Chapter 3  Averages and Variation

Section 3.1  Measures of Central Tendency: Mode, Median, and Mean

Objective: In this lesson you learned how to compute, interpret, and explain mean, median, and mode.

<table>
<thead>
<tr>
<th>Important Vocabulary</th>
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<tbody>
<tr>
<td>Average</td>
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<tr>
<th>Important Notation</th>
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<td>$\sum x$</td>
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What is an average used to describe?

I. Mode

The mode:

What are some disadvantages to using mode?

What are some advantages to using mode?

Focus Points:
- Compute mean, median, and mode from raw data
- Interpret what mean, median, and mode tell you
- Explain how mean, median, and mode can be affected by extreme data values
- What is a trimmed mean? How do you compute it?

II. Median

The median:

What is an average used to describe?
How to find the median
1.

2.

3.

What are some advantages to using median?

III. Mean

The mean:

What does the following notation mean and when is it used?
- \( \sum x \)
- \( \bar{x} \)
- \( \mu \)

How to find the mean
1.

2.
What do averages tell us?

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What is a major disadvantage to using mean?

What is a trimmed mean?

How to compute a 5% trimmed mean

1.

2.

3.
In general, when a data distribution is mound-shaped symmetrical, the values for mean, median, and mode are:

**IV. Weighted Average**

\[
\text{Weighted Average} = \text{Focus Point:} \\
\text{• Compute a weighted average}
\]
Section 3.1 Examples – Measures of Central Tendency: Mode, Median, Mean

Belleview College must make a report to the budget committee about the average credit hour load a full-time student carries. (A 12-hour credit load is the minimum requirement for full-time students. For the same tuition, students may take up to 20 credit hours.) A random sample of 40 students yielded the following information (in credit hours):

17 12 14 17 13 16 18 20 13 12
12 17 16 15 14 12 12 13 17 14
15 12 15 16 12 18 20 19 12 15
18 14 16 17 15 19 12 13 12 15

a. Organize the data from smallest to largest number of credit hours.

b. Since there are an _________ (odd, even) number of values, we add the two middle values and divide by 2 to get the median. What is the median credit hour load?

c. What is the mode of this distribution? Is it different from the median?

d. If the budget committee is going to fund the college according to the average student credit hour load (more money for higher loads), which of these two averages do you think the college will report?
Barron’s Profiles of American Colleges, 19th Edition, lists average class size for introductory lecture courses at each of the profiled institutions. A sample of 20 colleges and universities in California showed class sizes for introductory lecture courses to be

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a. Compute the mean for the entire sample.

b. Compute a 5% trimmed mean for the sample.

c. Find the median of the original data set.

d. Find the median of the 5% trimmed data set. Does the median change when you trim the data?

e. Is the trimmed mean or the original mean closer to the median?

(3) Suppose your midterm test score is 83 and your final exam score is 95. Using weights of 40% for the midterm and 60% for the final exam, compute the weighted average of your scores. If the minimum average for an A is 90, will you earn an A?
I. **Variance and Standard Deviation**

What are two measures that will measure the distribution or spread of data around an expected value (either $\bar{x}$ or $\mu$)?

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Formula</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Mean</td>
<td>$\mu$</td>
<td></td>
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**Important Vocabulary**

- Range
- Variance
- Standard Deviation
- Sum of Squares
- Sample Variance

- Sample Standard Deviation
- Population mean
- Population Variance

- Population Standard Deviation
- Coefficient of Variation
- Chebyshev’s Theorem

**Important Notation**

- $s^2$
- $s$
- $\mu$
- $\sigma^2$
- $\sigma$
- $CV$

**Focus Point:**
- Find the range, variance, and standard deviation
What do measures of variation tell us?

- 
- 
- 
-
II. **Coefficient of Variation**  
What is a disadvantage of the standard deviation as a unit of measure?

How is the *coefficient of variation* expressed?

If $\bar{x}$ and $s$ represent:

III. **Chebyshev’s Theorem**  

Focus Point:  
- Apply Chebyshev’s theorem to raw data.  
What does a Chebyshev interval tell us?

Results of Chebyshev’s Theorem
What does Chebyshev’s Theorem tell us?

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•
Section 3.2 Examples – Measures of Variation

(1) Big Blossom Greenhouse gathered another random sample of mature peak blooms from Hybrid B. The six blossoms had the following widths (in inches):

\[5 \ 5 \ 5 \ 6 \ 7 \ 8\]

a. Again, we will construct a table so that we can find the mean, variance, and standard deviation more easily. In this case, what is the value of \(n\)? Find the sum of Column I in the table, and compute the mean.

