# MATH110: Descriptive Statistics

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Name: _____ Date: _____ Score: / 30

**Learning Objectives**

- Calculate the mean, median, mode, and range of a data set
- Compute sample variance and standard deviation
- Construct quartiles, the IQR, and identify outliers
- Describe the shape, center, and spread of a distribution

*Simplify each expression completely. Show all steps and circle your final answer.*

## Box-and-Whisker Plot

**1.** Find the five-number summary (Min, Q1, Median, Q3, Max) for the data set below, then construct a box-and-whisker plot.

{14, 16, 21, 24, 25, 28, 38, 41, 50, 56, 57, 60}

Construct your box-and-whisker plot here


Answer: _____

**2.** Find the five-number summary (Min, Q1, Median, Q3, Max) for the data set below, then construct a box-and-whisker plot.

{10, 14, 19, 21, 30, 36, 41, 49, 56, 59}

Construct your box-and-whisker plot here


Answer: _____

**3.** Find the five-number summary (Min, Q1, Median, Q3, Max) for the data set below, then construct a box-and-whisker plot.

$$\{10,\ 13,\ 25,\ 28,\ 30,\ 32,\ 36,\ 39,\ 41,\ 44,\ 56,\ 59\}$$

Construct your box-and-whisker plot here


Answer: _____

## Empirical rule (68-95-99.7)

**4.** Scores are normally distributed. What percent of scores fall within 3 standard deviation(s) of the mean?

$$\mu = 61,\quad \sigma = 8,\quad [37,\ 85]$$

Answer: _____

**5.** Scores are normally distributed. What percent of scores fall within 2 standard deviation(s) of the mean?

$$\mu = 79,\quad \sigma = 7,\quad [65,\ 93]$$

Answer: _____

**6.** Scores are normally distributed. What percent of scores fall within 2 standard deviation(s) of the mean?

$$\mu = 74,\quad \sigma = 11,\quad [52,\ 96]$$

Answer: _____

## Quartiles and IQR

**7.** Find Q1, Q3, and the IQR:

$$\{7,\ 18,\ 20,\ 26,\ 28,\ 29,\ 32,\ 38\}$$

Answer: _____

**8.** Find Q1, Q3, and the IQR:

$$\{1,\ 6,\ 8,\ 14,\ 27,\ 37\}$$

Answer: _____

**9.** Find Q1, Q3, and the IQR:

$\{5, 11, 12, 20, 21, 27, 29, 33\}$

Answer: _____

## Mean of a data set

**10.** Find the mean of the data set:

$\{18, 40, 15, 16, 8, 13, 19\}$

Answer: _____

**11.** Find the mean of the data set:

$\{3, 5, 36, 15, 34\}$

Answer: _____

**12.** Find the mean of the data set:

$\{17, 1, 23, 38, 10, 28, 5, 25\}$

Answer: _____

## Median of a data set

**13.** Find the median of the data set:

$\{4, 6, 22, 24, 31\}$

Answer: _____

**14.** Find the median of the data set:

$\{6, 16, 17, 37, 38\}$

Answer: _____

**15.** Find the median of the data set:

$\{2, 10, 21, 24, 34\}$

Answer: _____

## Mode of a data set

**16.** Find the mode:

$\{2, 4, 6, 11, 11, 11, 17, 18, 19\}$

Answer: _____

**17.** Find the mode:

$\{9,\ 10,\ 14,\ 15,\ 19,\ 20,\ 20\}$

Answer: _____

**18.** Find the mode:

$\{2,\ 6,\ 6,\ 9,\ 11,\ 12,\ 13,\ 20\}$

Answer: _____

## Outlier detection (1.5xIQR rule)

**19.** Using the 1.5xIQR rule, determine if the value is an outlier:

$Q_1 = 15, \quad Q_3 = 24, \quad \text{IQR} = 9, \quad x = 34$

