The table containing our working is placed awkwardly to save space. We see that the first two reasons (both die repairs) account for 70% of all downtime. It is here we look first.



Reason	Minutes	Percent
Die repair (in press)	548	46.8
Die repair (in tool room)	224	19.1
Material handling	98	8.4
Start new coil	81	6.9
Die change	48	4.1
R+R die for repair	44	3.8
Nobody at machine	43	3.7
Operator adjustment	32	2.7
Maintenance	21	1.8
Inspection	20	1.7
Steel jammed	7	0.6
Operator change	6	0.5
Total	1172	

Review Exercises 2

1. **(a)** We have presented two plots, the second being a stretched out version of the first. We see a slightly positively skewed shape with two outlying large values.

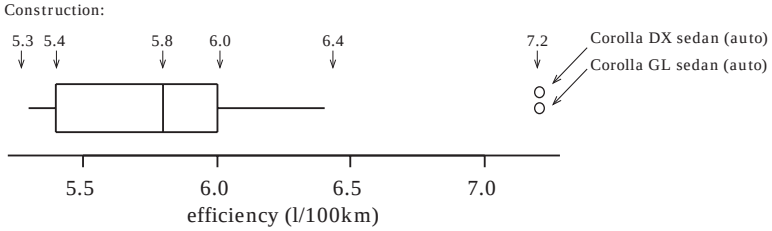
```
Units 5 | 3 = 5.3 l/(100ml)

5 | 344444
5 | 6677899999
6 | 124
6 |
7 | 22
```

```
5 | 3
5 | 44444
5 | 6677
5 | 899999
6 | 1
6 | 2
6 | 4
6 |
6 |
7 |
7 | 22
```

(b) Med $= 5.8$, $IQR = Q_3 - Q_1 = 6.0 - 5.4 = 0.6$.

(c)



Both show a central group with two large outliers.

(d) The outliers are the only two cars with automatic transmissions.

2. We provide two simplified tables. Using a spreadsheet, we have ordered sectors from largest to smallest on the latest (1994) figures and rounded heavily. We have placed Total GDP at the top. The table is ordered primarily for comparing sectors (down columns) but we can also track across time (across rows). We notice changes in ordering of the sectors over time, but the rapid increase in Total GDP over time means that this pattern of increase tends to overwhelm all other trends.

U.S. GDP by sector ($billions)

	1959	1967	1977	1982	1987	1992	1994	Mean
Total GDP	510	830	2000	3200	4700	6200	6900	3500
Sector								
Services	48	91	260	470	790	1200	1340	600
Finance, insur., real est.	69	117	280	500	830	1150	1270	600
Manufacturing (durable)	82	134	280	380	510	570	670	380
Retail trade	49	78	190	290	440	540	610	310
Transportation & public util.	45	71	180	290	420	530	610	310
State and local govt.	30	61	170	270	400	550	600	300
Manufacturing (nondurable)	59	87	180	270	370	490	520	280
Wholesale trade	36	58	140	220	300	410	460	230
Federal Government	35	57	120	190	260	320	330	190
Construction	24	40	94	130	220	230	270	140
Agriculture, forestry, fish.	20	25	54	77	89	110	120	71
Mining	13	15	54	150	88	92	90	72

Percentage of GDP by sector

Sector	1959	1967	1977	1982	1987	1992	1994	Mean
Services	10	11	13	15	17	19	19	15
Finance, insur., real est.	14	14	14	16	18	18	18	16
Manufacturing (durable)	16	16	14	12	11	9	10	12
Retail trade	10	9	9	9	9	9	9	9
Transportation & public util.	9	8	9	9	9	8	9	9
State and local government	6	7	9	8	8	9	9	8
Manufacturing (nondurable)	12	10	9	8	8	8	8	9
Wholesale trade	7	7	7	7	6	7	7	7
Federal Government	7	7	6	6	5	5	5	6
Construction	5	5	5	4	5	4	4	4
Agriculture, forestry, fish.	4	3	3	2	2	2	2	2
Mining	2	2	3	5	2	1	1	2

In the second table, we use percentages of GDP to better see patterns of change in the share each sector makes up of the total economy. The most obvious change is the growth in the service sector from number 3 at 10% of GDP in 1959 to number 1 with 18% of GDP. The finance sector has grown from 14% to 18%. The biggest falls have been in manufacturing (durable) from number 1 at 16% in 1959 to number 3 at 12% in 1994, and manufacturing (nondurable) from number 3 at 12% in 1959 to number 7 at 9% in 1994.

3. **(a)** *Home*: mean = 20.227, sd = 6.510; *away*: mean = 14.364, sd = 5.104. There were nearly six more goals scored on average for away games. The spread (sd) is also somewhat greater at home.

(b) Use back-to-back stem-and-leaf plots.

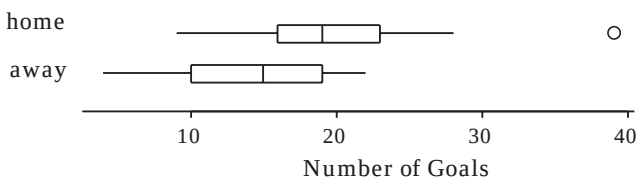
```
Units  1 | 9 = 19 goals
   HOME          AWAY

        | 0 | 4
      9 | 0 | 688
    432 | 1 | 002334
99988865 | 1 | 555688999
  433220 | 2 | 112
     877 | 2 |
         | 3 |
      9 | 3 |
```

These give the gives same basic impression.

