GLOBAL EDITION

Elementary Statistics

Picturing the World

SEVENTH EDITION

Ron Larson • Betsy Farber

Director, Portfolio Management: *Deirdre Lynch*
Senior Courseware Portfolio Manager: *Patrick Barbera*
Acquisitions Editor, Global Edition: *Sourabh Maheshwari*
Editorial Assistant: *Morgan Danna*
Content Producer: *Tamela Ambush*
Assistant Project Editor, Global Edition: *Sulagna Dasgupta*
Managing Producer: *Karen Wernholm*
Media Producer: *Audra Walsh*
Media Production Manager, Global Edition: *Vikram Kumar*
Manager, Courseware QA: *Mary Durnwald*
Manager, Content Development: *Robert Carroll*
Product Marketing Manager: *Emily Ockay*
Field Marketing Manager: *Andrew Noble*
Marketing Assistants: *Shannon McCormack, Erin Rush*
Senior Author Support/Technology Specialist: *Joe Vetere*
Manager, Rights and Permissions: *Gina Cheselka*
Manufacturing Buyer: *Carol Melville, LSC Communications*
Senior Manufacturing & Composition Controller, Global Edition: *Angela Hawksbee*
Text Design: *Cenveo Publisher Services*
Cover Design: *Lumina Datamatics*

Attributions of third party content appear on page P1, which constitutes an extension of this copyright page.

Pearson Education Limited
KAO Two
KAO Park
Harlow
CM17 9NA
United Kingdom

and Associated Companies throughout the world

Visit us on the World Wide Web at: www.pearsonglobaleditions.com

Authorized adaptation from the United States edition, entitled Elementary Statistics: Picturing the World, *Seventh Edition, ISBN 978-0-134-68341-6 by Ron Larson and Betsy Farber, published by Pearson Education © 2018.*

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

ISBN 10: 1-292-26046-7
ISBN 13: 978-1-292-26046-4

10 9 8 7 6 5 4 3 2 1

Typeset by Integra Software Services Private Limited
Printed and bound by Vivar in Malaysia

Mean, Variance, and Standard Deviation

Although you can use the formulas you learned in Section 4.1 for mean, variance, and standard deviation of a discrete probability distribution, the properties of a binomial distribution enable you to use much simpler formulas.

Population Parameters of a Binomial Distribution

Mean: $\mu = np$

Variance: $\sigma^2 = npq$

Standard deviation: $\sigma = \sqrt{npq}$

EXAMPLE 8

Finding and Interpreting Mean, Variance, and Standard Deviation

In Pittsburgh, Pennsylvania, about 56% of the days in a year are cloudy. Find the mean, variance, and standard deviation for the number of cloudy days during the month of June. Interpret the results and determine any unusual values. *(Source: National Climatic Data Center)*

SOLUTION

There are 30 days in June. Using $n = 30$, $p = 0.56$, and $q = 0.44$, you can find the mean, variance, and standard deviation as shown below.

$$\begin{aligned}\mu &= np\\ &= 30 \cdot 0.56\\ &= 16.8 && \text{Mean}\end{aligned}$$

$$\begin{aligned}\sigma^2 &= npq\\ &= 30 \cdot 0.56 \cdot 0.44\\ &\approx 7.4 && \text{Variance}\end{aligned}$$

$$\begin{aligned}\sigma &= \sqrt{npq}\\ &= \sqrt{30 \cdot 0.56 \cdot 0.44}\\ &\approx 2.7 && \text{Standard deviation}\end{aligned}$$

Interpretation On average, there are 16.8 cloudy days during the month of June. The standard deviation is about 2.7 days. Values that are more than two standard deviations from the mean are considered unusual. Because

$$16.8 - 2(2.7) = 11.4$$

a June with 11 cloudy days or less would be unusual. Similarly, because

$$16.8 + 2(2.7) = 22.2$$

a June with 23 cloudy days or more would also be unusual.