Answer: _____

**20.** Using the 1.5xIQR rule, determine if the value is an outlier:

$Q_1 = 11, \quad Q_3 = 22, \quad \text{IQR} = 11, \quad x = 37$

Answer: _____

**21.** Using the 1.5xIQR rule, determine if the value is an outlier:

$Q_1 = 19, \quad Q_3 = 27, \quad \text{IQR} = 8, \quad x = 38$

Answer: _____

## Range

**22.** Find the range:

$\{1,\ 17,\ 42,\ 28,\ 50\}$

Answer: _____

**23.** Find the range:

$\{23,\ 33,\ 13,\ 5,\ 49,\ 4\}$

Answer: _____

**24.** Find the range:

$\{18,\ 16,\ 15,\ 49,\ 20\}$

Answer: _____

## Sample variance and standard deviation

**25.** Find the sample variance and standard deviation (round to 2 decimal places):

$\{11, 6, 8, 12, 2, 4, 18\}$

Answer: _____

**26.** Find the sample variance and standard deviation (round to 2 decimal places):

$\{16, 8, 19, 13, 20, 12\}$

Answer: _____

**27.** Find the sample variance and standard deviation (round to 2 decimal places):

$\{17, 2, 14, 18\}$

Answer: _____

## Z-score

**28.** Find the z-score and interpret it:

$x = 80, \quad \mu = 65, \quad \sigma = 11$

Answer: _____

**29.** Find the z-score and interpret it:

$x = 96, \quad \mu = 81, \quad \sigma = 5$

Answer: _____

**30.** Find the z-score and interpret it:

$x = 89, \quad \mu = 70, \quad \sigma = 11$

Answer: _____

# MATH110: Descriptive Statistics

ANSWER KEY & SOLUTIONS

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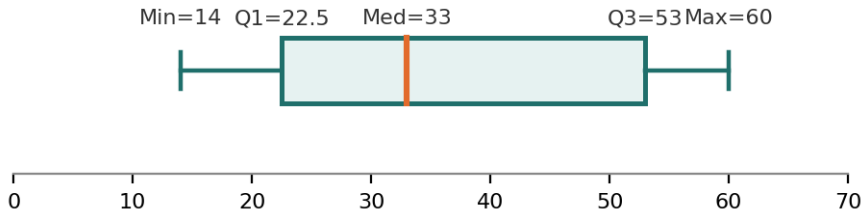
*Topics: Sample variance and standard deviation, Z-score, Range, Empirical rule (68-95-99.7), Box-and-Whisker Plot, Median of a data set, Quartiles and IQR, Outlier detection (1.5xIQR rule), Mode of a data set, Mean of a data set. All answers verified by independent computation.*

## Solutions

## Box-and-Whisker Plot

**1.** Find the five-number summary (Min, Q1, Median, Q3, Max) for the data set below, then construct a box-and-whisker plot.

{14, 16, 21, 24, 25, 28, 38, 41, 50, 56, 57, 60}

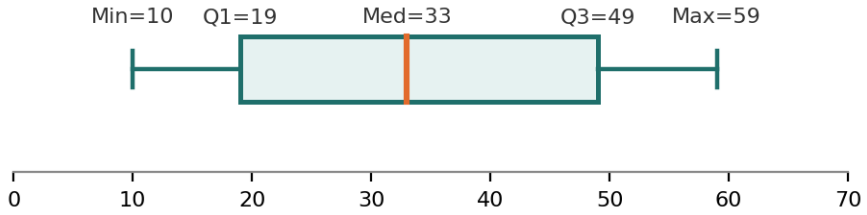



→ *Sort the data in ascending order: [14, 16, 21, 24, 25, 28, 38, 41, 50, 56, 57, 60].*
→ *Min = 14, Max = 60.*
→ *Median = 33.0.*
→ *Q1 (median of lower half) = 22.5; Q3 (median of upper half) = 53.0.*
→ *IQR = Q3 - Q1 = 30.5.*
→ *Draw the box from Q1 to Q3 with a line at the median; extend whiskers to Min and Max (see plot).*

**Answer:** $\text{Min} = 14,\ Q_1 = 22.5,\ \text{Med} = 33.0,\ Q_3 = 53.0,\ \text{Max} = 60$

**2.** Find the five-number summary (Min, Q1, Median, Q3, Max) for the data set below, then construct a box-and-whisker plot.

{10, 14, 19, 21, 30, 36, 41, 49, 56, 59}

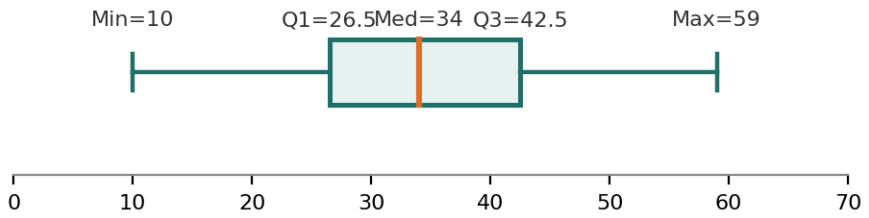



→ *Sort the data in ascending order: [10, 14, 19, 21, 30, 36, 41, 49, 56, 59].*
→ *Min = 10, Max = 59.*
→ *Median = 33.0.*
→ *Q1 (median of lower half) = 19.0; Q3 (median of upper half) = 49.0.*
→ *IQR = Q3 - Q1 = 30.0.*
→ *Draw the box from Q1 to Q3 with a line at the median; extend whiskers to Min and Max (see plot).*