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x)</td>
<td>(x^2)</td>
</tr>
<tr>
<td>5</td>
<td></td>
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<tr>
<td>5</td>
<td></td>
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<tr>
<td>5</td>
<td></td>
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<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

b. Complete Column II in the table.

c. What is the value of \(n\)? of \(n-1\)? Use the computation formula to find the sample variance \(s^2\). \(NOTE:\) Be sure to distinguish between \(\sum x^2\) and \((\sum x)^2\).

\[\sum x = \quad \sum x^2 = \]

d. Use a calculator to find the square root of the variance. Is this the standard deviation?

(2) Cabela’s in Sindey, Nebraska, is a very large outfitter that carries a broad selection of fishing tackle. It markets its products nationwide through a catalog service. A random sample of 10 spinners (a type of fishing reel) from Cabela’s extensive spring catalog gave the following prices (in dollars):

\[1.69 \ 1.49 \ 3.09 \ 1.79 \ 1.39 \ 2.89 \ 1.49 \ 1.39 \ 1.49 \ 1.99\]

a. Use a calculator with sample mean and sample standard deviation keys to compute \(\bar{x}\) and \(s\).

b. Compute the \(CV\) for the spinner prices at Cabela’s.
The East Coast Independent News periodically runs ads in its classified section offering a month’s free subscription to those who respond. In this way, management can get a sense about the number of subscribers who read the classified section each day. Over a period of 2 years, careful records have been kept. The mean number of responses per ad is \( \bar{x} = 525 \) with standard deviation \( s = 30 \).

Determine a Chebyshev interval about the mean in which at least 88.9% of the data fall.
Section 3.3 Percentiles and Box-and-Whisker Plots

Objective: In this lesson you learned to interpret percentile scores; compute five-number summaries; and make, interpret, and describe box-and-whisker plots.

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<tr>
<td>Percentile</td>
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<tr>
<td>Five-Number Summary</td>
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</table>

I. Percentiles

General definition of the $P$th percentile:

How to compute quartiles:
1. 
2. 
3. 
4. 

What is the interquartile range (IQR)? How is it calculated?

Focus Point:
- Interpret the meaning of percentile scores
- Compute the median, quartiles, and five-number summary from raw data
II. **Box-and-Whisker Plots**

| Five-Number Summary |

What is a box-and-whisker plot?

How to make a box-and-whisker plot:
1. 
2. 
3. 
4. 

What does a box-and-whisker plot tell us:

- The minimum and maximum values.
- The interquartile range (IQR), which shows the middle 50% of the data.
- The median, which is the middle value in the dataset.
- The presence of outliers, which are values that lie outside the range of the IQR.

**Focus Point:**
- Make a box-and-whisker plot.
- Interpret the results.
- Describe how a box-and-whisker plot indicates spread of data about the median.
Section 3.3 Examples – Percentiles and Box-and-Whisker Plots

(1) You took the English achievement test to obtain college credit in freshman English by examination.

a. If your score is at the 89th percentile, what percentage of scores are at or below yours?

b. If the scores range from 1 to 100 and your raw score is 95, does this necessarily mean that your score is at the 95th percentile?

(2) Many people consider the number of calories in an ice cream bar as important as, if not more important than, the cost. The Consumer Reports article also included the calorie count of the rated ice cream bars (see table). There were 22 vanilla-flavored bars rated. Again, the bars varied in size, and some of the smaller bars had fewer calories. The calorie counts for the vanilla bars follow.

<table>
<thead>
<tr>
<th>Calories in Vanilla-Flavored Ice Cream Bars</th>
</tr>
</thead>
<tbody>
<tr>
<td>342</td>
</tr>
<tr>
<td>234</td>
</tr>
<tr>
<td>310</td>
</tr>
<tr>
<td>197</td>
</tr>
<tr>
<td>131</td>
</tr>
</tbody>
</table>

a. Order the data.

b. There are 22 data values. Find the median.

c. How many values are below the median position? Find $Q_1$.

d. There are the same number of data above as below the median. Use this fact to find $Q_3$.

e. Find the interquartile range (IQR) and comment on its meaning.
The Renata College Development Office sent salary surveys to alumni who graduated 2 and 5 years ago. The voluntary responses received are summarized in the box-and-whisker plots shown below.

a. From the plots shown, estimate the median and extreme values of salaries of alumni graduating 2 years ago. In what range are the middle half of the salaries?

b. From the plots shown, estimate the median and extreme values of salaries of alumni graduating 5 years ago. What is the location of the middle half of the salaries?

c. Compare the two box-and-whisker plots and make comments about the salaries of alumni graduating 2 and 5 years ago.