



Learning Objectives

- Define a scale of measurement
- Classify data according to their scale of measurement
- Distinguish between discrete and continuous variables
- Establish real limits for continuously scored data

Module Summary

- Statistics are used to investigate variables. Just as there are different types of variables (age, height, gender, occupation, etc.), there are different scales in which variables can be measured. Measurement refers to the value that is assigned to a specific trait. The meaning that you assign to a certain measurement depends on the scale of measurement that was used. In statistics, there are four types of scales of measurement: nominal, ordinal, interval, and ratio.
- A **nominal scale** is one that is divided into distinct categories. Additionally, the categories are not ranked; one category is not higher or lower than the next. Favorite color would be an example of a nominal scale. My favorite color is blue, whereas yours may be red. Personal opinion aside, my preference for blue is no better or worse than your preference for red.
- An **ordinal scale** is one that ranks cases in order, but the precise difference between two cases is unknown. For example, you might classify one person as attractive and another as gorgeous. You know from these descriptors that gorgeous is above attractive, but you cannot be certain of the exact amount of improvement from one rank to the next.
- An **interval scale** is similar to an ordinal scale in that individuals are ranked in order, but in contrast to an ordinal scale, the precise difference between individuals is known. There is, however, no **true zero**. A true zero means that it is possible to have a complete absence of the variable being measured. For example, the Fahrenheit temperature scale is an interval scale. When comparing 36 degrees and 12 degrees, you can be certain that there is a 24-degree difference between the two temperatures. You cannot, however, ever have no Fahrenheit temperature. Most measures of mental ability or traits (intelligence, extraversion, etc.) also are interval scale.
- A **ratio scale** is similar to an interval scale but possesses a true zero. Again, a true zero means it is possible to have a complete absence of the variable being measured. The amount of money in your wallet is a ratio scale. This is because it is possible for you to have no money, regardless of the amount of money that you actually do have.
- Variables can also be considered either continuous or discrete. **Continuous variables** have values that can fall anywhere on the scale, including between two adjacent values. An example of a continuous variable would be time (as specified by minutes and seconds). You could have a value 1 min and 3 s. In comparison, **discrete variables** have values that cannot fall between adjacent values. An example of a discrete variable would be the number of students in your class, because there cannot be less than a full student, or a fraction of a student.

- Continuous variables are defined by their real limits. A **real limit** is defined as ± 0.5 of the score's unit. This makes each score contiguous with the next score. Thus, for a score of 10, when the scores are scaled in units of 1, the **upper real limit** would be 10.5 and the **lower real limit** would be 9.5. For a score of 10 when scores are scaled in units of 5, the upper real limit would be 12.5 and the lower real limit would be 7.5. Note that an observed score will never fall at the real limit.

True/False Questions

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1. The scale of measurement for the favorite animals of your classmates would be a nominal scale.
2. In an interval scale, there is an equal amount of distance between adjacent ranks and there is a true zero.
3. You are attending a swim competition and notice that the swimmers are ranked by their time. Their ranking is an ordinal scale.
4. (Refer to Question 3.) The ranking through the use of their time is an interval scale.
5. Flavors of ice cream would be a discrete and ordinal scale.
6. The number of trumpet players in an orchestra is a discrete variable.
7. The distance that you can throw a football is a discrete variable.
8. For a scale of 4 when scores are in single units, the real limits are 3 and 5.

True/False Answers

1. True
2. False
3. True
4. False
5. False
6. True
7. False
8. False

Short-Answer Questions

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1. What scale of measurement best classifies the following?
 - a. Number of calories in a candy bar
 - b. Colors in a bouquet of flowers
 - c. Elevation in reference to sea level
2. What is the highest scale of measurement for the following?
 - a. Number of available TV channels
 - b. Number of pets you can own
 - c. Responses to a questionnaire that ranges from -5 to 5
3. What is a nominal scale?
4. What are the limitations of a nominal scale?
5. What is the difference between an interval and a ratio scale?
6. What is meant by a ratio scale having an absolute zero?

7. What advantage does an interval scale have in comparison with an ordinal scale?
8. Distinguish between a continuous and a discrete variable.
9. The type of exercise that Ethan does most often is running, Arnold does yoga, and Jill takes kickboxing classes. What scale of measurement would best classify these variables?
10. You are conducting a study on social anxiety in males and females. You decide to classify your subjects as having either social anxiety or not having social anxiety. You then give them a question with a rating scale of -7 (very anxious) to 7 (very calm). They are then placed in a social situation, and the amount of time it takes for them to leave the situation is recorded. Identify the four variables in this study and the scales of measurement that each is using.