**Answer:** $\text{Min} = 10,\ Q_1 = 19.0,\ \text{Med} = 33.0,\ Q_3 = 49.0,\ \text{Max} = 59$

**3.** Find the five-number summary (Min, Q1, Median, Q3, Max) for the data set below, then construct a box-and-whisker plot.

$\{10, 13, 25, 28, 30, 32, 36, 39, 41, 44, 56, 59\}$




→ *Sort the data in ascending order: [10, 13, 25, 28, 30, 32, 36, 39, 41, 44, 56, 59].*

→ *Min = 10, Max = 59.*

→ *Median = 34.0.*

→ *Q1 (median of lower half) = 26.5; Q3 (median of upper half) = 42.5.*

→ *IQR = Q3 - Q1 = 16.0.*

→ *Draw the box from Q1 to Q3 with a line at the median; extend whiskers to Min and Max (see plot).*

**Answer:** $\text{Min} = 10,\ Q_1 = 26.5,\ \text{Med} = 34.0,\ Q_3 = 42.5,\ \text{Max} = 59$

## Empirical rule (68-95-99.7)

**4.** Scores are normally distributed. What percent of scores fall within 3 standard deviation(s) of the mean?

$\mu = 61, \quad \sigma = 8, \quad [37, 85]$

→ *Lower bound: 61 - 3(8) = 37.*
→ *Upper bound: 61 + 3(8) = 85.*
→ *Empirical rule: {answer}% of data falls within {k} standard deviation(s) of the mean.*

**Answer:** $37 = \mu - 3\sigma, \quad 85 = \mu + 3\sigma \Rightarrow 99.7\%$

**5.** Scores are normally distributed. What percent of scores fall within 2 standard deviation(s) of the mean?

$\mu = 79, \quad \sigma = 7, \quad [65, 93]$

→ *Lower bound: 79 - 2(7) = 65.*
→ *Upper bound: 79 + 2(7) = 93.*
→ *Empirical rule: {answer}% of data falls within {k} standard deviation(s) of the mean.*

**Answer:** $65 = \mu - 2\sigma, \quad 93 = \mu + 2\sigma \Rightarrow 95\%$

**6.** Scores are normally distributed. What percent of scores fall within 2 standard deviation(s) of the mean?

$\mu = 74, \quad \sigma = 11, \quad [52, 96]$

→ *Lower bound: 74 - 2(11) = 52.*
→ *Upper bound: 74 + 2(11) = 96.*
→ *Empirical rule: {answer}% of data falls within {k} standard deviation(s) of the mean.*

**Answer:** $52 = \mu - 2\sigma, \quad 96 = \mu + 2\sigma \Rightarrow 95\%$

## Quartiles and IQR

**7.** Find Q1, Q3, and the IQR:

$$\{7,\ 18,\ 20,\ 26,\ 28,\ 29,\ 32,\ 38\}$$

→ *Sort: [7, 18, 20, 26, 28, 29, 32, 38]. n = 8.*
→ *Lower half: [7, 18, 20, 26] -> Q1 = 19.0.*
→ *Upper half: [28, 29, 32, 38] -> Q3 = 30.5.*
→ *IQR = Q3 - Q1 = 30.5 - 19.0 = 11.5.*

**Answer:** $Q_1 = 19.0,\ Q_3 = 30.5,\ \text{IQR} = 11.5$

**8.** Find Q1, Q3, and the IQR:

$$\{1,\ 6,\ 8,\ 14,\ 27,\ 37\}$$

→ *Sort: [1, 6, 8, 14, 27, 37]. n = 6.*
→ *Lower half: [1, 6, 8] -> Q1 = 6.0.*
→ *Upper half: [14, 27, 37] -> Q3 = 27.0.*
→ *IQR = Q3 - Q1 = 27.0 - 6.0 = 21.0.*

