Measures of Relative Standing and Boxplots

Colby Community College

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- A data value is *significantly high* if $z \geq 2$.
- If a data value is less than the mean, its z-score will be negative.

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The weights of a sample of 400 newborn baby weights has mean $\bar{x} = 3152.0$ g and standard deviation $s = 693.4$ g. What is the z-score of a 4000 g baby?

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Rounding

Round z-scores to two decimal places.

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Round percentiles to the nearest whole number.

Example 3

The table lists the 50 Verizon airport data speeds, in Mbps, from Data Set 32 in Appendix B.

38.5	55.6	22.4	14.1	23.1	24.5	6.5	21.5	25.7	14.7
77.8	71.3	43.0	20.2	15.5	13.7	11.1	13.5	10.2	21.1
15.1	14.2	4.5	7.9	9.9	10.3	6.2	17.5	22.2	13.1
18.2	28.5	15.8	15.0	11.1	11.8	16.0	10.9	1.8	34.6
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What percentile is the data value 11.8 Mbps in?

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There are 20 data values less than 11.8 Mbps.

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Note

This can be interpreted loosely as 40% of Verizon data speeds are slower than 11.8 Mbps and 60% of Verizon data speeds are faster than 11.8 Mbps.

Converting a Percentile to a Data Value

Notation:

- n is the total number of values in the data set.
- k is the percentile being used.
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- P_k is the kth percentile.

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    - If L is a whole number, the value of the kth percentile is midway between the Lth value and the next value in the sorted data. Add the Lth value and $(L+1)$th value, then divide by 2.
    - If L is not a whole number, round L up to the nearest whole number. $P_k$is the Lth data value.

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The table lists the 50 Verizon airport data speeds, in Mbps, from Data Set 32 in Appendix B.

38.5	55.6	22.4	14.1	23.1	24.5	6.5	21.5	25.7	14.7
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What is the value in the 25th percentile, P_{25}?

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11.8	12.0	13.1	13.5	13.7	14.1	14.2	14.7	15.0	15.1
15.5	15.8	16.0	17.5	18.2	20.2	21.1	21.5	22.2	22.4
23.1	24.5	25.7	28.5	34.6	38.5	43.0	55.6	71.3	77.8

What is the value in the 25th percentile, P_{25}?
First, sort the data.

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What is the value in the 25th percentile, P_{25}?
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We next need to compute

$$L = \frac{k}{100} \cdot n$$

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First, sort the data.
We next need to compute

$$L = \frac{k}{100} \cdot n = \frac{25}{100} \cdot 50 = 12.5$$

Since $L = 12.5$ is not a whole number, we round up to 13.
So, P_{25} is the 13th data value, 7.9 Mbps.

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Note

Use the same procedure for calculating percentiles to calculate quartiles.

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The **midquartile** is $\frac{Q_3 + Q_1}{2}$.

Definition

The **10-90 percentile range** is $P_{90} - P_{10}$.

Definition

For a set of data, the **5-number summary** consists of the five values:

1. Minimum
2. Q_1
3. Median (Q_2)
4. Q_3
5. Maximum

Example 5

The table lists, in order from lowest to highest, the 50 Verizon airport data speeds, in Mbps, from
Data Set 32 in Appendix B.

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We can compute the following:

$$\text{minimum} = 0.8$$

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6.5	7.7	7.9	9.9	10.2	10.3	10.9	11.1	11.1	11.6
11.8	12.0	13.1	13.5	13.7	14.1	14.2	14.7	15.0	15.1
15.5	15.8	16.0	17.5	18.2	20.2	21.1	21.5	22.2	22.4
23.1	24.5	25.7	28.5	34.6	38.5	43.0	55.6	71.3	77.8

We can compute the following:

$$\text{minimum} = 0.8$$
$$Q_1 = 7.9$$
$$Q_2 = 13.9$$

Example 5

The table lists, in order from lowest to highest, the 50 Verizon airport data speeds, in Mbps, from
Data Set 32 in Appendix B.

0.8	1.4	1.8	1.9	3.2	3.6	4.5	4.5	4.6	6.2
6.5	7.7	7.9	9.9	10.2	10.3	10.9	11.1	11.1	11.6
11.8	12.0	13.1	13.5	13.7	14.1	14.2	14.7	15.0	15.1
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We can compute the following:

$$\begin{aligned} \text{minimum} &= 0.8 \\ Q_1 &= 7.9 \\ Q_2 &= 13.9 \\ Q_3 &= 21.5 \\ \text{maximum} &= 77.8 \end{aligned}$$

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The table lists, in order from lowest to highest, the 50 Verizon airport data speeds, in Mbps, from
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23.1	24.5	25.7	28.5	34.6	38.5	43.0	55.6	71.3	77.8

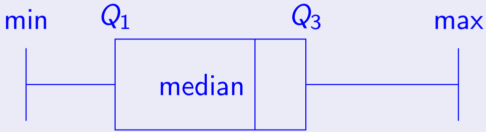
We can compute the following:

$$\text{minimum} = 0.8$$
$$Q_1 = 7.9$$
$$Q_2 = 13.9$$
$$Q_3 = 21.5$$
$$\text{maximum} = 77.8$$

And so, the 5-number summary is 0.8 7.9 13.9 21.5 77.8

Definition

A **boxplot** is a graph of a data set that consists of a line extending from the minimum value to the maximum value, and a box with lines drawn at the first quartile Q_1, the median, and the third quartile Q_3.

