

is that the precise probabilities would not actually change enough to affect the value of the answer. We are considering eight programs; thus, $n = 8$. If we define a success to be receiving a discount coupon, then the probability of obtaining a success is $p = 0.2$. Let X be the number of discount coupons received in the eight programs bought by your friends. We are interested in the probability that *at least half of the eight* friends get a discount coupon, so at least four out of the eight, or $P(X \geq 4)$. As in the previous example, in order to use the cumulative binomial probability function to solve this problem, we will need to use the Complement Rule.

$$P(X \geq 4) = 1 - P(X < 4)$$

This is still not exactly what we need because the cumulative binomial distribution is only cumulative probabilities of the form $P(X \leq x)$. Fortunately, this situation is not too difficult to deal with due to one of the characteristics of the binomial distribution. The value for x must be a whole number; therefore, $P(X < 4) = P(X \leq 3)$.

Tables: Find the row for $n = 8$, $x = 3$, and the column for $p = 0.2$. The probability where they intersect is 0.9437. Thus,

$$\begin{aligned} P(X \geq 4) &= 1 - P(X \leq 3) \\ &= 1 - 0.9437 \\ &= 0.0563 \end{aligned}$$

TI-83/84 Plus: Using all of this information we calculate the probability as shown below and in the screenshot in the margin.

$$\begin{aligned} P(X \geq 4) &= 1 - P(X < 4) \\ &= 1 - P(X \leq 3) \\ &= 1 - \text{binomcdf}(8, 0.2, 3) \\ &\approx 0.0563 \end{aligned}$$

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1-binomcdf(8,0.2,3)
.0562816
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Therefore, the probability that at least half of the eight friends find discount coupons in their programs is approximately 0.0563, or 5.63%, which indicates that it is not very likely.

5.2 Section Exercises

Properties of a Binomial Distribution

Determine whether the given procedure meets the criteria of a binomial distribution. If not, identify at least one requirement that is not satisfied.

1. A survey of college students rating the food in the campus dining hall on a scale from 1–10.
2. Drawing a card from a standard deck of 52 cards and recording whether the card drawn is a face card, number card, or an ace.
3. The number of times a professional baseball player hits a home run each time at bat.
4. Surveying 124 people living in the United States who use Internet service and recording their “no” responses to the question: “Do you think that Internet sites should be federally regulated?”

Probability for Binomial Distributions

Assume that the random variable X has a binomial distribution with the given probability of obtaining a success. Find each specified probability, given the number of trials.

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|---|--|
| 5. $P(X = 3)$, $n = 5$, $p = 0.4$ | 6. $P(X = 4)$, $n = 10$, $p = 0.3$ |
| 7. $P(X \leq 8)$, $n = 12$, $p = 0.1$ | 8. $P(X \leq 2)$, $n = 3$, $p = 0.9$ |
| 9. $P(X < 7)$, $n = 18$, $p = 0.4$ | 10. $P(X < 9)$, $n = 17$, $p = 0.5$ |
| 11. $P(X > 3)$, $n = 4$, $p = 0.8$ | 12. $P(X > 5)$, $n = 10$, $p = 0.7$ |
| 13. $P(X \geq 6)$, $n = 7$, $p = 0.2$ | 14. $P(X \geq 8)$, $n = 15$, $p = 0.6$ |

Find each specified probability for the given scenario.

15. Suppose that the probability of Thad making a free throw in the championship basketball game is 60%, and each throw is independent of his last throw. Assume that Thad attempts seven free throws during the game.
 - a. What is the probability that he will make more than four of his free throws?
 - b. What is the probability that he will make all of his free throws?
 - c. How many free throws should we expect Thad to make of the seven attempts during this game?
16. At one large university, freshmen account for 30% of the student body.
 - a. If a group of twelve students is randomly chosen by the school newspaper to comment on textbook prices, what is the probability that fewer than three of the students are freshmen? (Assume that this situation can be modeled using a binomial distribution.)
 - b. If a group of ten students is randomly chosen by the school newspaper to comment on textbook prices, what is the probability that more than three of the students are freshmen? (Assume that this situation can be modeled using a binomial distribution.)
 - c. If a group of 40 students is randomly chosen by the school newspaper to comment on textbook prices, how many of the students can you expect to be freshmen?
17. The SugarBear Candy Factory makes two types of chocolate candy bars—milk chocolate and milk chocolate with almonds. In a typical day, 60% of the candy bars being made are milk chocolate, and the rest are milk chocolate with almonds. At the end of the day, a quality control expert randomly chooses 14 chocolate bars for inspection.
 - a. What is the probability that half of them contain almonds?
 - b. What is the probability that at least half of them contain almonds?
 - c. Of the 14 chocolate bars chosen for inspection, what is the variation in the number of bars containing almonds that the inspector could get?
18. Suppose that the probability of your favorite baseball player getting a hit at each at-bat is 0.30. Assume that each at-bat is independent of any other at-bat.
 - a. What is the probability that he bats six times and gets fewer than two hits?
 - b. What is the probability that he bats nine times and gets at most four hits?
 - c. In a three-game series where the player bats a total of 10 times, what is the variation in the number of hits he might get?

19. Suppose that Carlos is taking a multiple-choice test where there are five answer choices for each question, and he randomly guesses on four questions.
- What is the probability that he gets exactly three of those questions correct?
 - What is the probability that he gets at least one out of the four questions correct?
 - What is the probability that he gets none of the four questions correct?
20. In a pediatrician's office, the probability of a "no show" for any checkup appointment on any given day is 1 out of 10. Suppose that there are 18 appointments scheduled for one day.
- Find the probability that fewer than 4 don't show.
 - Find the probability that at least 2 don't show.
 - Find the probability that the doctor sees every patient scheduled.
21. The probability of any plant surviving in Kerry's garden is 0.8. Suppose she plants 19 new plants this year.
- What is the probability that at least 5 of them survive?
 - What is the probability that more than $\frac{3}{4}$ of them survive?
 - What is the probability that she has a bad year and none of them survive?
22. In a national park in Alaska, there are 100 polar bears. As part of the monitoring of the park, the rangers caught 20 bears, tagged them and released them back into the park during the first year. A year later they caught 13 bears. (Assume that the bears are caught at different times, and the same bear could be caught more than once.)
- What is the probability that 6 are tagged?
 - What is the probability that at least 10 are tagged?
 - What is the probability that none are tagged?
23. Underneath each cap of Brand X cola bottles is a chance to win a free cola. Suppose that the probability of winning is 1 out of 11 and you buy 16 colas.
- What is the probability that you win at least once?
 - What is the probability that you don't win at all?
 - What is the probability that you win with half of the bottles?
24. Ronnie owns a fireworks stand and knows that in the fireworks business, 1 out of every 13 fireworks is a dud. Suppose that Juanita buys 10 firecrackers at Ronnie's stand.
- What is the probability that no more than 3 are duds?
 - What is the probability that she has a perfect display with no duds?
 - What is the probability that more than half are duds?