**Answer:** $Q_1 = 6.0,\ Q_3 = 27.0,\ \text{IQR} = 21.0$

**9.** Find Q1, Q3, and the IQR:

$$\{5,\ 11,\ 12,\ 20,\ 21,\ 27,\ 29,\ 33\}$$

→ *Sort: [5, 11, 12, 20, 21, 27, 29, 33]. n = 8.*
→ *Lower half: [5, 11, 12, 20] -> Q1 = 11.5.*
→ *Upper half: [21, 27, 29, 33] -> Q3 = 28.0.*
→ *IQR = Q3 - Q1 = 28.0 - 11.5 = 16.5.*

**Answer:** $Q_1 = 11.5,\ Q_3 = 28.0,\ \text{IQR} = 16.5$

## Mean of a data set

**10.** Find the mean of the data set:

$\{18, 40, 15, 16, 8, 13, 19\}$

→ *Add all 7 values: 129.*
→ *Divide by n = {n}: {sum_values} ÷ {n} = {answer}.*

**Answer:** $\bar{x} = 18.4286$

**11.** Find the mean of the data set:

$\{3, 5, 36, 15, 34\}$

→ *Add all 5 values: 93.*
→ *Divide by n = {n}: {sum_values} ÷ {n} = {answer}.*

**Answer:** $\bar{x} = 18.6$

**12.** Find the mean of the data set:

$\{17, 1, 23, 38, 10, 28, 5, 25\}$

→ *Add all 8 values: 147.*
→ *Divide by n = {n}: {sum_values} ÷ {n} = {answer}.*

**Answer:** $\bar{x} = 18.375$

## Median of a data set

**13.** Find the median of the data set:

$\{4,\ 6,\ 22,\ 24,\ 31\}$

→ *Sort the data: [4, 6, 22, 24, 31].*
→ *n = 5 — odd — take the middle value.*
→ *Median = {answer}.*

**Answer:** $\text{Median} = 22$

**14.** Find the median of the data set:

$\{6,\ 16,\ 17,\ 37,\ 38\}$

→ *Sort the data: [6, 16, 17, 37, 38].*
→ *n = 5 — odd — take the middle value.*
→ *Median = {answer}.*

**Answer:** $\text{Median} = 17$

**15.** Find the median of the data set:

$\{2,\ 10,\ 21,\ 24,\ 34\}$

→ *Sort the data: [2, 10, 21, 24, 34].*
→ *n = 5 — odd — take the middle value.*
→ *Median = {answer}.*

**Answer:** $\text{Median} = 21$

## Mode of a data set

**16.** Find the mode:

$\{2, 4, 6, 11, 11, 11, 17, 18, 19\}$

→ *Tally each value's frequency.*
→ *11 appears 3 times — more than any other value.*
→ *Mode = {answer}.*

**Answer:** $\text{Mode} = 11$

**17.** Find the mode:

$\{9, 10, 14, 15, 19, 20, 20\}$

→ *Tally each value's frequency.*
→ *20 appears 2 times — more than any other value.*
→ *Mode = {answer}.*

**Answer:** $\text{Mode} = 20$

**18.** Find the mode:

$\{2, 6, 6, 9, 11, 12, 13, 20\}$

→ *Tally each value's frequency.*
→ *6 appears 2 times — more than any other value.*
→ *Mode = {answer}.*

**Answer:** $\text{Mode} = 6$

## Outlier detection (1.5xIQR rule)

**19.** Using the 1.5xIQR rule, determine if the value is an outlier:

$Q_1 = 15, \quad Q_3 = 24, \quad \text{IQR} = 9, \quad x = 34$

→ *Upper fence = Q3 + 1.5 x IQR = 24 + 13.5 = 37.5.*
→ *Lower fence = Q1 - 1.5 x IQR = 15 - 13.5 = 1.5.*
→ *34 is within [1.5, 37.5] -> 34 is NOT an outlier.*

**Answer:** $\text{Fences: } [1.5,\ 37.5]; \quad 34 \textit{is NOT an outlier}$

**20.** Using the 1.5xIQR rule, determine if the value is an outlier:

$Q_1 = 11, \quad Q_3 = 22, \quad \text{IQR} = 11, \quad x = 37$

→ *Upper fence = Q3 + 1.5 x IQR = 22 + 16.5 = 38.5.*
→ *Lower fence = Q1 - 1.5 x IQR = 11 - 16.5 = -5.5.*
→ *37 is within [-5.5, 38.5] -> 37 is NOT an outlier.*

