Chapter 5 – Computing Probabilities
Section 1 – Meaning of Probability

Objectives
1. Compute and interpret probabilities.
2. Use simulation to estimate a probability.
3. Use the equally likely probability formula to find probabilities.
4. Describe properties of probability.
5. Use a pie chart to find probabilities.
6. Use a density histogram to find probabilities.
7. Use the Empirical Rule to find probabilities.

Vocabulary
1. random experiment
2. probability
3. simulation
4. sample space
5. event
6. impossible/sure event
7. probability of an event
8. random variable

Lesson/Activity

OBJECTIVE 1 – Compute and interpret probabilities.

Recall from Section 2.1 that **if we randomly select one item from a group of items, each item has the same chance of being selected**. We call a process that selects items randomly a **random experiment**.

Definition: Probability

The **probability** of an outcome from a random experiment is the relative frequency of the outcome if the experiment were run an infinite number of times.

1. An experiment consists of rolling a six-sided die once. Find and interpret the probability of rolling a 5.

A probability does not tell us what to expect if we run an experiment a small number of times.

OBJECTIVE 2 – Use simulation to estimate a probability.

Using technology to imitate a random experiment is called a **simulation**.

2. Use technology to simulate flipping a coin the given number of times. Discuss how well the relative frequency of tails estimates the probability of getting tails.
   a. 5 times b. 100 times c. 1100 times d. 10,100 times

By running a random experiment many times, we can use relative frequency to estimate the probability.

OBJECTIVE 3 – Use the equally likely probability formula to find probabilities.

3. An experiment consists of rolling a six-sided die once. Find and interpret the probability of rolling an odd number.

Definition: Sample space

The **sample space** of a random experiment is the group of all possible outcomes.

Definition: Event

An **event** is some of the outcomes in the sample space, all of them, or none of them.

Equally Likely Probability Formula

If the sample space of a random experiment consists of **n** equally likely outcomes and an event **E** consists of **m** of those outcomes, then P(E) = m/n.

If the outcomes of a random experiment are not equally likely, then we cannot use the equally likely probability formula.

4. For a group of 10 students in one of the author's prestatistics classes, there are 4 sociology majors, 2 graphic design majors, 3 communications majors, and 1 art major. None of the students are double-majors. Assume one student is randomly selected from the group. Use S for sociology, G for graphic design, C for communications, and A for art.
   a. Construct a frequency and relative frequency table of the students' majors.
   b. Find P(S), P(G), P(C), and P(A). How do your results tie into the table you constructed in Part (a)?
   c. Find P(math).
   d. Find the probability of randomly selecting a sociology, graphic design, communications, OR art major.
   e. Find P(S) + P(G) + P(C) + P(A). Why does the result make sense?

OBJECTIVE 4 – Describe properties of probability.

An **impossible event** does not contain any outcomes of the sample space.
A **sure event** (or **certain event**) contains all the outcomes in the sample space.
An event that contains just one outcome is a **single-outcome event**.

Probability Properties

- The probability of an impossible event is equal to 0.
- The probability of a sure event is equal to 1.
- The probability of an event is between 0 and 1, inclusive.
- The sum of the probabilities of all the single-outcome events in the sample space is equal to 1.

If you ever calculate a probability to be negative or greater than 1, you should realize that you've made an error.

5. A student surveys other students about their favorite sport. For each sport, the student calculates the probability of randomly selecting that sport from the responses (see the following table). What would you tell the student?

Sport	Probability
Basketball	0.3
Football	0.5
Baseball	0.2
Soccer	0.2
Other	0.3

6. A student calculates that the probability of randomly selecting a car that has gas mileage of 25 miles per gallon is -0:32. What would you tell the student?

If a situation involves a proportion or probability, it can be interpreted to involve the other as well.

OBJECTIVE 5 – Use a pie chart to find probabilities.

7. Some adult employees were surveyed about how often they are late for work. The percentages for various responses are described by the following pie chart (Source: YouGov).

Find the probability that a person randomly selected from the survey is
a. never late to work.
b. late to work at least once a month.
c. late to work at most once a month.

Definition Random variable
A random variable is a numerical measure of an outcome from a random experiment. We often use a capital letter such as X to stand for a random variable.

8. Let X be the outcome of rolling a six-sided die once. Find the given probability.
a. P(X = 5).
b. P(X 3)
c. P(X > 3)
d. P(2 X 5)
e. P(2 < X < 5)

OBJECTIVE 6 – Use a density histogram to find probabilities.
The following density histogram describes the number of mammal species threatened in each country in the world.
Some countries have at least 80 threatened mammal species, but the bars would not be visible.
0 10 20 30 40 50 60 70 80
0:01
0:02
0:03
0:04
0:05
0:06
0.60
0.22
0.05 0.06
Threatened Mammal Species, by Country
Density
Number of threatened mammal species
LetX be the number of threatened mammal species in a randomly selected country. Find the given probability.
1. P(10 X 40)
2. P(X < 30)
3. P(X 30)

Interpreting the Area of a Bar of a Density Histogram
We can interpret the area of a bar of a density histogram as
the proportion of observations that lie in the bar's class.
the probability of randomly selecting an observation that lies in the bar's class.

OBJECTIVE 7 – Use the Empirical Rule to find probabilities.
9. The Wechsler IQ test measures a person's intelligence. The distribution of IQ scores is unimodal and symmetric. The test is designed so that the mean score is 100 points and the standard deviation is 15 points (Source: Essentials of WAIS-IV Assessment, Elizabeth Lichtenberger et al.). Find the probability of
randomly selecting a person who has IQ between 55 and 145 points.

Homework/Assessment
1, 3, 5, 7, 15, 19, 23, 29, 31, 35, 41, 45, 49, 53, 55, 57, 59, 65, 73