3.3 Constructing Frequency Distributions for Quantitative Data

3.4 Histograms and Other Graphical Displays of Quantitative Data

Heart Rates (per min.) of 50 Students

77	84	79	90	67	84	82	74	88	75
69	81	94	68	65	86	78	79	79	70
83	83	84	82	93	80	81	80	87	80
62	98	77	83	82	80	82	73	85	77
77	79	81	70	72	85	84	80	74	83

Table 3.3.1 - Frequency Distribution of Heart Rates

Heart Rate	Number of Students
57–66	2
67–76	10
77–86	32
87–96	5
97–106	1

1. **Determine how many classes should be in the distribution.** Choosing the number of classes is arbitrary and should depend on the amount of data available. The more data available, the more classes that can be used. Generally, fewer than four classes would be too much compression of the data, and greater than 20 classes provides too little summary information.

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2. **Determine the class width.** In some cases, the data set easily lends itself to natural divisions, such as decades or years. At other times, we must choose divisions for ourselves. You will want to choose a width so that the classes formed present a clear representation of the data and include all values in the data set. The width of each class should be the same whenever possible; exceptions may occur for the beginning and ending intervals. There is really no perfect formula for class width that will work for every data set. However, a good starting point for class width is to divide the difference between the maximum observation and minimum observation by the number of classes.

$$\text{Class Width} = \frac{\text{Maximum Value} - \text{Minimum Value}}{\text{Number of Classes}}$$

Class endpoints with fractional values will make the graph harder to understand. If possible, try to keep the width to an integer value by rounding the class width up to the next largest integer or choosing an integer value close to the calculated class width that makes sense.

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$$CW = \frac{98 - 62}{5}$$

$$= 7.2$$

CW = 8

60 - 67 (Lower Limit, Upper Limit)

68 - 75

76 - 83

CW = 6

62 - 67

68 - 73

74 - 79

80 - 85

3. **Find the class limits.** The **lower class limit** is the smallest number that can belong to a particular class, and the **upper class limit** is the largest number that can belong to a class. Using the minimum data value, or a smaller number, as the lower limit of the first class is a good place to start. However, judgment is required. You should choose the first lower limit so that reasonable classes will be produced. After choosing the lower limit of the first class, add the class width to it to find the lower limit of the second class. Continue until you have the desired number of lower class limits. The upper limit of each class is determined such that the classes do not overlap. Once you create your classes, if there are any data values that fall outside the class limits, you must adjust either the class width or your choice for the first lower class limit.
4. **Determine the frequency of each class.** Make a tally mark for each data value in the appropriate class. Count the marks to find the total frequency for each class. Summing the frequencies in each class together should equal the total number of observations in the data set.

PROCEDURE

Heart Rates (per min.) of 50 Students

77	84	79	90	67	84	82	74	88	75
69	81	94	68	65	86	78	79	79	70
83	83	84	82	93	80	81	80	87	80
62	98	77	83	82	80	82	73	85	77
77	79	81	70	72	85	84	80	74	83

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97–106	1

Table 3.3.2 - Heart Rate Relative Frequency Distribution

Heart Rate	Relative Frequency
57–66	2/50 = 0.04
67–76	10/50 = 0.20
77–86	32/50 = 0.64
87–96	5/50 = 0.10
97–106	1/50 = 0.02

Cumulative Frequency

The **cumulative frequency** is the sum of the frequency of a particular class and all preceding classes.

DEFINITION

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Table 3.3.3 - Heart Rate Cumulative Frequency Distribution

Heart Rate	Frequency	Cumulative Frequency
57–66	2	2
67–76	10	12
77–86	32	44
87–96	5	49
97–106	1	50

107-116 0

117-126 1

Cumulative Relative Frequency

The **cumulative relative frequency** is the proportion of observations in a particular class and all preceding classes.