(c) *Home*: (Min, Q_1, Med, Q_3, Max) = (9, 16, 19, 23, 39).

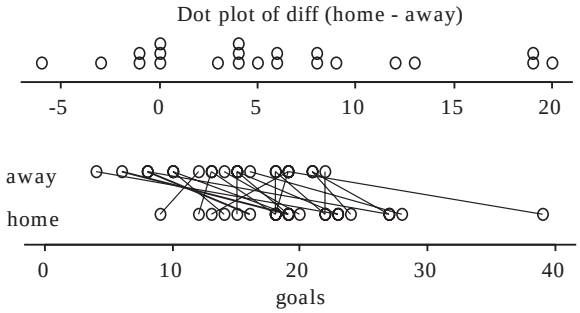
(d)

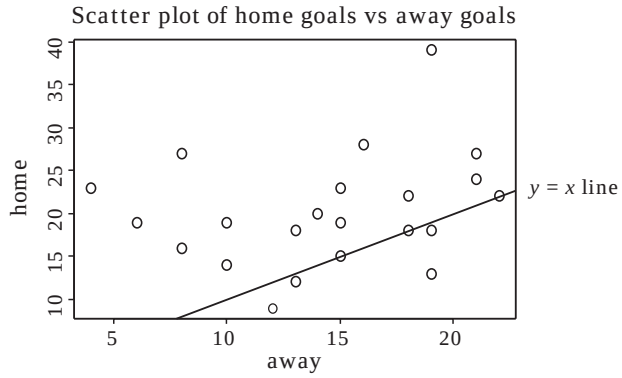


We see the shift toward higher values for home games, the long lower whisker of the "away" box coming from the negative skew in the "away" stem-and-leaf plot. The unusual home-games score of 39 shows up in both the box plot and stem-and-leaf.

(e) We need ways that let us know which pairs of home and away points belong together. We mention three ways. First, we can use a dot plot of the differences. This shows that the home−away differences are almost always positive (i.e., most

teams got more goals at home than away). It also shows the variability in the differences. We see 3 teams (Blackburn Rovers, Manchester City & Everton) with unusually large home−away differences. Second, we can use a linked dot plot. Here points that belong together are linked by lines. We can see that the home score is almost always bigger than the away score. This plot also displays the variability in home scores and in away scores. The variability in the differences is harder to see. Third, we can use a scatter plot (discussed in Chapter 3) to show a tendency for teams who get more away goals to also get more home goals. A point would lie on the $y = x$ line if the number of home and away goals were identical. Most points lie considerably above the line (more home goals than away).





4. (We constructed, ordered and simplified our tables using a spreadsheet.)

(a) In the first table below have ordered the table by largest to smallest on the rate of deforestation during 1990. The rate has been highest in the Ivory Coast and Nigeria. The rate has also been high in Thailand and the Phillipines (though half and one third the rate of the Ivory Coast, respectively). Three South American countries fall at the bottom of the table.

Ordered by rate of deforestation

Country	original	1990	rate
Ivory Coast	160	20	16
Nigeria	70	30	14
Thailand	440	70	8.4
Philippines	250	50	5.4
Malaysia	310	160	3.1
Brazil	2900	2200	2.3
Colombia	700	280	2.3
Bolivia	90	70	2.1
Indonesia	1200	860	1.4
Peru	700	520	0.7
Venezuela	420	350	0.4
Guyana	500	410	0.1

(b) In the table below we have included 2 new columns. We have assumed that the 1990 area was the area at the start of the year and we created the right-most column *1990 area destroyed* by multiplying the 1990 column by the 1990 rate column (which is a percentage) divided by 100. We have also ordered by decreasing amount of deforestation in 1990. This shows which countries destroyed the biggest amounts of forest in that year.

We also constructed another column for part (e), *% destroyed to 1990* as $\frac{(\text{original} - 1990 \text{ area})}{\text{original}} \times 100\%$.

Ordered by amount of deforestation in 1990

Country	original area	area in 1990	% destroyed to 1990	1990 rate (% destroyed)	1990 area destroyed
Brazil	2900	2200	24	2.3	51.0
Indonesia	1200	860	28	1.4	12.0
Colombia	700	280	60	2.3	6.4
Thailand	440	70	84	8.4	5.9
Malaysia	310	160	48	3.1	5.0
Nigeria	70	30	57	14.3	4.3
Peru	700	520	26	0.7	3.6
Philippines	250	50	80	5.4	2.7
Ivory Coast	160	20	88	15.6	3.1
Bolivia	90	70	22	2.1	1.5
Venezuela	420	350	17	0.4	1.4
Guyana	500	410	18	0.1	0.4

(c) Brazil destroyed by far the largest amount in 1990 (Even though 6 countries destroyed a greater percentage, they had less forest to destroy.) The second most went from Indonesia.

(d) Ivory Coast – nearly 16% of remaining forest went.

