

1.7: Stem-and-Leaf Graphs (Stemplots), Line Graphs, and Bar Graphs

One simple graph, the *stem-and-leaf graph* or *stemplot*, comes from the field of exploratory data analysis. It is a good choice when the data sets are small. To create the plot, divide each observation of data into a stem and a leaf. The leaf consists of a final significant digit. For example, 23 has stem two and leaf three. The number 432 has stem 43 and leaf two. Likewise, the number 5,432 has stem 543 and leaf two. The decimal 9.3 has stem nine and leaf three. Write the stems in a vertical line from smallest to largest. Draw a vertical line to the right of the stems. Then write the leaves in increasing order next to their corresponding stem.

Creating a stem-and-leaf plot involves organizing numerical data into a visual format that shows the distribution and helps identify patterns. Here are the steps to create a stem-and-leaf plot:

Step 1. Organize the Data:

- Gather the data you want to represent in the stem-and-leaf plot.
- Arrange the data in ascending order for easier plotting.

Step 2. Determine the Stem and Leaf:

- Decide on the place value for the stem and the leaf. Typically, the stem represents the leading digits, and the leaf represents the trailing digits.
- For example, for numbers in the tens (e.g., 43, 56, 78), the stem could be the tens place (4, 5, 7) and the leaf could be the ones place (3, 6, 8).

Step 3. Create the Stem Column:

- List the stems in a vertical column from the smallest to the largest.
- Write the stems only once, even if they appear multiple times in the data.

Step 4. Add the Leaves:

- For each data point, write the leaf next to its corresponding stem.
- Arrange the leaves in ascending order next to each stem.

Step 5. Title and Label the Plot:

- Provide a title that describes the data being represented.
- Label the stem and leaf columns to make the plot easy to understand.

✓ Example 1.7.1

Consider the following data set:

52, 63, 55, 32, 67, 35, 36, 41, 46, 48, 57, 59, 63, 64, 65, 42, 44 (1.7.1)

Step-by-Step Process:

1. Organize the Data:

- Sorted data:

32, 35, 36, 41, 42, 44, 46, 48, 52, 55, 57, 59, 63, 64, 65, 67 (1.7.2)

2. Determine the Stem and Leaf:

- Stem: Tens place (3, 4, 5, 6)

