Chapter 1

Descriptive Statistics

1.1 Populations, Samples, and Processes

1.2 Pictorial and Tabular Methods in Descriptive Statistics

1.3 Measures of Location

1.4 Measures of Variability

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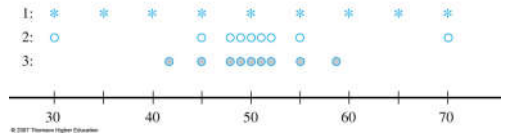
Variability



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The Range

is the difference between the largest and smallest sample values.

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Example

US beer production (in millions of barrels) for different quarters during 1975 – 1982:

32, 47, 48, 34, 35, 46, 47, 33, 37, 51, 49, 33, 40, 52, 51, 39, 42, 56, 55, 43, 45, 57, 57, 43, 45, 58, 57, 44, 49, 56, 54, 50.

Find the range of this data set.

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The (Sample) Variance

of observations $x_1, x_2, \ldots, x_n$ is given by

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2$$

The root of the sample variance is called the sample standard deviation

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Example

A sample of eight resistors of a certain type resulted in the following sample resistances (in ohm):

40, 43, 39, 35, 37, 43, 46, 37.

Find the sample variance.

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A Computing Formula for the Variance

An alternative expression for s^2 is

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n} x_i^2 - \frac{1}{n(n-1)}\left(\sum_{i=1}^{n} x_i\right)^2$$

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Example

A sample of eight resistors of a certain type resulted in the following sample resistances (in ohm):

40, 43, 39, 35, 37, 43, 46, 37.

Find the sample variance using the shortcut formula.

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Properties of the Variance

1. **Adding the same number to each element of a data set leaves the sample variance unchanged.**
2. **Multiplying each element of a data set with the same number results in a data set with new sample variance equal to the old sample variance times the square of that number.**

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Example

A sample of eight resistors of a certain type resulted in the following sample resistances (in ohm):

40, 43, 39, 35, 37, 43, 46, 37.

Find the sample variance if each of the resistances were

(a) reduced by 35

(b) multiplied by 10.

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Lower/Upper Fourth, Fourth Spread

1. **Order the observations from smallest to largest and separate the smallest half from the largest half (the median is included in both if the sample size is odd).**
2. **The lower fourth is the median of the smallest half.**
3. **The upper fourth is the median of the largest half.**
4. **The fourth spread is the difference between the upper fourth and the lower fourth.**

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Boxplots

1. **Draw a horizontal measure scale.**
2. **Place a rectangle above the axis, where the left edge of the rectangle is at the lower fourth and the right edge at the upper fourth.**
3. **Place a vertical line segment inside the rectangle at the location of the median.**
4. **Draw "whiskers" out from either end of the rectangle to the smallest and largest observations.**

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Example

US beer production (in millions of barrels) for different quarters during 1975 – 1982:

32, 47, 48, 34, 35, 46, 47, 33, 37, 51, 49, 33, 40, 52, 51, 39, 42, 56, 55, 43, 45, 57, 57, 43, 45, 58, 57, 44, 49, 56, 54, 50.

Draw a boxplot of this data set.

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Outliers

- **Any observation farther than 1.5 times the fourth spread from the closest fourth is called an outlier.**
- **An outlier is extreme if it is more than 3 times the fourth spread from the closest fourth.**
- **An outlier is mild if it is not extreme.**

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Example

A sample of pulse widths from slow discharges in a cylindrical cavity made of polyethylene is as follows:

5.3, 8.2, 13.8, 74.1, 85.3, 88.0, 90.2, 91.5, 92.4, 92.9, 93.6, 94.3, 94.8, 94.9, 95.5, 95.8, 95.9, 96.6, 96.7, 98.1, 99.0, 101.4, 103.7, 106.0, 113.5.

Draw a boxplot of this data set that shows and classifies the outliers.

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