DEFINITION

Table 3.3.4 - Heart Rate Cumulative Relative Frequency

Heart Rate	Relative Frequency	Cumulative Relative Frequency
57–66	0.04	0.04
67–76	0.20	0.24
77–86	0.64	0.88
87–96	0.10	0.98
97–106	0.02	1.00

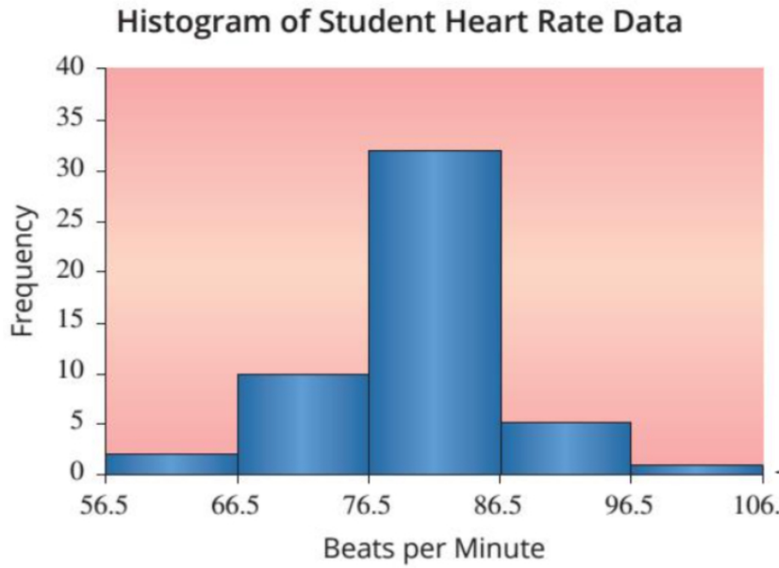
62.4	63.5	60.9	63.3	66.3
61.5	64.3	62.9	60.6	63.8
58.8	64.9	65.7	62.5	70.9
62.9	63.1	62.2	58.7	64.7
66.0	60.5	64.7	65.4	60.2
65.0	64.1	61.1	65.3	64.6
59.2	61.4	62.0	63.5	61.4
65.5	62.3	65.5	64.7	58.8
66.1	64.9	66.9	57.9	69.8
58.5	63.4	69.2	65.9	62.2
60.0	58.1	62.5	62.4	59.1
66.4	61.2	60.4	58.7	66.7
67.5	63.2	56.6	67.7	62.5

max 71.6

$\frac{71.6 - 35.2}{6}$

2.7

55 - 57.9
58 - 60.9 ← 60.4
61 - 63.9
64 - 66.9
67 - 69.9
70 - 72.9



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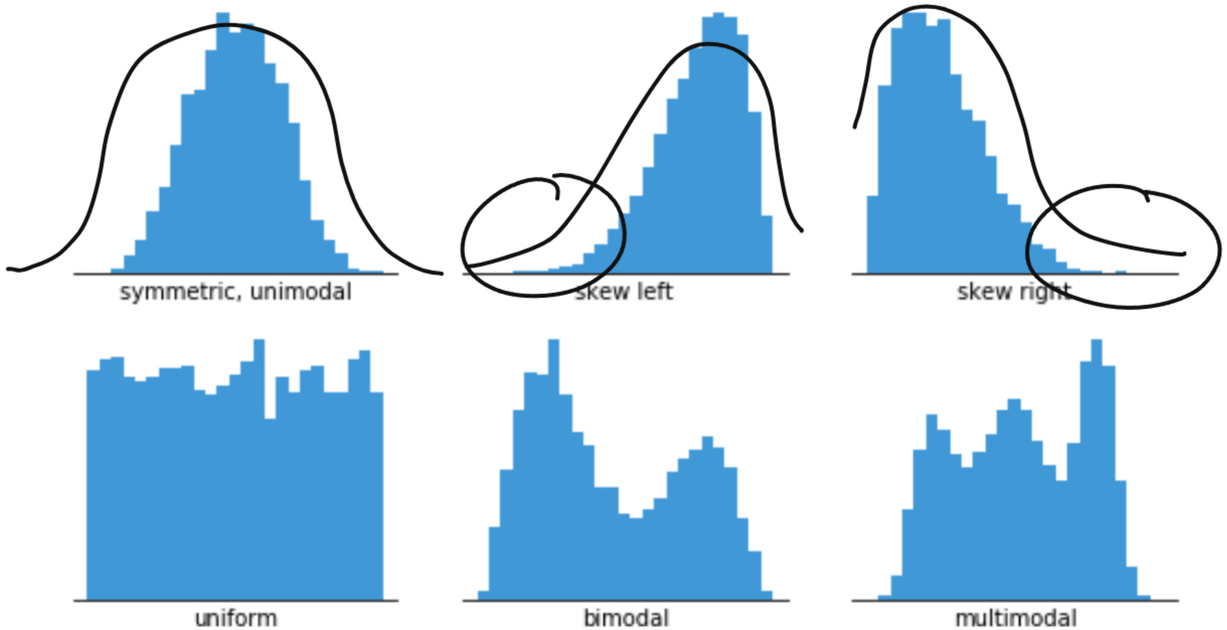
Histogram