Answers

1.
 - a. Ratio
 - b. Nominal
 - c. Ratio
2.
 - a. Ratio
 - b. Ratio
 - c. Interval or ordinal (per debate on measurement)
3. A nominal scale is one that classifies categories.
4. Nominal scales are unable to explain rank or order.
5. An interval scale lacks a true zero point, whereas a ratio scale has a true zero point. The presence of a true zero indicates that it is possible to have a complete absence of the trait.
6. It means that it is possible to have a complete lack of the trait being studied.
7. An interval scale enables you to measure the exact distance between two scores.
8. Continuous variables have values that can fall anywhere on the scale. Discrete variables have distinct values, and a value cannot fall between the values.
9. Nominal
10. Nominal—Male/Female; Nominal—Social anxiety/Not socially anxious; Interval or ordinal—Rating scale; Ratio—Time in a social encounter.

Multiple-Choice Questions

1. If you were interested in measuring the salary of teachers, what is the highest order scale you could use?
 - a. Nominal
 - b. Ordinal
 - c. Interval
 - d. Ratio
2. You are interested in studying depression. You obtain a sample of 100 people and divide them into the following categories: Depressed and Not depressed. These categories are an example of
 - a. a discrete variable with an ordinal scale.
 - b. a continuous variable with an ordinal scale.
 - c. a discrete variable with a nominal scale.
 - d. a continuous variable with a nominal scale.

3. You are interested in measuring the sizes of amoebas; however, the ruler on your microscope has broken and you are no longer able to measure them in a proper unit of measurement. As an alternative, you decide to classify them as small, medium, and large. It would be impossible for an amoeba to fall between categories. This scale is an example of
- a discrete variable with an ordinal scale.
 - a continuous variable with an ordinal scale.
 - a discrete variable with an interval scale.
 - a continuous variable with an interval scale.
4. You obtain a score of 100 on a statistics aptitude test and scores are reported in whole points. Your upper real limit (*UL*) and lower real limit (*LL*) are as follows:
- $UL = 100, LL = 99.5$
 - $UL = 100.5, LL = 99.5$
 - $UL = 101, LL = 99$
 - $UL = 99.5, LL = 100$
5. The real limits of a scale that ranges from 1 to 7 and are reported in whole points are
- $UL = 1, LL = 7$
 - $UL = 1.5, LL = 6.5$
 - $UL = 0, LL = 8$
 - $UL = 0.5, LL = 7.5$
6. You have created a scale measuring anxiety with the following scale: None, A little bit, Moderate, A lot. Your scale is _____.
- ordinal
 - interval
 - ratio
 - ordinal or interval (per debate on measurement)
7. A chef is developing a feedback card to determine if people like his food. He creates a card that provides people with an option to check a box representing that they either enjoyed the food or disliked the food. What type of scale is this?
- Nominal
 - Ordinal
 - Interval
 - Ratio
8. (Refer to Question 7.) The chef is upset that almost 50% of those who completed the cards checked the “disliked” box. He decides to give his customers more options to choose from to get a better understanding of their opinion. His new scale ranges from -5 to $+5$. What type of scale is this?
- Nominal
 - Ordinal
 - Interval
 - Ordinal or interval (per debate on measurement)
 - Ratio

Multiple-Choice Answers

- D
- C
- A

4. B
5. D
6. D
7. A
8. D

Module Quiz

1. In a marathon, Katelyn was placed first, while Patrick was placed 50th. Is Katelyn 50 times as fast as Patrick? Why or why not?
2. You are interested in obtaining the following information from the class. List the best scale of measurement for each:
 - a. Favorite movie
 - b. Grade in last math class
 - c. Self-rating on a 0 to 10 scale of confidence for statistics
3. Which scale would be considered the lowest level of measurement?
 - a. Nominal
 - b. Ordinal
 - c. Interval
 - d. Ratio
4. An ordinal scale
 - a. ranks scores in order on a continuous scale
 - b. places scores in discrete ranked values without equal distance between the values for the trait being measured
 - c. ranks scores in order, and the distance between adjacent ranks is equal
 - d. possesses a true zero point
5. You are asked by a professor to develop a grading scheme for his or her next class. Develop a separate grading scheme for a nominal scale, an ordinal scale, an interval scale, and a ratio scale.

Quiz Answers

1. Katelyn is not 50 times as fast. You cannot determine this type of information from an ordinal measurement scale.
2.
 - a. Nominal
 - b. Interval
 - c. Ordinal or interval, per debate on measurement
3. A
4. B
5. Answers will vary.