- Leaf: Ones place

3. Create the Stem Column:

```

Stem | Leaf

-----

3 |

4 |

5 |

6 |  
 ...

4. Add the Leaves:  
 ...

Stem | Leaf

-----  
 3 | 2 5 6  
 4 | 1 2 4 6 8  
 5 | 2 5 7 9  
 6 | 3 4 5 7  
 ...

5. Title and Label the Plot:  
 ...

Distribution of Data

Stem | Leaf

-----  
 3 | 2 5 6  
 4 | 1 2 4 6 8  
 5 | 2 5 7 9  
 6 | 3 4 5 7  
 ...

By following these steps, you can create a stem-and-leaf plot that visually represents your data set.

### ✓ Example 1.7.2

For Susan Dean's spring pre-calculus class, scores for the first exam were as follows (smallest to largest):

33; 42; 49; 49; 53; 55; 55; 61; 63; 67; 68; 68; 69; 69; 72; 73; 74; 78; 80; 83; 88; 88; 88; 88; 90; 92; 94; 94; 94; 94; 96; 100

Stem-and-Leaf Graph

| Stem | Leaf          |
|------|---------------|
| 3    | 3             |
| 4    | 2 9 9         |
| 5    | 3 5 5         |
| 6    | 1 3 7 8 8 9 9 |
| 7    | 2 3 4 8       |
| 8    | 0 3 8 8 8     |
| 9    | 0 2 4 4 4 4 6 |
| 10   | 0             |

The stemplot shows that most scores fell in the 60s, 70s, 80s, and 90s. Eight out of the 31 scores or approximately 26% ( $\frac{8}{31}$ ) were in the 90s or 100, a fairly high number of As.

### ? Exercise 1.7.3

For the Park City basketball team, scores for the last 30 games were as follows (smallest to largest):

32; 32; 33; 34; 38; 40; 42; 42; 43; 44; 46; 47; 47; 48; 48; 48; 49; 50; 50; 51; 52; 52; 52; 53; 54; 56; 57; 57; 60; 61

Construct a stem plot for the data.

**Answer**

| Stem | Leaf                    |
|------|-------------------------|
| 3    | 2 2 3 4 8               |
| 4    | 0 2 2 3 4 6 7 7 8 8 8 9 |
| 5    | 0 0 1 2 2 2 3 4 6 7 7   |
| 6    | 0 1                     |

The stemplot is a quick way to graph data and gives an exact picture of the data. You want to look for an overall pattern and any outliers. An outlier is an observation of data that does not fit the rest of the data. It is sometimes called an **extreme value**. When you graph an outlier, it will appear not to fit the pattern of the graph. Some outliers are due to mistakes (for example, writing down 50 instead of 500) while others may indicate that something unusual is happening. It takes some background information to explain outliers, so we will cover them in more detail later.

#### ✓ Example 1.7.4

The data are the distances (in kilometers) from a home to local supermarkets. Create a stemplot using the data:

1.1; 1.5; 2.3; 2.5; 2.7; 3.2; 3.3; 3.3; 3.5; 3.8; 4.0; 4.2; 4.5; 4.5; 4.7; 4.8; 5.5; 5.6; 6.5; 6.7; 12.3

Do the data seem to have any concentration of values?

HINT: The leaves are to the right of the decimal.

**Answer**

The value 12.3 may be an outlier. Values appear to concentrate at three and four kilometers.

| Stem | Leaf        |
|------|-------------|
| 1    | 1 5         |
| 2    | 3 5 7       |
| 3    | 2 3 3 5 8   |
| 4    | 0 2 5 5 7 8 |
| 5    | 5 6         |
| 6    | 5 7         |
| 7    |             |
| 8    |             |
| 9    |             |
| 10   |             |
| 11   |             |
| 12   | 3           |

### ? Exercise 1.7.5

The following data show the distances (in miles) from the homes of off-campus statistics students to the college. Create a stem plot using the data and identify any outliers:

0.5; 0.7; 1.1; 1.2; 1.2; 1.3; 1.3; 1.5; 1.5; 1.7; 1.7; 1.8; 1.9; 2.0; 2.2; 2.5; 2.6; 2.8; 2.8; 2.8; 3.5; 3.8; 4.4; 4.8; 4.9; 5.2; 5.5; 5.7; 5.8; 8.0

**Answer**

| Stem | Leaf                  |
|------|-----------------------|
| 0    | 5 7                   |
| 1    | 1 2 2 3 3 5 5 7 7 8 9 |
| 2    | 0 2 5 6 8 8 8         |
| 3    | 5 8                   |
| 4    | 4 8 9                 |
| 5    | 2 5 7 8               |
| 6    |                       |
| 7    |                       |
| 8    | 0                     |

The value 8.0 may be an outlier. Values appear to concentrate at one and two miles.

### ✓ Example 1.7.6: Side-by-Side Stem-and-Leaf plot

A side-by-side stem-and-leaf plot allows a comparison of the two data sets in two columns. In a side-by-side stem-and-leaf plot, two sets of leaves share the same stem. The leaves are to the left and the right of the stems. Tables 1.7.1 and 1.7.2 show the ages of presidents at their inauguration and at their death. Construct a side-by-side stem-and-leaf plot using this data.

Table 1.7.1: Presidential Ages at Inauguration

| President   | Age at Inauguration | President    | Age | President    | Age |
