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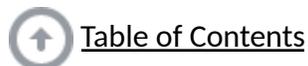
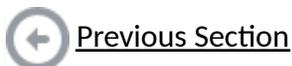
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## 4.1 Random Variables

### LEARNING OBJECTIVES

1. To learn the concept of a random variable.
2. To learn the distinction between discrete and continuous random variables.

### Definition

A **random variable** is a numerical quantity that is generated by a random experiment.

We will denote random variables by capital letters, such as  $X$  or  $Z$ , and the

actual values that they can take by lowercase letters, such as  $x$  and  $z$ .

Table 4.1 "Four Random Variables" gives four examples of random variables. In the second example, the three dots indicates that every counting number is a possible value for  $X$ . Although it is highly unlikely, for example, that it would take 50 tosses of the coin to observe heads for the first time, nevertheless it is conceivable, hence the number 50 is a possible value. The set of possible values is infinite, but is still at least *countable*, in the sense that all possible values can be listed one after another. In the last two examples, by way of contrast, the possible values cannot be individually listed, but take up a whole interval of numbers. In the fourth example, since the light bulb could conceivably continue to shine indefinitely, there is no natural greatest value for its lifetime, so we simply place the symbol  $\infty$  for infinity as the right endpoint of the interval of possible values.

Table 4.1 Four Random Variables

Experiment	Number $X$	Possible Values of $X$
Roll two fair dice	Sum of the number of dots on the top faces	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Flip a fair coin repeatedly	Number of tosses until the coin lands heads	1, 2, 3, 4, ...
Measure the voltage at an electrical outlet	Voltage measured	$118 \leq x \leq 122$
Operate a light bulb until it burns out	Time until the bulb burns out	$0 \leq x < \infty$

### Definition

A random variable is called **discrete** if it has either a finite or a countable number of possible values. A random variable is called **continuous** if its possible values contain a whole interval of numbers.

The examples in the table are typical in that discrete random variables typically arise from a counting process, whereas continuous random variables typically arise from a measurement.

## KEY TAKEAWAYS

- A random variable is a number generated by a random experiment.
- A random variable is called *discrete* if its possible values form a finite or countable set.
- A random variable is called *continuous* if its possible values contain a whole interval of numbers.

## EXERCISES

### BASIC

1. Classify each random variable as either discrete or continuous.
  - a. The number of arrivals at an emergency room between midnight and 6:00 a.m.
  - b. The weight of a box of cereal labeled "18 ounces."
  - c. The duration of the next outgoing telephone call from a business office.
  - d. The number of kernels of popcorn in a 1-pound container.
  - e. The number of applicants for a job.
2. Classify each random variable as either discrete or continuous.
  - a. The time between customers entering a checkout lane at a retail store.
  - b. The weight of refuse on a truck arriving at a landfill.
  - c. The number of passengers in a passenger vehicle on a highway at rush hour.
  - d. The number of clerical errors on a medical chart.
  - e. The number of accident-free days in one month at a factory.
3. Classify each random variable as either discrete or continuous.
  - a. The number of boys in a randomly selected three-child family.
  - b. The temperature of a cup of coffee served at a restaurant.

- c. The number of no-shows for every 100 reservations made with a commercial airline.
  - d. The number of vehicles owned by a randomly selected household.
  - e. The average amount spent on electricity each July by a randomly selected household in a certain state.
4. Classify each random variable as either discrete or continuous.
- a. The number of patrons arriving at a restaurant between 5:00 p.m. and 6:00 p.m.
  - b. The number of new cases of influenza in a particular county in a coming month.
  - c. The air pressure of a tire on an automobile.
  - d. The amount of rain recorded at an airport one day.
  - e. The number of students who actually register for classes at a university next semester.
5. Identify the set of possible values for each random variable. (Make a reasonable estimate based on experience, where necessary.)
- a. The number of heads in two tosses of a coin.
  - b. The average weight of newborn babies born in a particular county one month.
  - c. The amount of liquid in a 12-ounce can of soft drink.
  - d. The number of games in the next World Series (best of up to seven games).
  - e. The number of coins that match when three coins are tossed at once.
6. Identify the set of possible values for each random variable. (Make a reasonable estimate based on experience, where necessary.)
- a. The number of hearts in a five-card hand drawn from a deck of 52 cards that contains 13 hearts in all.
  - b. The number of pitches made by a starting pitcher in a major league baseball game.
  - c. The number of breakdowns of city buses in a large city in one week.
  - d. The distance a rental car rented on a daily rate is driven each day.
  - e. The amount of rainfall at an airport next month.

## ANSWERS

- 1. a. discrete
- b. continuous

- c. continuous
  - d. discrete
  - e. discrete
3. a. discrete
- b. continuous
  - c. discrete
  - d. discrete
  - e. continuous
5. a.  $\{0.1, 2\}$
- b. an interval  $(a, b)$  (answers vary)
  - c. an interval  $(a, b)$  (answers vary)
  - d.  $\{4, 5, 6, 7\}$
  - e.  $\{2, 3\}$

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