TRY IT YOURSELF 8

In San Francisco, California, about 44% of the days in a year are clear. Find the mean, variance, and standard deviation for the number of clear days during the month of May. Interpret the results and determine any unusual events. *(Source: National Climatic Data Center)*

Answer: Page A35

4.2 EXERCISES

For Extra Help: MyLab Statistics

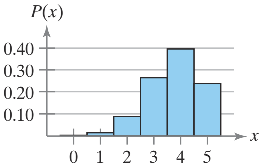
Building Basic Skills and Vocabulary

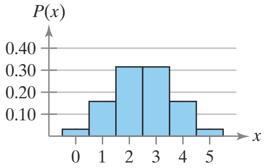
1. In a binomial experiment, what does it mean to say that each trial is independent of the other trials?

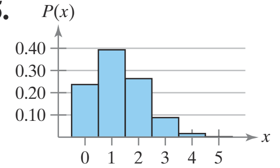
2. In a binomial experiment with n trials, what does the random variable measure?

Graphical Analysis *In Exercises 3–5, the histogram represents a binomial distribution with 5 trials. Match the histogram with the appropriate probability of success p. Explain your reasoning.*

(a) $p = 0.25$ (b) $p = 0.50$ (c) $p = 0.75$

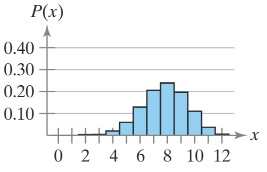
3.


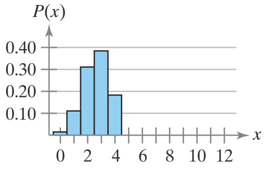
4.


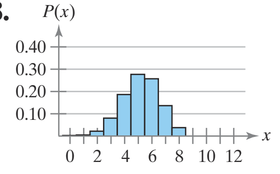
5.


Graphical Analysis *In Exercises 6–8, the histogram represents a binomial distribution with probability of success p. Match the histogram with the appropriate number of trials n. Explain your reasoning. What happens as the value of n increases and p remains the same?*

(a) $n = 4$ (b) $n = 8$ (c) $n = 12$

6.


7.


8.


9. Identify the unusual values of x in each histogram in Exercises 3–5.

10. Identify the unusual values of x in each histogram in Exercises 6–8.

Mean, Variance, and Standard Deviation *In Exercises 11–14, find the mean, variance, and standard deviation of the binomial distribution with the given values of n and p.*

11. $n = 50, p = 0.4$

12. $n = 84, p = 0.65$

13. $n = 124, p = 0.26$

14. $n = 316, p = 0.82$

Using and Interpreting Concepts

Identifying and Understanding Binomial Experiments *In Exercises 15–18, determine whether the experiment is a binomial experiment. If it is, identify a success, specify the values of n, p, and q, and list the possible values of the random variable x. If it is not a binomial experiment, explain why.*

15. Video Games A survey found that 36% of frequent gamers play video games on their smartphones. Ten frequent gamers are randomly selected. The random variable represents the number of frequent gamers who play video games on their smartphones. *(Source: Entertainment Software Association)*

16. Lucky Toss A person is required to toss 8 unbiased coins and note down the outcome of each. The random variable represents the number of heads.

17. Cards You draw four cards, one at a time, from a standard deck. You note the suit and replace the card in the deck. The random variable represents the number of cards that are diamonds.

18. Women Who Are Mothers A survey found that 42% of women ages 18 to 33 are mothers. Eight women ages 18 to 33 are randomly selected. The random variable represents the number of women ages 18 to 33 who are mothers. *(Source: Pew Research Center)*

Finding Binomial Probabilities *In Exercises 19–26, find the indicated probabilities. If convenient, use technology or Table 2 in Appendix B.*

19. Gamers Fifty-two percent of the women in the UK play video games regularly. You randomly select seven women in the UK. Find the probability that the number of women in the UK who are gamers is (a) exactly four, (b) at least five, and (c) less than four. *(Source: The Guardian)*