|-------------|---------------------|--------------|-----|--------------|-----|
| Pierce      | 48                  | Harding      | 55  | Obama        | 47  |
| Polk        | 49                  | T. Roosevelt | 42  | G.H.W. Bush  | 64  |
| Fillmore    | 50                  | Wilson       | 56  | G. W. Bush   | 54  |
| Tyler       | 51                  | McKinley     | 54  | Reagan       | 69  |
| Van Buren   | 54                  | B. Harrison  | 55  | Ford         | 61  |
| Washington  | 57                  | Lincoln      | 52  | Hoover       | 54  |
| Jefferson   | 57                  | Grant        | 46  | Truman       | 60  |
| Madison     | 57                  | Hayes        | 54  | Eisenhower   | 62  |
| J. Q. Adams | 57                  | Arthur       | 51  | L. Johnson   | 55  |
| Monroe      | 58                  | Garfield     | 49  | Kennedy      | 43  |
| J. Adams    | 61                  | A. Johnson   | 56  | F. Roosevelt | 51  |
| Jackson     | 61                  | Cleveland    | 47  | Nixon        | 56  |

| President      | Age at Inauguration | President | Age | President | Age |
|----------------|---------------------|-----------|-----|-----------|-----|
| Taylor         | 64                  | Taft      | 51  | Clinton   | 47  |
| Buchanan       | 65                  | Coolidge  | 51  | Trump     | 70  |
| W. H. Harrison | 68                  | Cleveland | 55  | Carter    | 52  |

#### 1.7.2 Presidential Age at Death

| President      | Age | President    | Age | President    | Age |
|----------------|-----|--------------|-----|--------------|-----|
| Washington     | 67  | Lincoln      | 56  | Hoover       | 90  |
| J. Adams       | 90  | A. Johnson   | 66  | F. Roosevelt | 63  |
| Jefferson      | 83  | Grant        | 63  | Truman       | 88  |
| Madison        | 85  | Hayes        | 70  | Eisenhower   | 78  |
| Monroe         | 73  | Garfield     | 49  | Kennedy      | 46  |
| J. Q. Adams    | 80  | Arthur       | 56  | L. Johnson   | 64  |
| Jackson        | 78  | Cleveland    | 71  | Nixon        | 81  |
| Van Buren      | 79  | B. Harrison  | 67  | Ford         | 93  |
| W. H. Harrison | 68  | Cleveland    | 71  | Reagan       | 93  |
| Tyler          | 71  | McKinley     | 58  |              |     |
| Polk           | 53  | T. Roosevelt | 60  |              |     |
| Taylor         | 65  | Taft         | 72  |              |     |
| Fillmore       | 74  | Wilson       | 67  |              |     |
| Pierce         | 64  | Harding      | 57  |              |     |
| Buchanan       | 77  | Coolidge     | 60  |              |     |

#### Answer

| Ages at Inauguration                             |   | Ages at Death           |
|--------------------------------------------------|---|-------------------------|
| 9 9 8 7 7 7 6 3 2                                | 4 | 6 9                     |
| 8 7 7 7 7 6 6 6 5 5 5 5 4 4 4 4 2 1 1 1 1<br>1 0 | 5 | 3 6 6 7 7 8             |
| 9 5 4 4 2 1 1 1 0                                | 6 | 0 0 3 3 4 4 5 6 7 7 7 8 |
|                                                  | 7 | 0 0 1 1 1 3 4 7 8 8 9   |
|                                                  | 8 | 0 1 3 5 8               |
|                                                  | 9 | 0 0 3 3                 |

#### ? Exercise 1.7.7

The table shows the number of wins and losses the Atlanta Hawks have had in 42 seasons. Create a side-by-side stem-and-leaf plot of these wins and losses.

| Losses | Wins | Year      | Losses | Wins | Year      |
|--------|------|-----------|--------|------|-----------|
| 34     | 48   | 1968–1969 | 41     | 41   | 1989–1990 |
| 34     | 48   | 1969–1970 | 39     | 43   | 1990–1991 |
| 46     | 36   | 1970–1971 | 44     | 38   | 1991–1992 |
| 46     | 36   | 1971–1972 | 39     | 43   | 1992–1993 |
| 36     | 46   | 1972–1973 | 25     | 57   | 1993–1994 |
| 47     | 35   | 1973–1974 | 40     | 42   | 1994–1995 |
| 51     | 31   | 1974–1975 | 36     | 46   | 1995–1996 |
| 53     | 29   | 1975–1976 | 26     | 56   | 1996–1997 |
| 51     | 31   | 1976–1977 | 32     | 50   | 1997–1998 |
| 41     | 41   | 1977–1978 | 19     | 31   | 1998–1999 |
| 36     | 46   | 1978–1979 | 54     | 28   | 1999–2000 |
| 32     | 50   | 1979–1980 | 57     | 25   | 2000–2001 |
| 51     | 31   | 1980–1981 | 49     | 33   | 2001–2002 |
| 40     | 42   | 1981–1982 | 47     | 35   | 2002–2003 |
| 39     | 43   | 1982–1983 | 54     | 28   | 2003–2004 |