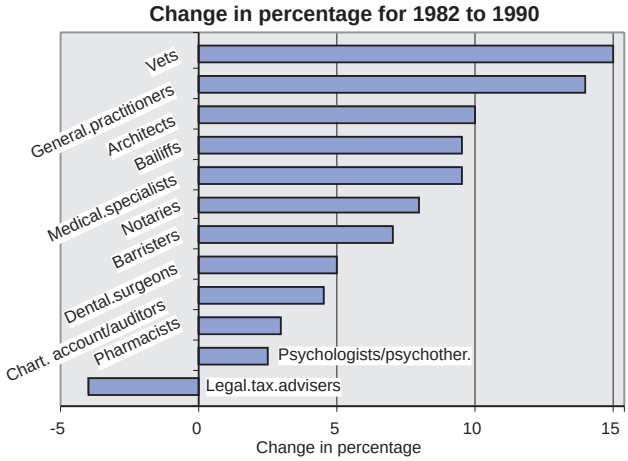
(e) Ivory Coast – 88% had been removed by 1990.

5. (a) 31%.

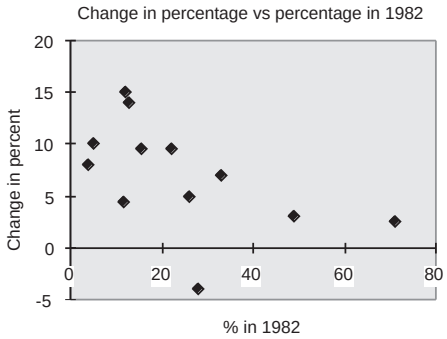
(b) We have constructed the table, ordered by decreasing *change in percentage* (1992 value − 1982 value), and constructed the bar graph. Both are given below. The biggest increases in female participation were for vets and general practitioners (family doctors). There was actually a decrease for legal tax advisers.

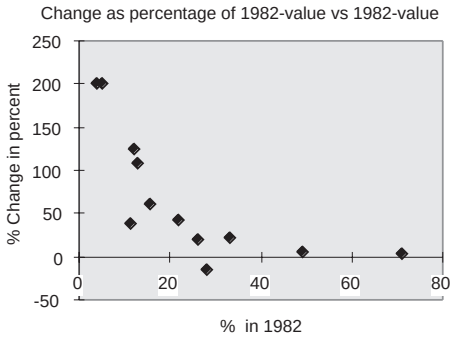
Women in the professions

Profession	%.1982	%.1990	change
Vets	12	27	15
General.practitioners	13	27	14
Architects	5	15	10
Medical.specialists	22	31.5	9.5
Bailiffs	15.5	25	9.5
Notaries	4	12	8
Barristers	33	40	7
Dental.surgeons	26	31	5
Charted.accountants.auditors	11.5	16	4.5
Pharmacists	49	52	3
Psychologists.psychotherapists	71	73.5	2.5
Legal.tax.advisers	28	24	-4



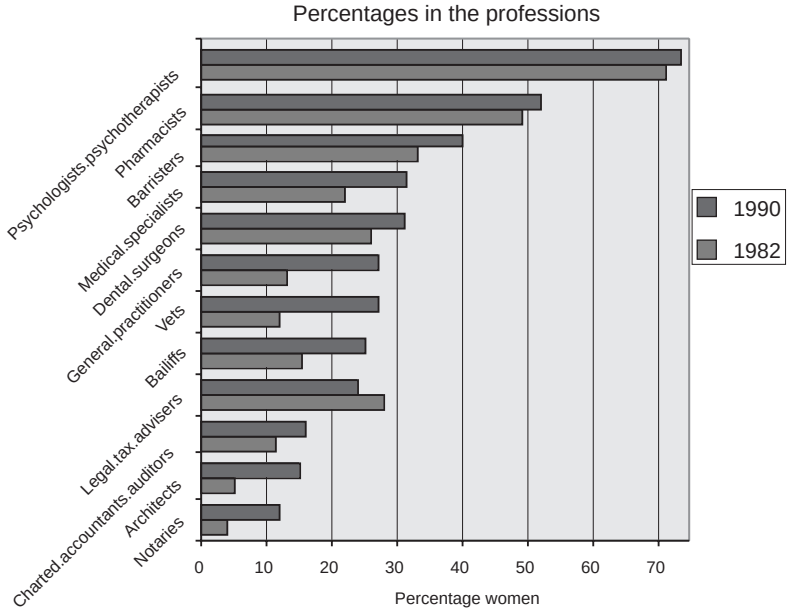
***(c)**





We have given two plots. It depends on what is meant by "gain", as it can be measured by the actual change or the percentage change. Either of these can be plotted against the 1982 percentage using a scatter plot (Chapter 3). Both plots support the conjecture, though the latter does so more strongly.

(d) Below we give a side-by-side bar graph with the two years together for each profession (a standard form of chart from Excel). The plot has been ordered so that the biggest professions with biggest female participation are at the top. We see that the psychologist-physiotherapist category is over 70% female. We also see the biggest changes occurring in the professions in the bottom two thirds of the plot.

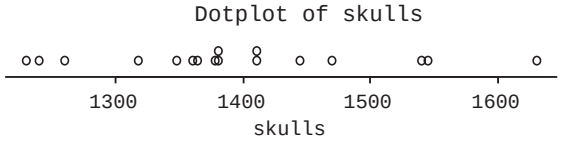


6. **(a)** The two 58's look highly suspect (a great jump in temperature in the middle of the night!). (In fact, from Barnett [1978], there was a change at midnight in the measuring scale from °F to 0.1°C. The last 4 readings should be: $42, 42, 39, 39$.)

