3.3: Other Graphical Representations of Data

There are many other types of graphs. Some of the more common ones are the frequency polygon, the dot plot, the stem plot, scatter plot, and a time-series plot. There are also many different graphs that have emerged lately for qualitative data. Many are found in publications and websites. The following is a description of the stem plot, the scatter plot, and the time-series plot.

Stem Plots

Stem plots are a quick and easy way to look at small samples of numerical data. You can look for any patterns or any strange data values. It is easy to compare two samples using stem plots.

The first step is to divide each number into 2 parts, the stem (such as the leftmost digit) and the leaf (such as the rightmost digit). There are no set rules, you just have to look at the data and see what makes sense.

Example 3.3.1 stem plot for grade distribution

The following are the percentage grades of 25 students from a statistics course. Draw a stem plot of the data.

Table 3.3.1: Data of Test Grades

62	87	81	69	87	62	45	95	76	76
62	71	65	67	72	80	40	77	87	58
84	73	93	64	89					

Solution

Divide each number so that the tens digit is the stem and the ones digit is the leaf. 62 becomes 6|2.

Make a vertical chart with the stems on the left of a vertical bar. Be sure to fill in any missing stems. In other words, the stems should have equal spacing (for example, count by ones or count by tens). The *Graph 2.3.1* shows the stems for this example.

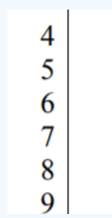


Figure 3.3.1: Stem Plot for Test Grades Step 1

Now go through the list of data and add the leaves. Put each leaf next to its corresponding stem. Don’t worry about order yet just get all the leaves down.

When the data value 62 is placed on the plot it looks like the plot in *Graph 2.3.2*.

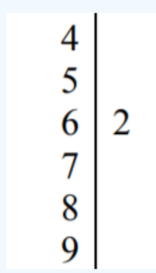


Figure 3.3.2: Stem Plot for Test Grades Step 2

When the data value 87 is placed on the plot it looks like the plot in *Graph 2.3.3*.

4	
5	
6	2
7	
8	7
9	

Figure 3.3.3: Stem Plot for Test Grades Step 3

Filling in the rest of the leaves to obtain the plot in *Graph 2.3.4*.

4	5 0
5	8
6	2 9 2 2 5 7 4
7	6 6 1 2 7 3
8	7 1 7 0 7 4 9
9	5 3

Figure 3.3.4: Stem Plot for Test Grades Step 4

Now you have to add labels and make the graph look pretty. You need to add a label and sort the leaves into increasing order. You also need to tell people what the stems and leaves mean by inserting a legend. **Be careful to line the leaves up in columns**. You need to be able to compare the lengths of the rows when you interpret the graph. The final stem plot for the test grade data is in *Graph 2.3.5*.

Test Scores

4	0 = 40%
4	0 5
5	8
6	2 2 2 4 5 7 9
7	1 2 3 6 6 7
8	0 1 4 7 7 7 9
9	3 5

Figure 3.3.5: Stem Plot for Test Grades

Now you can interpret the stem-and-leaf display. The data is bimodal and somewhat symmetric. There are no gaps in the data. The center of the distribution is around 70.

You can create a stem and leaf plot on R. the command is:

stem(variable) – creates a stem and leaf plot, if you do not get a stem plot that shows all of the stems then use scale = a number. Adjust the number until you see all of the stems. So you would have stem(variable, scale = a number)

For Example 3.3.1, the command would be

```
grades<-c(62, 87, 81, 69, 87, 62, 45, 95, 76, 76, 62, 71, 65, 67, 72, 80, 40, 77, 87, 58, 84, 73, 93, 64, 89)
stem(grades, scale = 2)
```

Output:

The decimal point is 1 digit(s) to the right of the |

4 | 05
5 | 8
6 | 2224579
7 | 123667
8 | 0147779
9 | 35

Now just put a title on the stem plot.

Scatter Plot

Sometimes you have two different variables and you want to see if they are related in any way. A scatter plot helps you to see what the relationship would look like. A scatter plot is just a plotting of the ordered pairs.