A **histogram** is a graphical representation of a frequency or relative frequency distribution. The horizontal scale corresponds to classes of quantitative data values and the vertical scale corresponds to the frequency or relative frequency of each class.

DEFINITION



Stem	Leaf
6	79852
7	7948973790270549
8	44216334201032021540305 78
9	0438
10	
11	5 7

67, 69, 68, 65, 62

77, 79

115

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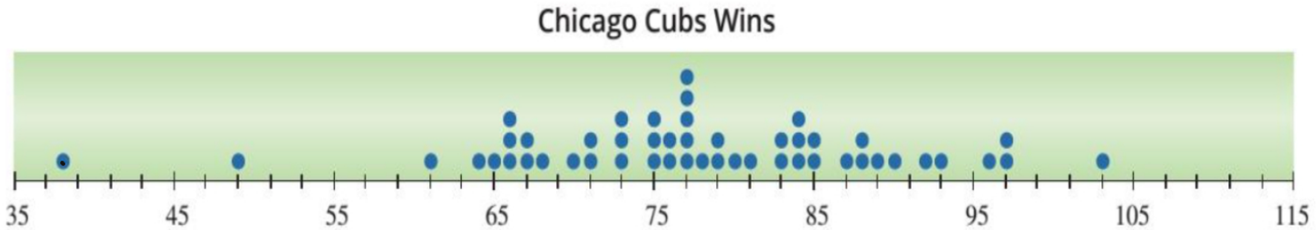
Ordered Stem-and-Leaf Plot	
Stem	**Leaf**
6	2 5 7 8 9
7	0 0 2 3 4 4 5 7 7 7 7 8 9 9 9 9
8	0 0 0 0 0 1 1 1 2 2 2 2 3 3 3 3 4 4 4 4 5 5 6 7 8
9	0 3 4 8
Key: 9	0 = 90 bpm

Figure 3.4.5

Home runs Hit per Season: Babe Ruth vs Barry Bonds		
Ruth		Bonds
04326	0	5
1	1	69
952	2	54568
54	3	3473749
1676961	4	620965
494	5	
0	6	
	7	3