20. Online Consumers Thirty-three percent of online consumers in Russia prefer to shop online using smartphones. You randomly select 12 consumers. Find the probability that the number of online consumers who purchase using smartphones is (a) exactly six, (b) more than six, (c) at most six. *(Source: East-West digital News)*

21. Flu Shots Fifty-six percent of U.S. adults say they intend to get a flu shot. You randomly select 10 U.S. adults. Find the probability that the number of U.S. adults who intend to get a flu shot is (a) exactly four, (b) at least five, and (c) less than seven. *(Source: Rasmussen Reports)*

22. Fast Food Eleven percent of U.S. adults eat fast food four to six times per week. You randomly select 12 U.S. adults. Find the probability that the number of U.S. adults who eat fast food four to six times per week is (a) exactly five, (b) at least two, and (c) less than three. *(Source: Statista)*

23. Consumer Electronics Forty percent of consumers prefer to purchase electronics online. You randomly select 11 consumers. Find the probability that the number of consumers who prefer to purchase electronics online is (a) exactly five, (b) more than five, and (c) at most five. *(Source: PwC)*

24. Grocery Shopping Twenty percent of consumers prefer to purchase groceries online. You randomly select 16 consumers. Find the probability that the number of consumers who prefer to purchase groceries online is (a) exactly one, (b) more than one, and (c) at most one. *(Source: PwC)*

25. Workplace Drug Testing Four percent of the U.S. workforce test positive for illicit drugs. You randomly select 14 workers. Find the probability that the number of workers who test positive for illicit drugs is (a) exactly two, (b) more than two, and (c) between two and five, inclusive. *(Source: Quest Diagnostics)*

26. Tax Holiday Forty-four percent of U.S. adults say they are more likely to make purchases during a sales tax holiday. You randomly select 15 adults. Find the probability that the number of adults who say they are more likely to make purchases during a sales tax holiday is (a) exactly seven, (b) more than seven, and (c) between seven and eleven, inclusive. *(Source: Rasmussen Reports)*

Constructing and Graphing Binomial Distributions *In Exercises 27–30, (a) construct a binomial distribution, (b) graph the binomial distribution using a histogram and describe its shape, and (c) identify any values of the random variable x that you would consider unusual. Explain your reasoning.*

27. Working Mothers Forty-nine percent of working mothers do not have enough money to cover their health insurance deductibles. You randomly select seven working mothers and ask them whether they have enough money to cover their health insurance deductibles. The random variable represents the number of working mothers who do not have enough money to cover their health insurance deductibles. *(Source: Aflac)*

28. Workplace Cleanliness Fifty-seven percent of employees judge their peers by the cleanliness of their workspaces. You randomly select 10 employees and ask them whether they judge their peers by the cleanliness of their workspaces. The random variable represents the number of employees who judge their peers by the cleanliness of their workspaces. *(Source: Adecco)*

29. Living to Age 100 Seventy-seven percent of adults want to live to age 100. You randomly select five adults and ask them whether they want to live to age 100. The random variable represents the number of adults who want to live to age 100. *(Source: Standford Center on Longevity)*

30. Meal Programs Fifty-seven percent of school districts offer locally sourced fruits and vegetables in their meal programs. You randomly select eight school districts and ask them whether they offer locally sourced fruits and vegetables in their meal programs. The random variable represents the number of school districts that offer locally sourced fruits and vegetables in their meal programs. *(Source: School Nutrition Association)*

Finding and Interpreting Mean, Variance, and Standard Deviation
In Exercises 31–36, find the mean, variance, and standard deviation of the binomial distribution for the given random variable. Interpret the results.