(b) The 1.55 looks suspect. The bird appears to be growing steadily except for this one low value. (Actually 1.55 should be 2.05.)

(c) The 12 is clearly wrong. (It should be 1, 2.)

(d) Barnett [1978] says that some statistical tests indicate that the largest value (1630) is an outlier. The following dot plot gives little if any indication that it is an outlier.



7. **(a)** The design seems reasonable. We could also have used BABA. To reduce the amount of change, ABBA or BAAB could have been used.

(b) We see that 738 were caught with mesh size= 35, and 787 were caught with mesh size = 87. Slightly more were caught with the larger mesh, whereas we would expect more to be caught with the smaller mesh (fewer escaping through the mesh). The most obvious explanation is that the boat just happened to come upon fewer fish when trawling the larger-mesh cod end.

(c) Using the rule for estimating means and standard deviations from grouped data, we have: (*35 mm mesh*) mean = 33.427, sd = 3.418; (*87 mm mesh*) mean = 34.549, sd = 3.154. This tells us that the fish caught by the larger-mesh net are slightly longer on average and slightly less variable in length. This is what we

should expect because the larger mesh is failing to hold some of the smaller fish. The 1- and 2-sigma rules would lead us to expect that, for each mesh size, about 68% of the fish caught would have a length within $mean \pm sd$, and about 95% would fall within $mean \pm 2sd$. (In fact, these approximations work quite well with these data).

(d) See Fig. 2(d). Relative frequency histograms let us compare the distributions of fish caught (e.g., the proportions caught within a given length range) by the two types of net in a way that is valid, even if the numbers swimming into the net are quite different.

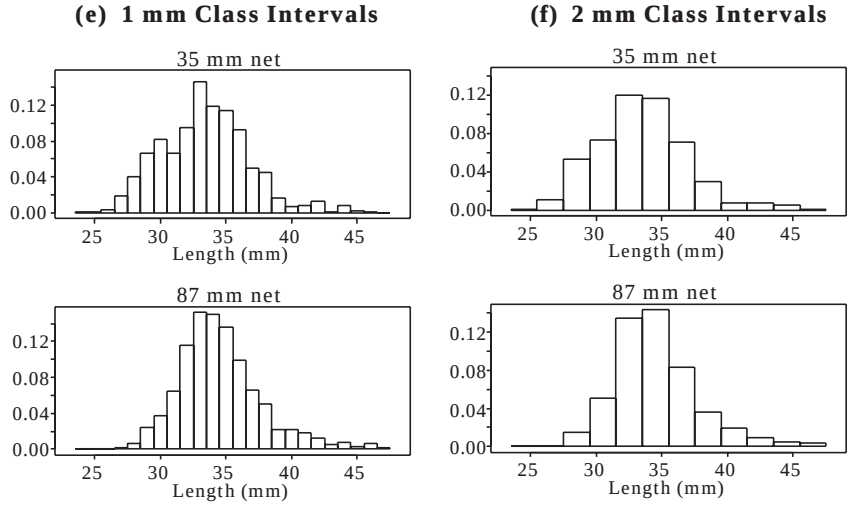


Figure 2 Plots for Question 7(e) and (f)

(e) See Fig. 2(e). The 35 mm mesh caught a higher proportion of smaller fish while the 87 mm mesh caught a higher proportion of larger fish, as expected. The 87 mm mesh would allow more of the smaller fish to escape.

(f) We come to similar conclusions though perhaps it is now easier to see the difference.

8. **(a)** No, because of the pooling in the "8 or more" category.

(b)

No. occupants	Census.1986	Census.1991	% in 1986	% in 1991
1	213876	248085	19.6	21.1
2	332574	375453	30.6	31.9
3	185517	205557	17.0	17.5
4	191772	191646	17.6	16.3
5	101280	97380	9.3	8.3
6	38547	36648	3.5	3.1
7	13848	12771	1.3	1.1
8+	11187	10122	1.0	0.9
Total	1088601	1177662	100	100

The percentages for the smaller numbers of occupants have gone up slightly and those for the larger numbers have decreased. The number of occupants per dwelling seems to have decreased slightly, on average, from 1986 to 1991.

(c) See Fig. 3. The shapes of the two bar graphs are very similar and fine differences between them cannot easily be seen from the separate bar graphs in Fig. 3(a). Even putting them back-to-back (Fig. 3(b)) does not help. However, the small differences can clearly be seen when we put the two years side by side on the same graph(Fig. 3(c)).