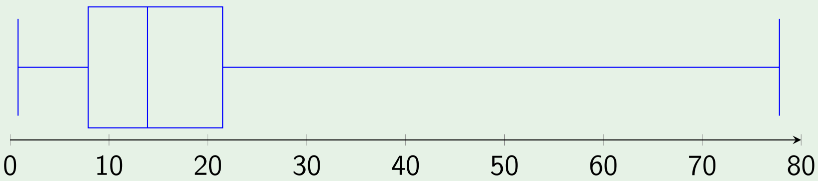


Example 6

The 5-number summary of the the 50 Verizon airport data speeds, in Mbps, from
Data Set 32 in Appendix B is:

0.8 7.9 13.9 21.5 77.8

The boxplot is:

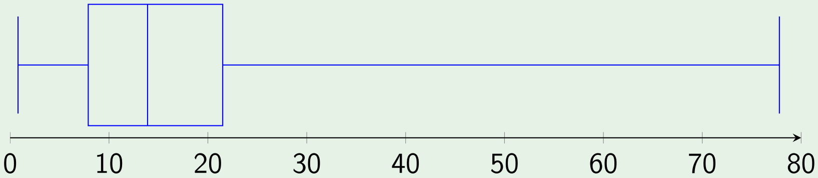


Example 6

The 5-number summary of the the 50 Verizon airport data speeds, in Mbps, from
Data Set 32 in Appendix B is:

$$0.8 \quad 7.9 \quad 13.9 \quad 21.5 \quad 77.8$$

The boxplot is:

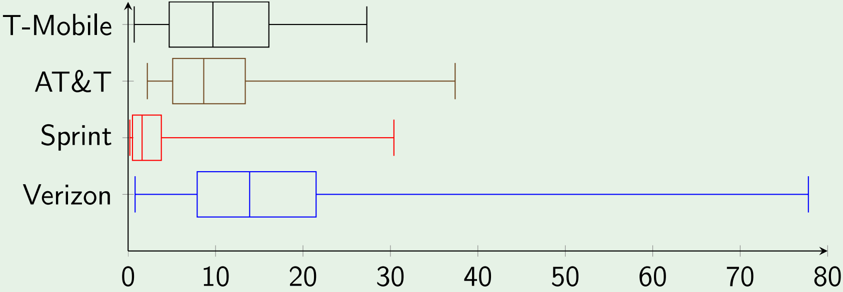


Note

A boxplot can often be used to identify skewness.

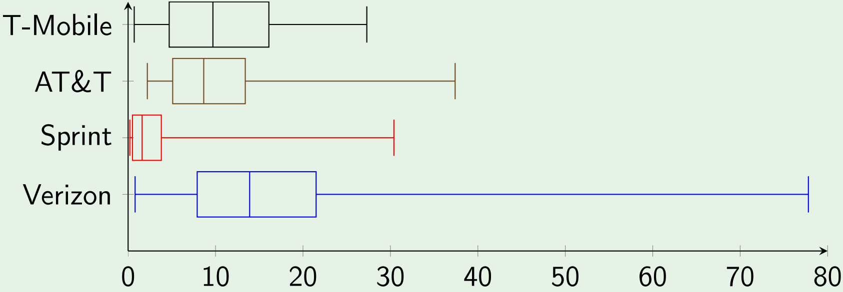
Example 7

We can use boxplots to easily compare the four carriers from Data Set 32 in Appendix B.



Example 7

We can use boxplots to easily compare the four carriers from Data Set 32 in Appendix B.



Verizon and T-Mobile are not that different for over 75% of customers.

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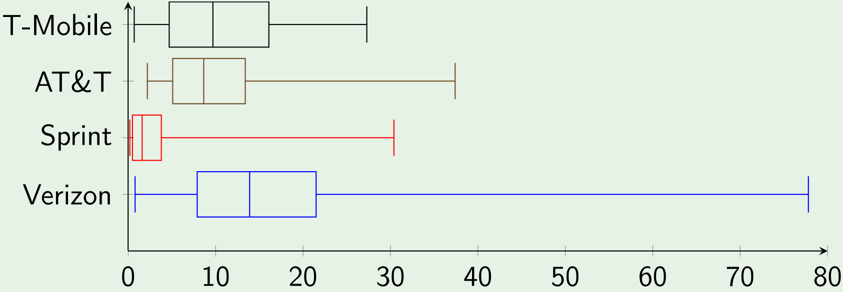

Verizon and T-Mobile are not that different for over 75% of customers.

Outliers

It is important to identify outliers because they can strongly affect the values of important statistics.