31. Political Correctness Seventy-one percent of U.S. adults think that political correctness is a problem in America today. You randomly select seven U.S. adults and ask them whether they think that political correctness is a problem in America today. The random variable represents the number of U.S. adults who think that political correctness is a problem in America today. *(Source: Rasmussen Reports)*

32. Rap and Hip-Hop Music Fifty percent of adults are offended by how men portray women in rap and hip-hop music. You randomly select four adults and ask them whether they are offended by how men portray women in rap and hip-hop music. The random variable represents the number of adults who are offended by how men portray women in rap and hip-hop music. *(Source: Empower Women)*

33. Life on Other Planets Seventy-nine percent of U.S. adults believe that life on other planets is plausible. You randomly select eight U.S. adults and ask them whether they believe that life on other planets is plausible. The random variable represents the number of adults who believe that life on other planets is plausible. *(Source: Ipsos)*

34. Federal Involvement in Fighting Local Crime Thirty-six percent of likely U.S. voters think that the federal government should get more involved in fighting local crime. You randomly select five likely U.S. voters and ask them whether they think that the federal government should get more involved in fighting local crime. The random variable represents the number of likely U.S. voters who think that the federal government should get more involved in fighting local crime. *(Source: Rasmussen Reports)*

35. Late for Work Thirty-two percent of U.S. employees who are late for work blame oversleeping. You randomly select six U.S. employees who are late for work and ask them whether they blame oversleeping. The random variable represents the number of U.S. employees who are late for work and blame oversleeping. *(Source: CareerBuilder)*

36. Supreme Court Ten percent of college graduates think that Judge Judy serves on the Supreme Court. You randomly select five college graduates and ask them whether they think that Judge Judy serves on the Supreme Court. The random variable represents the number of college graduates who think that Judge Judy serves on the Supreme Court. *(Source: CNN)*

Extending Concepts

Multinomial Experiments *In Exercises 37 and 38, use the information below.*

A **multinomial experiment** satisfies these conditions.

- The experiment has a fixed number of trials n, where each trial is independent of the other trials.
- Each trial has k possible mutually exclusive outcomes: $E_1, E_2, E_3, \ldots, E_k$.
- Each outcome has a fixed probability. So, $P(E_1) = p_1$, $P(E_2) = p_2$, $P(E_3) = p_3$, $\ldots$, $P(E_k) = p_k$. The sum of the probabilities for all outcomes is $p_1 + p_2 + p_3 + \cdots + p_k = 1$.
- The number of times E_1 occurs is x_1, the number of times E_2 occurs is x_2, the number of times E_3 occurs is x_3, and so on.
- The discrete random variable x counts the number of times x_1, x_2, x_3, $\ldots$, x_k that each outcome occurs in n independent trials where $x_1 + x_2 + x_3 + \cdots + x_k = n$. The probability that x will occur is

$$P(x) = \frac{n!}{x_1!x_2!x_3!\cdots x_k!}p_1^{x_1}p_2^{x_2}p_3^{x_3}\cdots p_k^{x_k}.$$

37. Genetics According to a theory in genetics, when tall and colorful plants are crossed with short and colorless plants, four types of plants will result: tall and colorful, tall and colorless, short and colorful, and short and colorless, with corresponding probabilities of $\frac{9}{16}$, $\frac{3}{16}$, $\frac{3}{16}$, and $\frac{1}{16}$. Ten plants are selected. Find the probability that 5 will be tall and colorful, 2 will be tall and colorless, 2 will be short and colorful, and 1 will be short and colorless.

38. Genetics Another proposed theory in genetics gives the corresponding probabilities for the four types of plants described in Exercise 37 as $\frac{5}{16}$, $\frac{4}{16}$, $\frac{1}{16}$, and $\frac{6}{16}$. Ten plants are selected. Find the probability that 5 will be tall and colorful, 2 will be tall and colorless, 2 will be short and colorful, and 1 will be short and colorless.

39. Manufacturing An assembly line produces 10,000 automobile parts. Twenty percent of the parts are defective. An inspector randomly selects 10 of the parts.

(a) Use the Multiplication Rule (discussed in Section 3.2) to find the probability that none of the selected parts are defective. (Note that the events are dependent.)

(b) Because the sample is only 0.1% of the population, treat the events as *independent* and use the binomial probability formula to approximate the probability that none of the selected parts are defective.

(c) Compare the results of parts (a) and (b).