**Answer:** $\text{Fences: } [-5.5,\ 38.5]; \quad 37 \textit{is NOT an outlier}$

**21.** Using the 1.5xIQR rule, determine if the value is an outlier:

$Q_1 = 19, \quad Q_3 = 27, \quad \text{IQR} = 8, \quad x = 38$

→ *Upper fence = Q3 + 1.5 x IQR = 27 + 12.0 = 39.0.*
→ *Lower fence = Q1 - 1.5 x IQR = 19 - 12.0 = 7.0.*
→ *38 is within [7.0, 39.0] -> 38 is NOT an outlier.*

**Answer:** $\text{Fences: } [7.0,\ 39.0]; \quad 38 \textit{is NOT an outlier}$

## Range

**22.** Find the range:

$\{1, 17, 42, 28, 50\}$

→ *Range = max – min.*
→ *max = 50, min = 1.*
→ *Range = {max_val} – {min_val} = {answer}.*

**Answer:** $\text{Range} = 49$

**23.** Find the range:

$\{23, 33, 13, 5, 49, 4\}$

→ *Range = max – min.*
→ *max = 49, min = 4.*
→ *Range = {max_val} – {min_val} = {answer}.*

**Answer:** $\text{Range} = 45$

**24.** Find the range:

$\{18, 16, 15, 49, 20\}$

→ *Range = max – min.*
→ *max = 49, min = 15.*
→ *Range = {max_val} – {min_val} = {answer}.*

**Answer:** $\text{Range} = 34$

## Sample variance and standard deviation

**25.** Find the sample variance and standard deviation (round to 2 decimal places):

$\{11, 6, 8, 12, 2, 4, 18\}$

→ *Mean = 8.7143.*
→ *Squared deviations: (11–8.71)²=5.22, (6–8.71)²=7.37, (8–8.71)²=0.51, (12–8.71)²=10.8, (2–8.71)²=45.08, (4–8.71)²=22.22, (18–8.71)²=86.22.*
→ *$s^2$ = sum ÷ (n–1) = 177.4286 ÷ 6 = 29.57.*
→ *$s = \sqrt{29.57} \approx 5.44$.*

**Answer:** $s^2 = 29.57, \quad s \approx 5.44$

**26.** Find the sample variance and standard deviation (round to 2 decimal places):

$\{16, 8, 19, 13, 20, 12\}$

→ *Mean = 14.6667.*
→ *Squared deviations: (16–14.67)²=1.78, (8–14.67)²=44.44, (19–14.67)²=18.78, (13–14.67)²=2.78, (20–14.67)²=28.44, (12–14.67)²=7.11.*
→ *$s^2$ = sum ÷ (n–1) = 103.3333 ÷ 5 = 20.67.*
→ *$s = \sqrt{20.67} \approx 4.55$.*

**Answer:** $s^2 = 20.67, \quad s \approx 4.55$

**27.** Find the sample variance and standard deviation (round to 2 decimal places):

$\{17, 2, 14, 18\}$

→ *Mean = 12.75.*
→ *Squared deviations: (17–12.75)²=18.06, (2–12.75)²=115.56, (14–12.75)²=1.56, (18–12.75)²=27.56.*
→ *$s^2$ = sum ÷ (n–1) = 162.75 ÷ 3 = 54.25.*
→ *$s = \sqrt{54.25} \approx 7.37$.*

**Answer:** $s^2 = 54.25, \quad s \approx 7.37$

## Z-score

**28.** Find the z-score and interpret it:

$$x = 80, \quad \mu = 65, \quad \sigma = 11$$

→ *z = (x – μ) / σ.*
→ *z = ({x_val} – {mu}) / {sigma} = {diff} / {sigma} = {answer}.*
→ *z = 1.36: score is 1.36 standard deviation(s) above the mean.*

**Answer:** $z = \frac{80 - 65}{11} = 1.36$

**29.** Find the z-score and interpret it:

$$x = 96, \quad \mu = 81, \quad \sigma = 5$$

→ *z = (x – μ) / σ.*
→ *z = ({x_val} – {mu}) / {sigma} = {diff} / {sigma} = {answer}.*
→ *z = 3.0: score is 3.0 standard deviation(s) above the mean.*

**Answer:** $z = \frac{96 - 81}{5} = 3.0$

**30.** Find the z-score and interpret it:

$$x = 89, \quad \mu = 70, \quad \sigma = 11$$

→ *z = (x – μ) / σ.*
→ *z = ({x_val} – {mu}) / {sigma} = {diff} / {sigma} = {answer}.*
→ *z = 1.73: score is 1.73 standard deviation(s) above the mean.*

**Answer:** $z = \frac{89 - 70}{11} = 1.73$