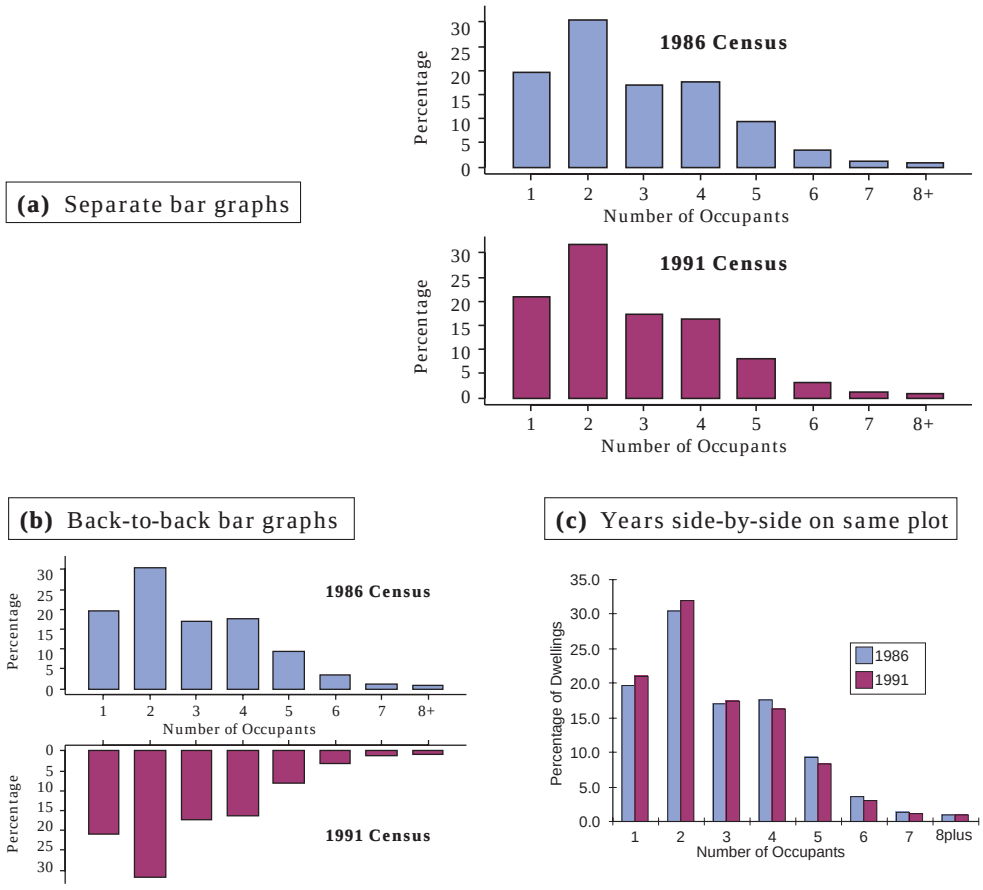
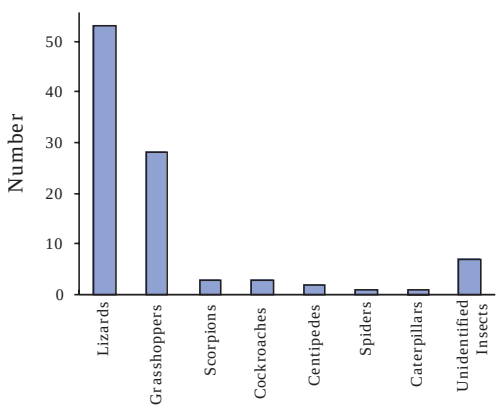


Figure 3 Plots for Question 8(c)

9. (a)



Lizards and grasshoppers are very high on the diet list. Between them they account for almost all of the animals eaten.

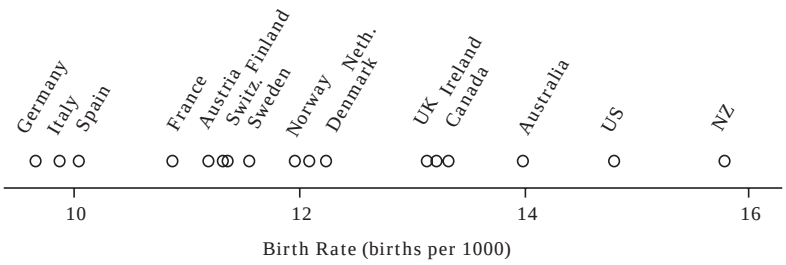
(b) Percentages, as the total numbers of stomachs are different for the two species.

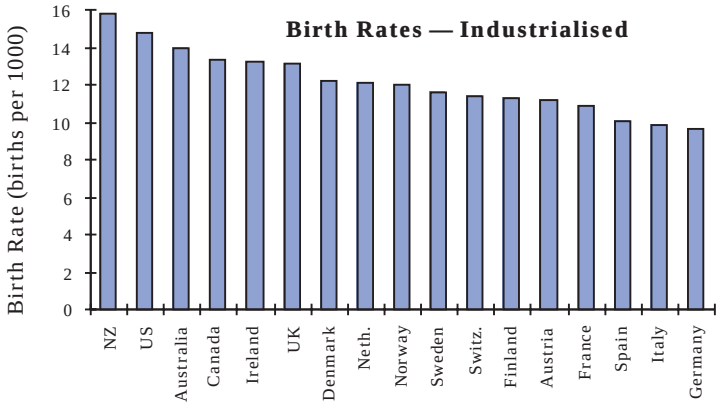
(c) No, because some of the percentages are too small to show on a pie chart.

(d) Depends on the purpose of the study. However, we suggest numbers, as they measure the number of "hits".

(e) Lizards could be more abundant. Preference studies are not easy to carry out. However, the naive approach would be to put *Varanus eremius* in an enclosure with different prey species and see what happens. (However, there can be problems relating to density-dependence which are too technical to discuss.)