Example 3.3.2 scatter plot

Is there any relationship between elevation and high temperature on a given day? The following data are the high temperatures at various cities on a single day and the elevation of the city.

Table 3.3.2: Data of Temperature versus Elevation

Elevation (in feet)	7000	4000	6000	3000	7000	4500	5000
Temperature (°F)	50	60	48	70	55	55	60

Solution

Preliminary: State the random variables

Let x = altitude

y = high temperature

Now plot the x values on the horizontal axis, and the y values on the vertical axis. Then set up a scale that fits the data on each axes. Once that is done, then just plot the x and y values as an ordered pair. In R, the command is:

independent variable<-c(type in data with commas in between values)
dependent variable<-c(type in data with commas in between values)
plot(independent variable, dependent variable, main="type in a title you want", xlab="type in a label for the horizontal axis", ylab="type in a label for the vertical axis", ylim=c(0, number above maximum y value)

For this example, that would be:
elevation<-c(7000, 4000, 6000, 3000, 7000, 4500, 5000)
temperature<-c(50, 60, 48, 70, 55, 55, 60)
plot(elevation, temperature, main="Temperature versus Elevation", xlab="Elevation (in feet)", ylab="Temperature (in degrees F)", ylim=c(0, 80))

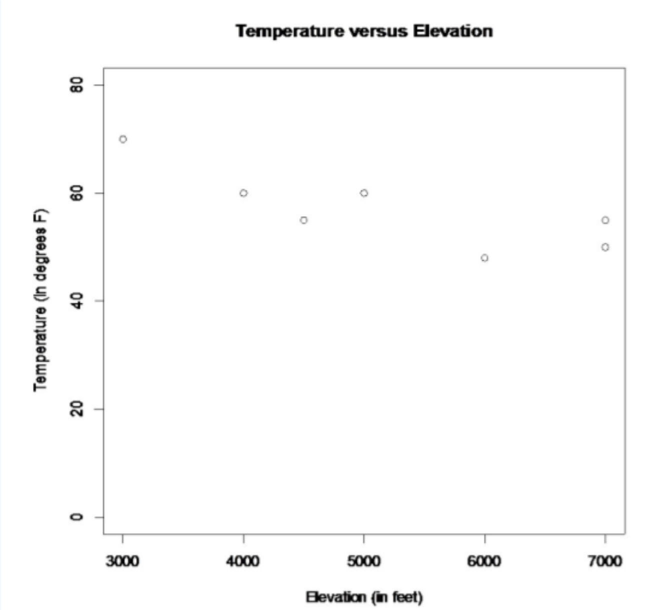


Figure $3.3.6$: Scatter Plot of Temperature versus Elevation

Looking at the graph, it appears that there is a linear relationship between temperature and elevation. It also appears to be a negative relationship, thus as elevation increases, the temperature decreases.

Time-Series

A time-series plot is a graph showing the data measurements in chronological order, the data being quantitative data. For example, a time-series plot is used to show profits over the last 5 years. To create a time-series plot, the time always goes on the horizontal axis, and the other variable goes on the vertical axis. Then plot the ordered pairs and connect the dots. The purpose of a time-series graph is to look for trends over time. Caution, you must realize that the trend may not continue. Just because you see an increase, doesn't mean the increase will continue forever. As an example, prior to 2007, many people noticed that housing prices were increasing. The belief at the time was that housing prices would continue to increase. However, the housing bubble burst in 2007, and many houses lost value, and haven't recovered.

Example $3.3.3$ Time-series plot

The following table tracks the weight of a dieter, where the time in months is measuring how long since the person started the diet

Table $3.3.3$: Data of Weights versus Time

Time (months)	0	1	2	3	4	5
Weight (pounds)	200	195	192	193	190	187

Make a time-series plot of this data

Solution

In R, the command would be:

variable1<-c(type in data with commas in between values, this should be the time variable)
variable2<-c(type in data with commas in between values)
plot(variable1, variable2, ylim=c(0,number over max), main="type in a title you want", xlab="type in a label for the horizontal axis", ylab="type in a label for the vertical axis")
lines(variable1, variable2) – connects the dots