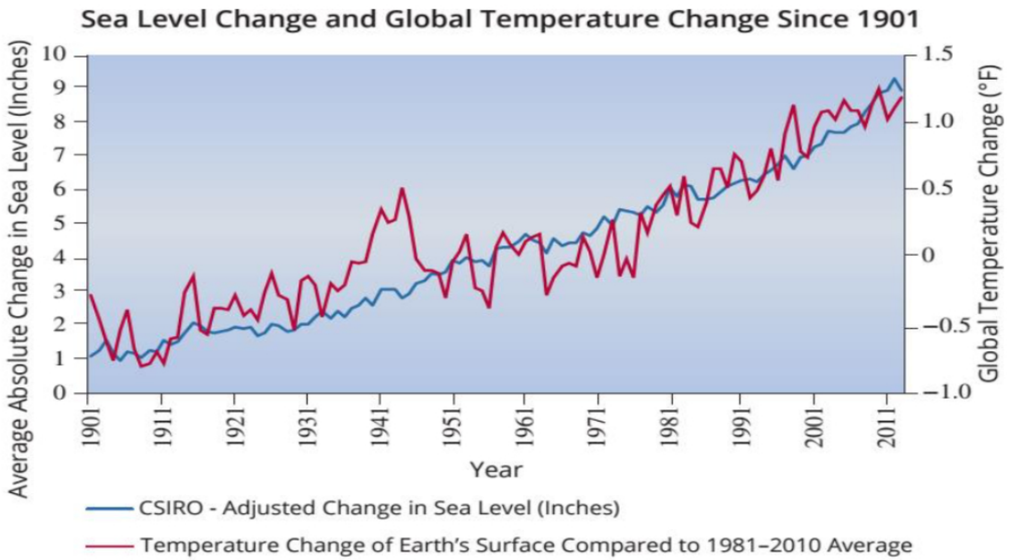


Figure 3.4.8

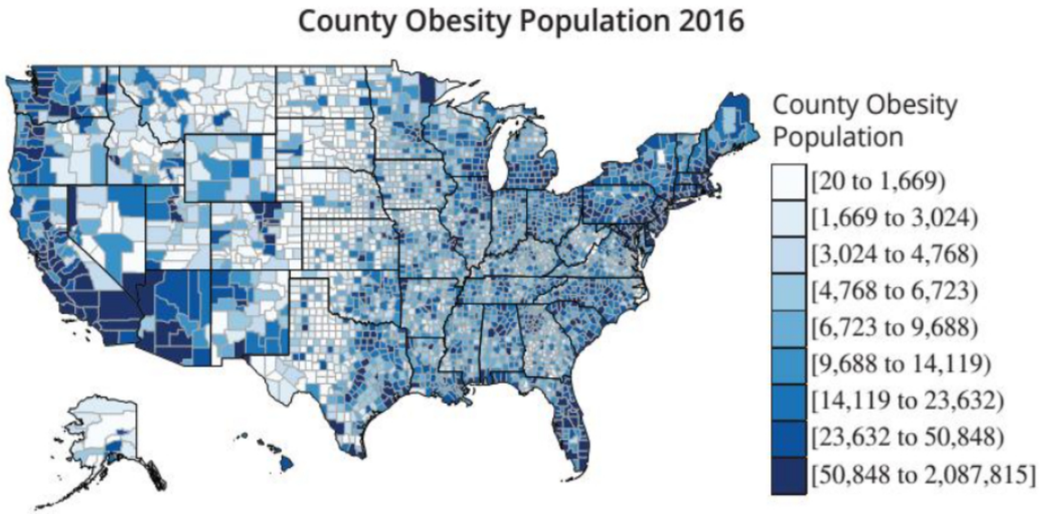
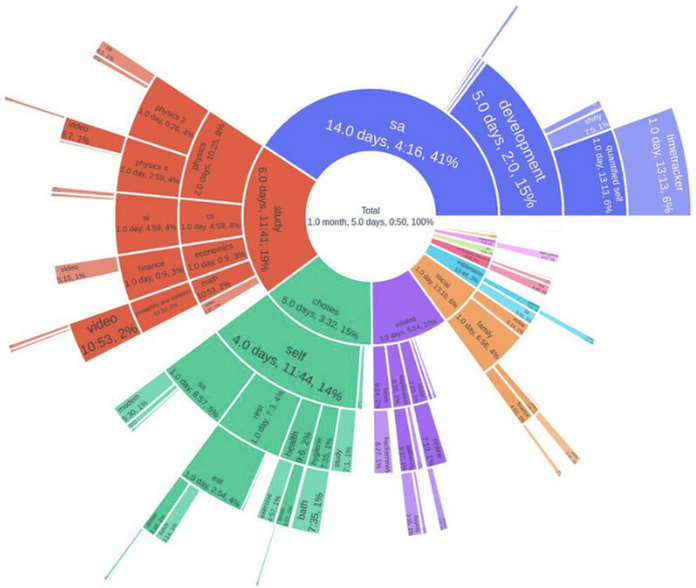


Figure 3.4.9


Total
1.0 month, 5.0 days, 0:50, 100%
sa
14.0 days, 4:16, 41%
development
5.0 days, 2:0, 15%
timetracker
1.0 day, 13:13, 6%
quantified self
1.0 day, 12:11, 6%
study
9.0 days, 11:47, 19%
physics
2.0 days, 10:25, 8%
physics 2
1.0 day, 4:26, 4%
physics 4
1.0 day, 2:59, 4%
ai
1.0 day, 4:59, 4%
cs
1.0 day, 4:59, 4%
economics
1.0 day, 0:9, 3%
finance
1.0 day, 0:9, 3%
video
10:53, 20%
chores
5.0 days, 3:32, 15%
self
4.0 days, 11:44, 14%
rest
1.0 day, 7:3, 4%
bath
7:35, 1%
weasel
2.0 days, 5:54, 10%
family
1.0 day, 6:54, 4%