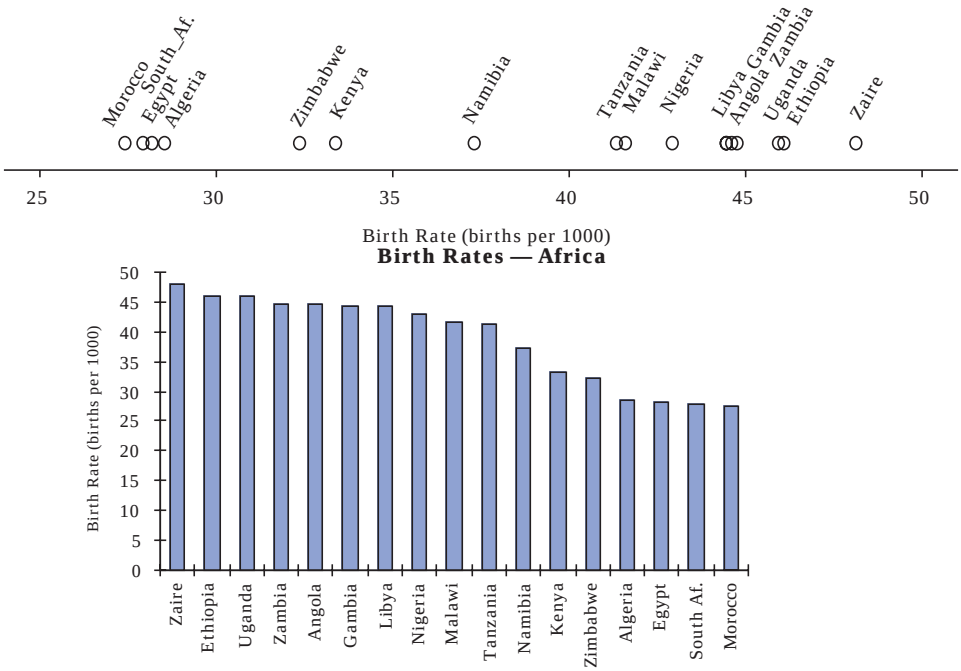
10.





From the dot plot it appears that the countries tend to form clusters. The European countries have lower birth rates than the Scandinavian countries. The United Kingdom and Canada form another group, while Australia, the United States, and New Zealand have higher birth rates. The bar graph does a better job of communicating relative sizes. We see, for example, that the smallest rate (for Germany) is about 2/3 as large as the highest rate (for New Zealand).

11. There is an enormous range in life expectancy, with the highest being Morocco (69.5 years) and the lowest Malawi (36.2 years). The data are fairly well spread out with a hint of small clusters of two or three countries about every five years. These clusters could be studied to see if there are any common features.



12. The following plots compare the male and female life expectancies for the industrialized countries. All the graphs below show similar patterns. In them, we see complete separation between female and male life expectancies (the worst female life expectancy is bigger than the best male life expectancy). The spreads are fairly similar though the female life expectancies seem slightly more variable.

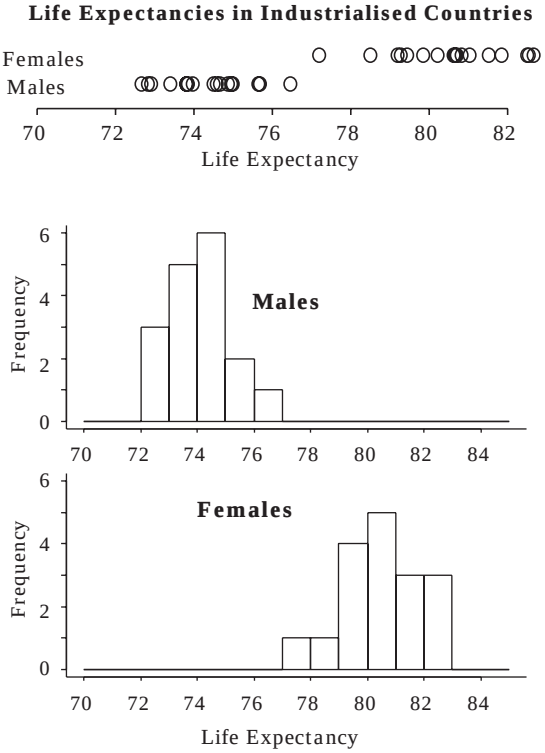
(a) (i)

```
Units  76 | 2 = 76.2 years

 MALES          FEMALES

    987 | 72 |
   8884 | 73 |
 986650 | 74 |
    760 | 75 |
      4 | 76 |
        | 77 | 2
        | 78 | 5
        | 79 | 2348
        | 80 | 26678
        | 81 | 058
        | 82 | 557
```

The graphs for **(ii)** and **(iii)** follow.

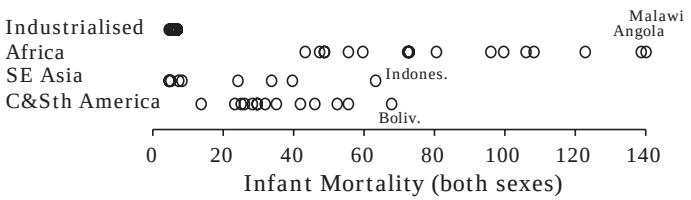


(b) The graphs we have drawn here show no relationships between male and female life expectancies from the same country. Another possibility that would do so is the line-linked dot plot shown in the solution to problem 3. A bar graph like Fig. 3(c) (see solution to problem 8(c)) with life expectancy on the vertical scale and countries ordered by decreasing female life expectancy along the horizontal scale might also be revealing.

