4

Probability

Lesson 4.2
Basic Probability Rules

Statistics and Probability with Applications, 3rd Edition
Starnes & Tabor

Bedford Freeman Worth Publishers

Basic Probability Rules

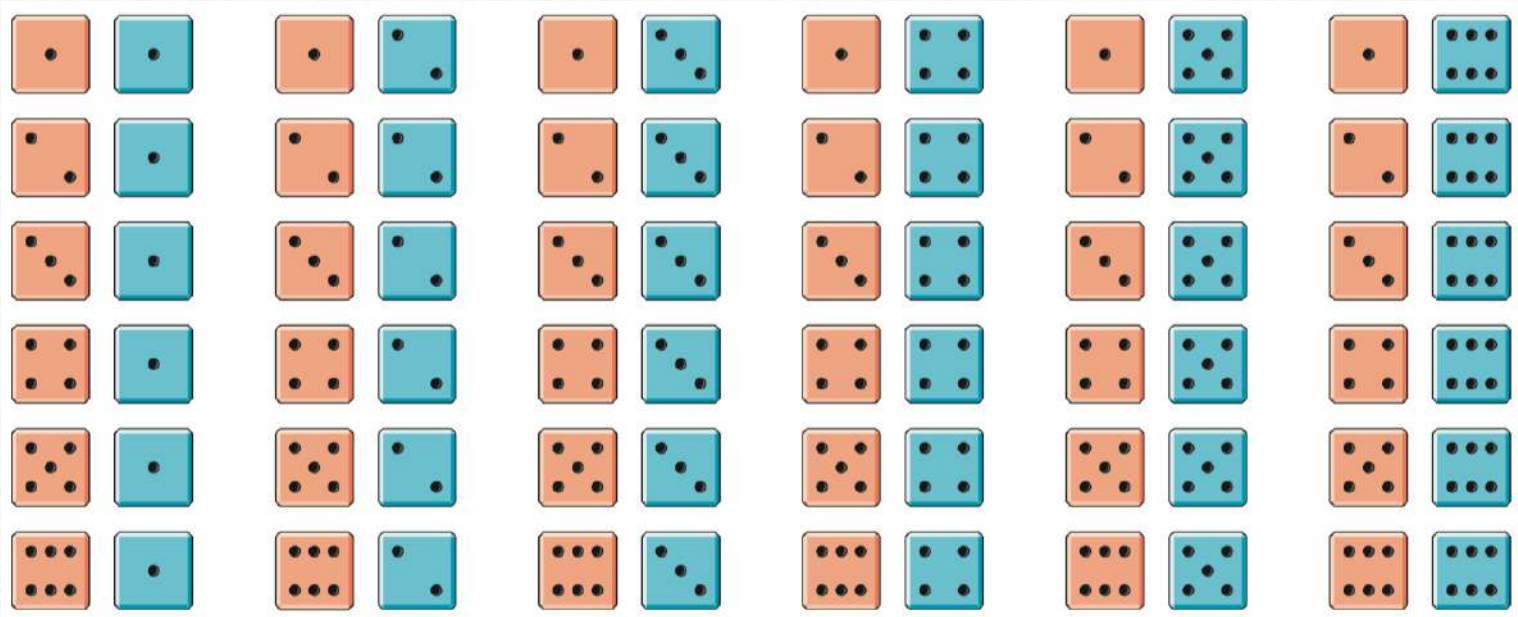
Learning Targets

After this lesson, you should be able to:

- ✓ Give a probability model for a chance process with equally likely outcomes and use it to find the probability of an event.
- ✓ Use the complement rule to find probabilities.
- ✓ Use the addition rule for mutually exclusive events to find probabilities.

Basic Probability Rules

Many board games involve rolling dice. Imagine rolling two dice – one that's red and one that's blue. We can use the outcomes to develop a **probability model**.



Basic Probability Rules

Probability Model, Sample Space

A **probability model** is a description of some chance process that consists of two parts: a list of all possible outcomes and the probability for each outcome.
The list of all possible outcomes is called the **sample space**.

A probability model does more than just assign a probability to each outcome. It allows us to find the probability of an **event**.

Event

An **event** is any collection of outcomes from some chance process.

Basic Probability Rules

Events are usually designated by capital letters, like A, B, C, and so on.

It is fairly easy to find the probability of an event in the case of equally likely outcomes.

Finding Probabilities: Equally Likely Outcomes

If all outcomes in the sample space are equally likely, the probability that event A occurs can be found using the formula

$$P(A) = \frac{\text{number of outcomes in event A}}{\text{total number of outcomes in sample space}}$$

Basic Probability Rules

Valid probability models must obey basic rules:

- **The probability of any event is a number between 0 and 1**. This rule follows from the definition of probability: the proportion of times the event would occur in many repetitions of the chance process.
  - **All possible outcomes together must have probabilities that add up to 1**. Any time we observe a chance process, some outcome must occur.
  - **The probability that an event does not occur is 1 minus the probability that the event does occur**. We refer to the event "not A" as the complement of A and denote it by A^C.

Complement Rule, Complement

The **complement rule** says that $P(A^C) = 1 - P(A)$ where A^C is the **complement** of event A; that is, the event that A does not happen.

Basic Probability Rules

When two events have no outcomes in common, we say they are **mutually exclusive**.

Mutually Exclusive, Addition Rule for Mutually Exclusive Events

Two events A and B are **mutually exclusive** if they have no outcomes in common and so can never occur together—that is, if $P(\text{A and B}) = 0$.

The **addition rule for mutually exclusive events** A and B says that $P(\text{A or B}) = P(\text{A}) + P(\text{B})$

Note that this rule only works for mutually exclusive events. We will develop a more general rule for finding P(A or B) that works for any two events in Lesson 4.3.

LESSON APP 4.2 How prevalent is high cholesterol?

Choose an American adult at random. Define two events:

A = the person has a cholesterol level of 240 milligrams per deciliter of blood (mg/dl) or above (high cholesterol)

B = the person has a cholesterol level of 200 to <240 mg/dl (borderline high cholesterol)

According to the American Heart Association,

$P(A) = 0.16$ and $P(B) = 0.29$.

1. Explain why events A and B are mutually exclusive.

2. Say in plain language what the event "A or B" is. Find $P(A \text{ or } B)$.

3. Let C be the event that the person chosen has a cholesterol level below 200 mg/dl (normal cholesterol). Find $P(C)$.

Basic Probability Rules

Learning Targets

After this lesson, you should be able to:

- ✓ Give a probability model for a chance process with equally likely outcomes and use it to find the probability of an event.
- ✓ Use the complement rule to find probabilities.
- ✓ Use the addition rule for mutually exclusive events to find probabilities.