For this example:
time<-c(0, 1, 2, 3, 4, 5)

weight<-c(200, 195, 192, 193, 190, 187)
plot(time, weight, ylim=c(0,250), main="Weight over Time", xlab="Time (Months) ", ylab="Weight (pounds)")
ines(time, weight)

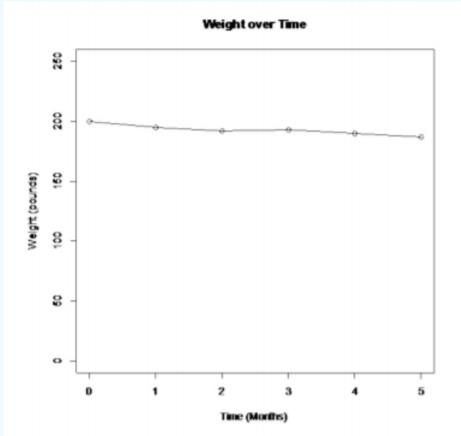
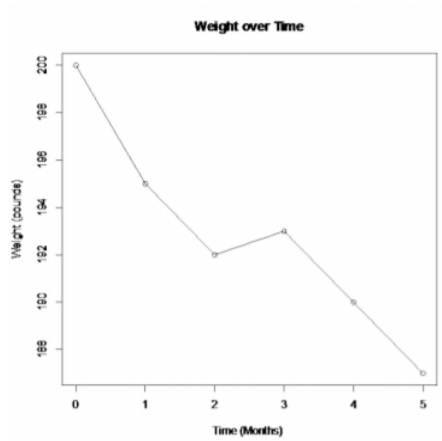


Figure of Weight versus Time

Notice, that over the 5 months, the weight appears to be decreasing. Though it doesn't look like there is a large decrease.

Be careful when making a graph. If you don't start the vertical axis at 0, then the change can look much more dramatic than it really is. As an example, *Graph 2.3.8* shows the *Graph 2.3.7* with a different scaling on the vertical axis. Notice the decrease in weight looks much larger than it really is.



Figure

Homework

1. Students in a statistics class took their first test. The data in Example $3.3.4$ are the scores they earned. Create a stem plot.

Table $3.3.4$: Data of Test 1 Grades

80	79	89	74	73	67	79
93	70	70	76	88	83	73
81	79	80	85	79	80	79
58	93	94	74			

2. Students in a statistics class took their first test. The data in Example $3.3.5$ are the scores they earned. Create a stem plot. Compare to the graph in question 1.

Table $3.3.5$: Data of Test 1 Grades

67	67	76	47	85	70
87	76	80	72	84	98
84	64	65	82	81	81
88	74	87	83		

3. When an anthropologist finds skeletal remains, they need to figure out the height of the person. The height of a person (in cm) and the length of one of their metacarpal bone (in cm) were collected and are in Example $3.3.6$ ("Prediction of height," 2013). Create a scatter plot and state if there is a relationship between the height of a person and the length of their metacarpal.

Table $3.3.6$: Data of Metacarpal versus Height

Length of Metacarpal	Height of Person
45	171
51	178
39	157
41	163
48	172
49	183
46	173
43	175
47	173

4. Example $3.3.7$ contains the value of the house and the amount of rental income in a year that the house brings in ("Capital and rental," 2013). Create a scatter plot and state if there is a relationship between the value of the house and the annual rental income.

Table $3.3.7$: Data of House Value versus Rental

Value	Rental	Value	Rental	Value	Rental	Value	Rental
81000	6656	77000	4576	75000	7280	67500	6864
95000	7904	94000	8736	90000	6240	85000	7072
121000	12064	115000	7904	110000	7072	104000	7904
135000	8320	130000	9776	126000	6240	125000	7904
145000	8320	140000	9568	140000	9152	135000	7488
165000	13312	165000	8528	155000	7488	148000	8320
178000	11856	174000	10400	170000	9568	170000	12688
200000	12272	200000	10608	194000	11232	190000	8320
214000	8528	280000	10400	200000	10400	200000	8320
240000	10192	240000	12064	240000	11648	225000	12480
289000	11648	270000	12896	262000	10192	244500	11232
325000	12480	310000	12480	303000	12272	300000	12480

5. The World Bank collects information on the life expectancy of a person in each country ("Life expectancy at," 2013) and the fertility rate per woman in the country ("Fertility rate," 2013). The data for 24 randomly selected countries for the year 2011 are in Example $3.3.8$. Create a scatter plot of the data and state if there appears to be a relationship between life expectancy and the number of births per woman.