13. (a) The female life expectancy is 3 years longer than for males. Zero is special because it is the equality value, namely the female life expectancy is the same as the male). Positive values correspond to a female life expectancy longer than the male.

(b) The female life expectancy is 1.2 times as long as for males (i.e., 20% longer). Unity is special because that is the equality value (female life expectancy same as the male). Values greater (resp. smaller) than 1 correspond to female life expectancies longer (resp. shorter) than male.

14. (i) (a)



The dot plots for the total infant mortality rate are given above.

(b) The infant mortality rate is low and is much the same for all the industrialized nations; it is much higher and very variable for the African countries, with very high rates for some countries; and it is low for some SE Asian countries, but higher and more variable for others. The rate is quite variable for C&Sth America, though lower than the rates of many African countries.

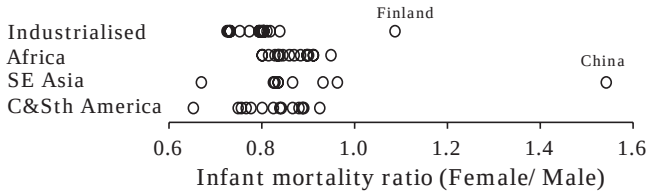
(c) The rates are particularly high for the African countries Malawi (140), Angola (139) and Ethiopia (123), and lowest for Morocco (43). They are low for the Asian countries Hong Kong (5.1), Japan (4.4) and Singapore (4.7), which may be grouped with the industrialized countries, and the rate is high for Indonesia (63). The rate is also high for the South American country Bolivia (68).

(d) The rate appears to be linked to the degree to which a country is industrialized. The wealthier countries might be expected to have better health care for pregnant mothers, and therefore lower rates.

(e) For class discussion. For example, you might like to check out the suggestion in (d). Perhaps the average size of a family is a relevant statistic; can you think of other statistics which might be useful? Also, how are the rates calculated? Are stillborn children included in the rates? What about abortions?

(f) You need a measure to rank countries on something like wealth, industrialization or standard of living etc., and then compare those ranks with the ones determined by the infant mortality rate. This measure could be used for the other data sets as well.

(ii) (a)



The dot plots for the infant mortality ratio (male/female) are given above.

(b) As might be expected, the ratio is a lot less variable across the groups of countries. What is interesting is that the ratio is below 1 for all but two countries indicating that males invariably have a higher mortality rate than females.

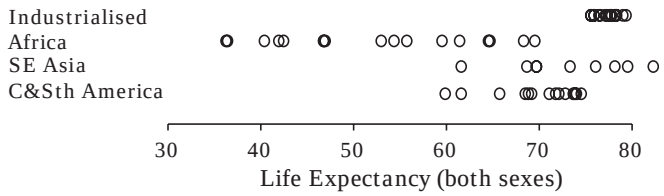
(c) The ratio is greater than 1 for Finland and China, the latter being an extreme outlier.

(d) It is not clear why Finland is different. Is there something wrong with the data, or perhaps there is something different about the way it was collected? The same question applies to China. If the data are reliable, then there appears to be some sort of selection process going on in China!

(e) For class discussion. For example, it would be interesting to explore why boys have a higher mortality rate than girls. Are boys are harder to bring to full term pregnancy than girls? The questions raised in (d) need to be followed up.

(f) You need to find out more about how the data were collected for the different countries, especially China.

(iii) (a)



The dot plots for the life expectancy data are given above.

(b) The life expectancies are high for the industrialized nations as well as for several Asian nations. There is an enormous range of life expectancies for the African nations, with some of them very low. The patterns are almost the reverse of those for infant mortality so that high infant mortality goes with low life expectancy.

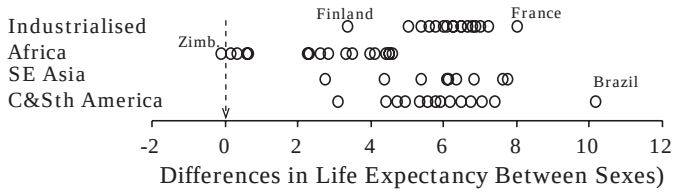
(c) Of the African countries, Malawi and Zambia have life expectancies less than 40, while Morocco has the highest life expectancy of 69.5 with Algeria close behind (68). The life expectancies for the industrialized countries are all over 75, and Hong Kong and Japan have the highest of all the countries. Of the SE Asian countries, Indonesia is clearly the lowest (60), while Bolivia (60) and Brazil (62) in South America are similar.

(d) The level of health care available is certainly a factor in the African countries. The United States, however, has one of the lowest life expectancies for the industrialized nations (76) in spite of its health care. Diet and perhaps lifestyle are key factors which may account for the high values for Hong Kong and Japan (essentially industrialized countries).

(e) For class discussion. There are endless possibilities here. Diet and nutrition are probably important factors to look at. How do you quantify such factors? There is also the question of how the life expectancies were calculated. Did they include the effect of infant mortality? The life expectancy from birth will be lower than the life expectancy from birth given survival at birth.

(f) For class discussion. You clearly need to resolve how the life expectancies were calculated.

(iv) (a)



The dot plots for the differences in the life expectancies are given above.

(b) The first thing we notice is that, except for Zimbabwe, women always have a higher average life expectancy than men. Also the differences are substantial, and they vary a lot for each group of countries. Apart from the African countries, where the difference ranges from about 0 to 4 years, the difference generally ranges from about 4 to 8 years.