| 42     | 40   | 1983–1984 | 69     | 13   | 2004–2005 |
| 48     | 34   | 1984–1985 | 56     | 26   | 2005–2006 |
| 32     | 50   | 1985–1986 | 52     | 30   | 2006–2007 |
| 25     | 57   | 1986–1987 | 45     | 37   | 2007–2008 |
| 32     | 50   | 1987–1988 | 35     | 47   | 2008–2009 |
| 30     | 52   | 1988–1989 | 29     | 53   | 2009–2010 |

## Answer

Table 1.7.3: Atlanta Hawks Wins and Losses

| Number of Wins              |   | Number of Losses            |  |
|-----------------------------|---|-----------------------------|--|
| 3                           | 1 | 9                           |  |
| 9 8 8 6 5                   | 2 | 5 5 9                       |  |
| 8 7 6 6 5 5 4 3 1 1 1 1 0   | 3 | 0 2 2 2 2 4 4 5 6 6 6 9 9 9 |  |
| 8 8 7 6 6 6 3 3 3 2 2 1 1 0 | 4 | 0 0 1 1 2 4 5 6 6 7 7 8 9   |  |
| 7 7 6 3 2 0 0 0 0           | 5 | 1 1 1 2 3 4 4 6 7           |  |
|                             | 6 | 9                           |  |

Another type of graph that is useful for specific data values is a **line graph**. In the particular line graph shown in Example, the **x-axis** (horizontal axis) consists of **data values** and the **y-axis** (vertical axis) consists of **frequency points**. The frequency points are connected using line segments.

### ✓ Example 1.7.8

In a survey, 40 mothers were asked how many times per week a teenager must be reminded to do his or her chores. The results are shown in Table and in Figure.

| Number of times teenager is reminded | Frequency |
|--------------------------------------|-----------|
| 0                                    | 2         |
| 1                                    | 5         |
| 2                                    | 8         |
| 3                                    | 14        |
| 4                                    | 7         |
| 5                                    | 4         |

### Answer

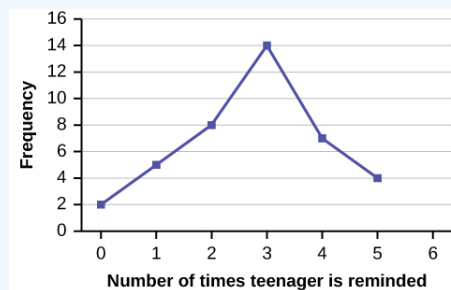


Figure 1.7.1: A line graph showing the number of times a teenager needs to be reminded to do chores on the x-axis and frequency on the y-axis.

### ? Exercise 1.7.9

In a survey, 40 people were asked how many times per year they had their car in the shop for repairs. The results are shown in Table. Construct a line graph.

| Number of times in shop | Frequency |
|-------------------------|-----------|
| 0                       | 7         |
| 1                       | 10        |
| 2                       | 14        |
| 3                       | 9         |

### Answer

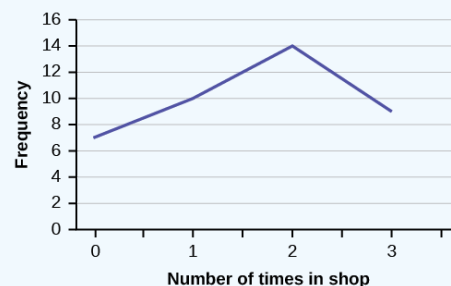


Figure 1.7.2: A line graph showing the number of times a car is in the shop on the x-axis and frequency on the y-axis.

**Bar graphs** consist of bars that are separated from each other. The bars can be rectangles or they can be rectangular boxes (used in three-dimensional plots), and they can be vertical or horizontal. The **bar graph** shown in Example 1.7.9 has age groups represented on the **x-axis** and proportions on the **y-axis**.

### ✓ Example 1.7.10

By the end of 2011, Facebook had over 146 million users in the United States. Table shows three age groups, the number of users in each age group, and the proportion (%) of users in each age group. Construct a bar graph using this data.

| Age groups | Number of Facebook users | Proportion (%) of Facebook users |
|------------|--------------------------|----------------------------------|
| 13–25      | 65,082,280               | 45%                              |
| 26–44      | 53,300,200               | 36%                              |
| 45–64      | 27,885,100               | 19%                              |

**Answer**

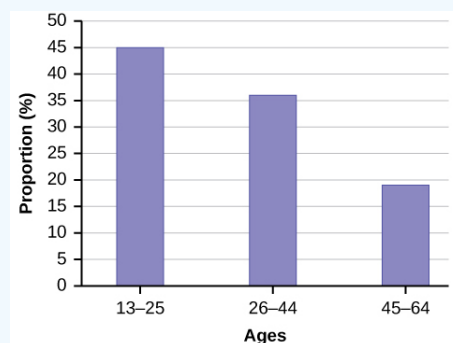


Figure 1.7.3: This is a bar graph that matches the supplied data. The x-axis shows age groups and the y-axis show the percentages of Facebook users

### ? Exercise 1.7.11

The population in Park City is made up of children, working-age adults, and retirees. Table shows the three age groups, the number of people in the town from each age group, and the proportion (%) of people in each age group. Construct a bar graph showing the proportions.

| Age groups         | Number of people | Proportion of population |
|--------------------|------------------|--------------------------|
| Children           | 67,059           | 19%                      |
| Working-age adults | 152,198          | 43%                      |