Table $3.3.8$: Data of Life Expectancy versus Fertility Rate

Life Expectancy	Fertility Rate	Life Expectancy	Fertility rate
77.2	1.7	72.3	3.9
55.4	5.8	76.0	1.5
69.9	2.2	66.0	4.2
76.4	2.1	5.9	5.2
75.0	1.8	54.4	6.8
78.2	2.0	62.9	4.7
73.0	2.6	78.3	2.1
70.8	2.8	72.1	2.9
82.6	1.4	80.7	1.4
68.9	2.6	74.2	2.5
81.0	1.5	73.3	1.5
54.2	6.9	67.1	2.4

6. The World Bank collected data on the percentage of gross domestic product (GDP) that a country spends on health expenditures ("Health expenditure," 2013) and the percentage of woman receiving prenatal care ("Pregnant woman receiving," 2013). The data for the countries where this information is available for the year 2011 is in Example $3.3.9$. Create a scatter plot of the data and state if there appears to be a relationship between percentage spent on health expenditure and the percentage of woman receiving prenatal care.

Table $3.3.9$: Data of Prenatal Care versus Health Expenditure

Prenatal Care (%)	Health Expenditure (% of GDP)
47.9	9.6
54.6	3.7
93.7	5.2
84.7	5.2
100.0	10.0
42.5	4.7
96.4	4.8
77.1	6.0
58.3	5.4
95.4	4.8
78.0	4.1
93.3	6.0
93.3	9.5

Prenatal Care (%)	Health Expenditure (% of GDP)
93.7	6.8
89.8	6.1

7. The Australian Institute of Criminology gathered data on the number of deaths (per 100,000 people) due to firearms during the period 1983 to 1997 ("Deaths from firearms," 2013). The data is in Example $3.3.10$. Create a time-series plot of the data and state any findings you can from the graph.

Table $3.3.10$: Data of Year versus Number of Deaths due to Firearms

Year	1983	1984	1985	1986	1987	1988	1989	1990
Rate	4.31	4.42	4.52	4.35	4.39	4.21	3.40	3.61
Year	1991	1992	1993	1994	1995	1996	1997	
Rate	3.67	3.61	2.98	2.95	2.72	2.95	2.3	

8. The economic crisis of 2008 affected many countries, though some more than others. Some people in Australia have claimed that Australia wasn't hurt that badly from the crisis. The bank assets (in billions of Australia dollars (AUD)) of the Reserve Bank of Australia (RBA) for the time period of March 2007 through March 2013 are contained in Example $3.3.11$("B1 assets of," 2013). Create a time-series plot and interpret any findings.

Table $3.3.11$: Data of Date versus RBA Assets

Date	Assets in Billions of AUD
Mar-2006	96.9
Jun-2006	107.4
Sep-2006	107.2
Dec-2006	116.2
Mar-2007	123.7
Jun-2007	134.0
Sep-2007	123.0
Dec-2007	93.2
Mar-2008	93.7
Jun-2008	105.6
Sep-2008	101.5
Dec-2008	158.8
Mar-2009	118.7
Jun-2009	111.9
Sep-2009	87.0
Dec-2009	86.1
Mar-2010	83.4
Jun-2010	85.7
Sep-2010	74.8
Dec-2010	76.0

Date	Assets in Billions of AUD
Mar-2011	75.7
Jun-2011	75.9
Sep-2011	75.2
Dec-2011	87.9
Mar-2012	91.0
Jun-2012	90.1
Sep-2012	83.9
Dec-2012	95.8
Mar-2013	90.5

9. The consumer price index (CPI) is a measure used by the U.S. government to describe the cost of living. Example $3.3.12$ gives the cost of living for the U.S. from the years 1947 through 2011, with the year 1977 being used as the year that all others are compared (DeNavas-Walt, Proctor & Smith, 2012). Create a time-series plot and interpret.