(c) Clearly women generally live longer than men even in countries where the lot of women is not easy! Of particular interest is Brazil, with a difference of 10 years. The next biggest difference is shown by France with 8 years.

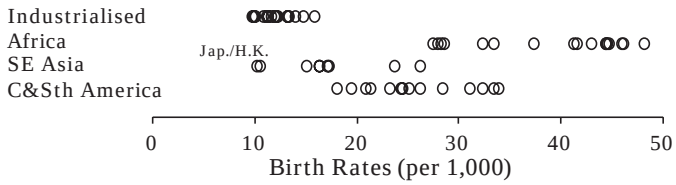
(d) Obviously the care of women will be an important factor, especially in preg-

nancy. Without further knowledge of the countries it is hard to give reasons for the differences.

(e) For class discussion. The key question is why do women live longer than men, and why is the difference so great for some countries. Is there any variable which may be linked to the magnitude of the difference?

(f) For class discussion.

(v) (a)



The dot plots for the birth rates are given above.

(b) The birth rate is low and is less variable for all the industrialized nations; it is much higher and very variable for the African countries, with very high rates for some countries. The rate is low for some SE Asian countries, but higher and more variable for others. The birth rate is quite variable for C&Sth America, though lower than the rates for some African countries. All the SE Asian countries have birth rates lower than those of all the African countries.

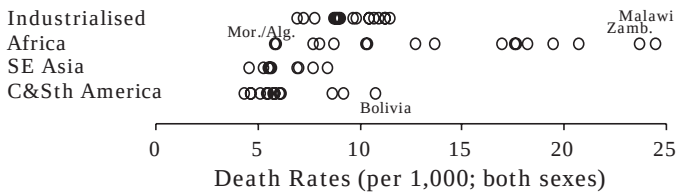
(c) Among the industrialized countries, New Zealand has the highest birth rate, followed by the United States; the European countries tend to have lower rates with Germany and Italy being the lowest for all the countries. There are a number of African countries with rates higher than 40. Of the SE Asian countries, Malaysia and Indonesia have the highest rates, while Hong Kong and Japan have lower rates which are close to being the lowest for all the countries. Again we can see the effects of industrialization of a country on the birth rate.

(d) The birth rates tend to show a similar pattern to the infant mortality rates. This might be expected as higher death rates could mean that women can have more children thus leading to higher birth rates.

(e) For class discussion. An important question is whether "births" include all births or just live births. A possibly useful statistic is the average age at which women get married; younger women can have more children. Also there is the question of the availability of contraceptive help. If the life expectancy is shorter then a bigger proportion of the female population is of child bearing age.

(f) For class discussion.

(vi) (a)



The dot plots for the death rates are given above.

(b) Apart from some of the African countries, the death rates are fairly similar in spread and location for the four groups of countries. The death rates for

some of the African countries are much higher than those of all the other countries. Perhaps surprising at first sight is the fact that the industrialized countries do not have the lowest death rates.

(c) Malawi and Zambia have the highest death rates of all the countries by a substantial margin. Of the industrialized countries, Australia and Canada have the lowest rates, while Morocco and Algeria have the lowest rates for the African countries. Bolivia has clearly the highest rate for the South American countries.

(d) Intuitively, one might expect a high life expectancy to go with a low death rate. This is not the case, as demonstrated by the industrialized countries. The relationship is much more complex as it involves, among other things, the age structure of the population. If you have a high life expectancy there will a big group of older people, and this group will have a higher death rate.

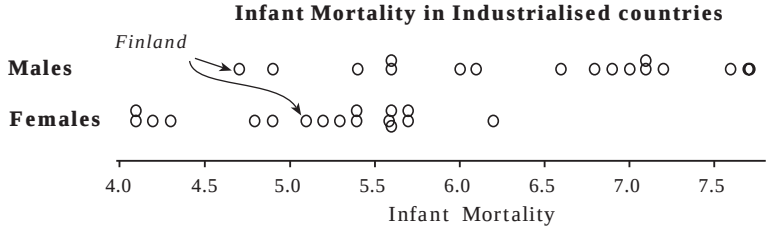
(e) For class discussion. It would be interesting to look at the prevalences of different diseases. For example, industrialized countries will have more deaths from noncommunicable diseases like diabetes and cancer than from communicable diseases like cholera.

(f) For class discussion.

15. (a) Age structure of the population, availability of birth control methods, infant mortality rate, and so on.

(b) The issues are complex. One reason for the higher death rates might be that the industrialized countries generally have higher life expectancies, which means there are more old people. This could apply to the Central and South American countries as well as the less industrialized Asian countries. However Hong Kong, Japan, and Singapore have lower death rates as well as lower infant mortality rates. The infant mortality rate will affect both the total death rate and the life expectancy, so that these factors are all interrelated.

(c) Finland is different in two respects: It has the lowest male mortality rate, and this rate is less than its female mortality rate.



(d) The mean is not very informative as the data set is small and the numbers quite variable. We have mean = 16.9 and median = 16.3. The median is more informative as it is less affected by the extreme values.

(e) If the emphasis is on global improvement, we should look at the number of people experiencing economic growth, rather than the number of countries.

(f) $Increase = Migrants + Births - Deaths.$