| Retirees           | 131,662          | 38%                      |

**Answer**



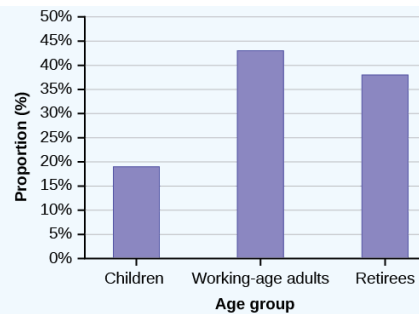


Figure 1.7.4: This is a bar graph that matches the supplied data. The x-axis shows age groups, and the y-axis shows the percentages of Park City's population.

### ✓ Example 1.7.12

The columns in Table contain: the race or ethnicity of students in U.S. Public Schools for the class of 2011, percentages for the Advanced Placement examinee population for that class, and percentages for the overall student population. Create a bar graph with the student race or ethnicity (qualitative data) on the x-axis, and the Advanced Placement examinee population percentages on the y-axis.

| Race/Ethnicity                                | AP Examinee Population | Overall Student Population |
|-----------------------------------------------|------------------------|----------------------------|
| 1 = Asian, Asian American or Pacific Islander | 10.3%                  | 5.7%                       |
| 2 = Black or African American                 | 9.0%                   | 14.7%                      |
| 3 = Hispanic or Latino                        | 17.0%                  | 17.6%                      |
| 4 = American Indian or Alaska Native          | 0.6%                   | 1.1%                       |
| 5 = White                                     | 57.1%                  | 59.2%                      |
| 6 = Not reported/other                        | 6.0%                   | 1.7%                       |

### Solution

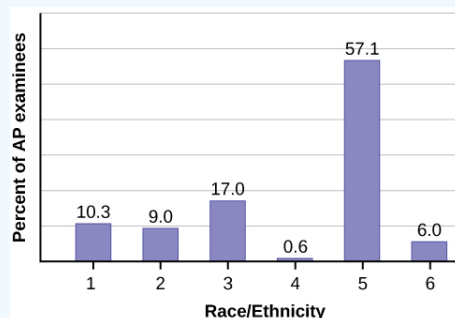


Figure 1.7.5: This is a bar graph that matches the supplied data. The x-axis shows race and ethnicity, and the y-axis shows the percentages of AP examinees.

### ? Exercise 1.7.13

Park city is broken down into six voting districts. The table shows the percent of the total registered voter population that lives in each district as well as the percent total of the entire population that lives in each district. Construct a bar graph that shows the registered voter population by district.

| District | Registered voter population | Overall city population |
|----------|-----------------------------|-------------------------|
| 1        | 15.5%                       | 19.4%                   |

| District | Registered voter population | Overall city population |
|----------|-----------------------------|-------------------------|
| 2        | 12.2%                       | 15.6%                   |
| 3        | 9.8%                        | 9.0%                    |
| 4        | 17.4%                       | 18.5%                   |
| 5        | 22.8%                       | 20.7%                   |
| 6        | 22.3%                       | 16.8%                   |

### Answer



Figure 1.7.6: This is a bar graph that matches the supplied data. The x-axis shows Park City voting districts, and the y-axis shows the percentages of the registered voter population.

## Summary

A **stem-and-leaf plot** is a way to plot data and look at the distribution. In a stem-and-leaf plot, all data values within a class are visible. The advantage in a stem-and-leaf plot is that all values are listed, unlike a histogram, which gives classes of data values. A **line graph** is often used to represent a set of data values in which a quantity varies with time. These graphs are useful for finding trends. That is, finding a general pattern in data sets including temperature, sales, employment, company profit or cost over a period of time. A **bar graph** is a chart that uses either horizontal or vertical bars to show comparisons among categories. One axis of the chart shows the specific categories being compared, and the other axis represents a discrete value. Some bar graphs present bars clustered in groups of more than one (grouped bar graphs), and others show the bars divided into subparts to show cumulative effect (stacked bar graphs). Bar graphs are especially useful when categorical data is being used.

### 1.7.1 - References

1. Burbary, Ken. *Facebook Demographics Revisited – 2001 Statistics*, 2011. Available online at [www.kenburbary.com/2011/03/facebook-demographics-revisited-2001-statistics-2/](http://www.kenburbary.com/2011/03/facebook-demographics-revisited-2001-statistics-2/) (accessed August 21, 2013).
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