Table 3.3.12: Data of Time versus CPI

Year	CPI-U-RS1 index (December 1977=100)	Year	CPI-U-RS1 index (December 1977=100)
1947	37.5	1980	127.1
1948	40.5	1981	139.2
1949	40.0	1982	147.6
1950	40.5	1983	153.9
1951	43.7	1984	160.2
1952	44.5	1985	165.7
1953	44.8	1986	168.7
1954	45.2	1987	174.4
1955	45.0	1988	180.8
1956	45.7	1989	188.6
1957	47.2	1990	198.0
1958	48.5	1991	205.1
1959	48.9	1992	210.3
1960	49.7	1993	215.5
1961	50.2	1994	220.1
1962	50.7	1995	225.4
1963	51.4	1996	231.4
1964	52.1	1997	236.4
1965	52.9	1998	239.7
1966	54.4	1999	244.7

Year	CPI-U-RS1 index (December 1977=100)	Year	CPI-U-RS1 index (December 1977=100)
1967	56.1	2000	252.9
1968	58.3	2001	260.0
1969	60.9	2002	264.2
1970	63.9	2003	270.1
1971	66.7	2004	277.4
1972	68.7	2005	286.7
1973	73.0	2006	296.1
1974	80.3	2007	304.5
1975	86.9	2008	316.2
1976	91.9	2009	315.0
1977	97.7	2010	320.2
1978	104.4	2011	330.3
1979	114.4		

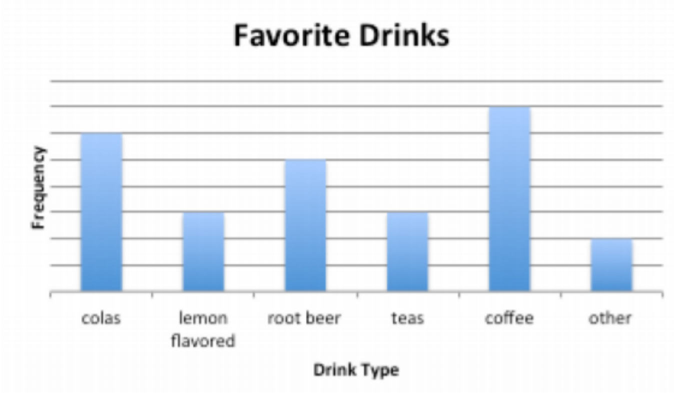
10. The median incomes for all households in the U.S. for the years 1967 to 2011 are given in Example $3.3.13$ (DeNavas-Walt, Proctor & Smith, 2012). Create a time-series plot and interpret.

Table $3.3.13$: Data of Time versus Median Income

Year	Median Income	Year	Median Income
1967	42,056	1990	49,950
1968	43,868	1991	48,516
1969	45,499	1992	48,117
1970	45,146	1993	47,884
1971	44,707	1994	48,418
1972	46,622	1995	49,935
1973	47,563	1996	50,661
1974	46,057	1997	51,704
1975	44,851	1998	53,582
1976	45,595	1999	54,932
1977	45,884	2000	54,841
1978	47,659	2001	53,646
1979	47,527	2002	53,019
1980	46,024	2003	52,973
1981	45,260	2004	52,788
1982	45,139	2005	53,371
1983	44,823	2006	53,768

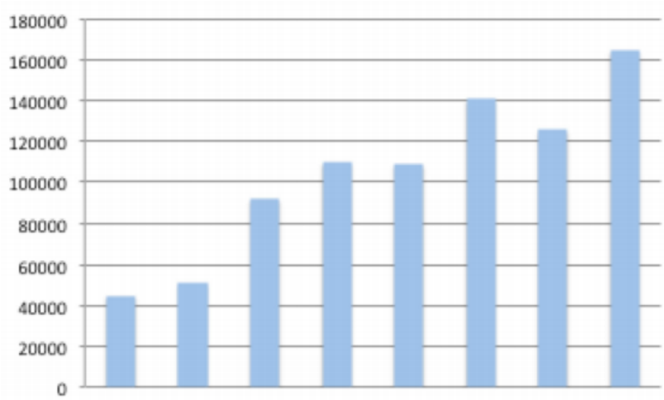
Year	Median Income	Year	Median Income
1984	46,215	2007	54,489
1985	47,079	2008	52,546
1986	48,746	2009	52,195
1987	49,358	2010	50,831
1988	49,737	2011	50,054
1989	50,624		

11. State everything that makes *Graph 2.3.9* a misleading or poor graph.



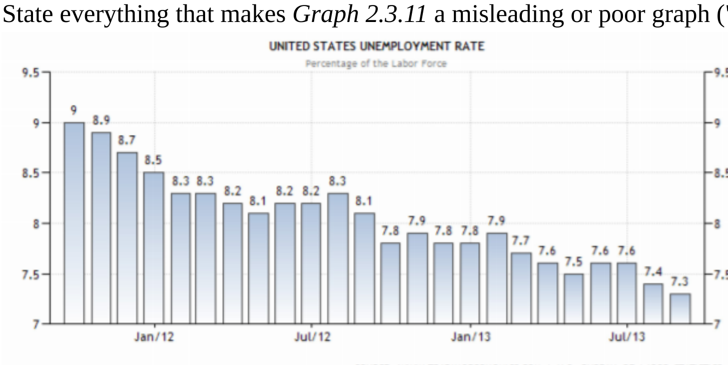
Graph 2.3.9*: Example of a Poor Graph*

12. State everything that makes *Graph 2.3.10* a misleading or poor graph (Benen, 2011).



Graph 2.3.10*: Example of a Poor Graph*

13. State everything that makes *Graph 2.3.11* a misleading or poor graph ("United States unemployment," 2013).



Graph 2.3.11*: Example of a Poor Graph*

14. State everything that makes *Graph 2.3.12* a misleading or poor graph.

***Graph 2.3.12**: Example of a Poor Graph*

Answer

See solutions

Data Sources:

B1 assets of financial institutions. (2013, June 27). Retrieved from www.rba.gov.au/statistics/tables/xls/b01hist.xls

Benen, S. (2011, September 02). [Web log message]. Retrieved from http://www.washingtonmonthly.com/pol...edit031960.php

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2,253,254,34227,255,257,258,259,260,261,262,263,264,265,266,267,268,269,270,271,27
2,274,275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,294,
295,296,297,298,299,300,301,302,304,305,306,307,308

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Gas usage. (2013, October 9). Retrieved from http://www.prb.org/DataFinder/Topic/...s.aspx?ind=165

Health expenditure. (2013, October 14). Retrieved from http://data.worldbank.org/indicator/SH.XPD.TOTL.ZS Hinatov, M. U.S. Consumer Product Safety Commission, Directorate of Epidemiology. (2012). *Incidents, deaths, and in-depth investigations associated with non-fire carbon monoxide from engine-driven generators and other engine-driven tools, 1999-2011*. Retrieved from website: www.cpsc.gov/PageFiles/129857/cogenerators.pdf

Life expectancy at birth. (2013, October 14). Retrieved from http://data.worldbank.org/indicator/SP.DYN.LE00.IN

Median income of males. (2013, October 9). Retrieved from http://www.prb.org/DataFinder/Topic/...s.aspx?ind=137

Median income of males. (2013, October 9). Retrieved from http://www.prb.org/DataFinder/Topic/...s.aspx?ind=136

Prediction of height from metacarpal bone length. (2013, September 26). Retrieved from http://www.statsci.org/data/general/stature.html

Pregnant woman receiving prenatal care. (2013, October 14). Retrieved from http://data.worldbank.org/indicator/SH.STA.ANVC.ZS

United States unemployment. (2013, October 14). Retrieved from http://www.tradingeconomics.com/unit...mployment-rate

Weissmann, J. (2013, March 20). A truly devastating graph on state higher education spending. *The Atlantic*. Retrieved from http://www.theatlantic.com/business/...ending/274199/