4.10: Homework

4.1 Hypergeometric Distribution

47. A group of Martial Arts students is planning on participating in an upcoming demonstration. Six are students of Tae Kwon Do; seven are students of Shotokan Karate. Suppose that eight students are randomly picked to be in the first demonstration. We are interested in the number of Shotokan Karate students in that first demonstration.
a. In words, define the random variable X.
b. List the values that X may take on.
c. How many Shotokan Karate students do we expect to be in that first demonstration?

48. In one of its Spring catalogs, L.L. Bean® advertised footwear on 29 of its 192 catalog pages. Suppose we randomly survey 20 pages. We are interested in the number of pages that advertise footwear. Each page may be picked at most once.
a. In words, define the random variable X.
b. List the values that X may take on.
c. How many pages do you expect to advertise footwear on them?
d. Calculate the standard deviation.

49. Suppose that a technology task force is being formed to study technology awareness among instructors. Assume that ten people will be randomly chosen to be on the committee from a group of 28 volunteers, 20 who are technically proficient and eight who are not. We are interested in the number on the committee who are not technically proficient.
a. In words, define the random variable X.
b. List the values that X may take on.
c. How many instructors do you expect on the committee who are not technically proficient?
d. Find the probability that at least five on the committee are not technically proficient.
e. Find the probability that at most three on the committee are not technically proficient.

50. Suppose that nine Massachusetts athletes are scheduled to appear at a charity benefit. The nine are randomly chosen from eight volunteers from the Boston Celtics and four volunteers from the New England Patriots. We are interested in the number of Patriots picked.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Are you choosing the nine athletes with or without replacement?

51. A bridge hand is defined as 13 cards selected at random and without replacement from a deck of 52 cards. In a standard deck of cards, there are 13 cards from each suit: hearts, spades, clubs, and diamonds. What is the probability of being dealt a hand that does not contain a heart?
a. What is the group of interest?
b. How many are in the group of interest?
c. How many are in the other group?
d. Let $X =$. What values does X take on?
e. The probability question is $P($).
f. Find the probability in question.
g. Find the (i) mean and (ii) standard deviation of X.

4.2 Binomial Distribution

52. According to a recent article the average number of babies born with significant hearing loss (deafness) is approximately two per 1,000 babies in a healthy baby nursery. The number climbs to an average of 30 per 1,000 babies in an intensive care nursery.

Suppose that 1,000 babies from healthy baby nurseries were randomly surveyed. Find the probability that exactly two babies were born deaf.

Use the following information to answer the next four exercises. Recently, a nurse commented that when a patient calls the medical advice line claiming to have the flu, the chance that they truly have the flu (and not just a nasty cold) is only about 4%. Of the next 25 patients calling in claiming to have the flu, we are interested in how many actually have the flu.

53. Define the random variable and list its possible values.

54. State the distribution of X.

55. Find the probability that at least four of the 25 patients actually have the flu.

56. On average, for every 25 patients calling in, how many do you expect to have the flu?

57. People visiting video game rental stores often rent more than one game at a time. The probability distribution for game rentals per customer at Game Stop is given Table

games.

x	*P*(*x*)
0	0.03
1	0.50
2	0.24
3	
4	0.07
5	0.04

Table 4.5

a. Describe the random variable *X* in words.
b. Find the probability that a customer purchases three games.
c. Find the probability that a customer purchases at least four games.
d. Find the probability that a customer purchases at most two games.

58. A school newspaper reporter decides to randomly survey 12 students to see if they will attend Tet (Vietnamese New Year) festivities this year. Based on past years, she knows that 18% of students attend Tet festivities. We are interested in the number of students who will attend the festivities.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$,)
d. How many of the 12 students do we expect to attend the festivities?
e. Find the probability that at most four students will attend.
f. Find the probability that more than two students will attend.

Use the following information to answer the next two exercises: The probability that the San Jose Sharks will win any given game is 0.3694 based on a 13-year win history of 382 wins out of 1,034 games played (as of a certain date). An upcoming monthly schedule contains 12 games.

59. The expected number of wins for that upcoming month is:
a. 1.67
b. 12
c. $\frac{382}{1043}$
d. 4.43

Let $X =$ the number of games won in that upcoming month.

60. What is the probability that the San Jose Sharks win six games in that upcoming month?
a. 0.1476
b. 0.2336
c. 0.7664
d. 0.8903

61. What is the probability that the San Jose Sharks win at least five games in that upcoming month
a. 0.3694

b. 0.5266
c. 0.4734
d. 0.2305

62. A student takes a ten-question true-false quiz, but did not study and randomly guesses each answer. Find the probability that the student passes the quiz with a grade of at least 70% of the questions correct.

63. A student takes a 32-question multiple-choice exam, but did not study and randomly guesses each answer. Each question has three possible choices for the answer. Find the probability that the student guesses more than 75% of the questions correctly.

64. Six different colored dice are rolled. Of interest is the number of dice that show a one.
a. In words, define the random variable X.
b. List the values that X may take on.
c. On average, how many dice would you expect to show a one?
d. Find the probability that all six dice show a one.
e. Is it more likely that three or that four dice will show a one? Use numbers to justify your answer numerically.

65. More than 96 percent of the very largest colleges and universities (more than 15,000 total enrollments) have some online offerings. Suppose you randomly pick 13 such institutions. We are interested in the number that offer distance learning courses.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (, _
d. On average, how many schools would you expect to offer such courses?
e. Find the probability that at most ten offer such courses.
f. Is it more likely that 12 or that 13 will offer such courses? Use numbers to justify your answer numerically and answer in a complete sentence.

66. Suppose that about 85% of graduating students attend their graduation. A group of 22 graduating students is randomly chosen.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (,)
d. How many are expected to attend their graduation?
e. Find the probability that 17 or 18 attend.
f. Based on numerical values, would you be surprised if all 22 attended graduation? Justify your answer numerically.

67. At The Fencing Center, 60% of the fencers use the foil as their main weapon. We randomly survey 25 fencers at The Fencing Center. We are interested in the number of fencers who do not use the foil as their main weapon.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (, _
d. How many are expected to not to use the foil as their main weapon?
e. Find the probability that six do not use the foil as their main weapon.
f. Based on numerical values, would you be surprised if all 25 did not use foil as their main weapon? Justify your answer numerically.

68. Approximately 8% of students at a local high school participate in after-school sports all four years of high school. A group of 60 seniors is randomly chosen. Of interest is the number who participated in afterschool sports all four years of high school.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (,)
d. How many seniors are expected to have participated in after-school sports all four years of high school?
e. Based on numerical values, would you be surprised if none of the seniors participated in after-school sports all four years of high school? Justify your answer numerically.
f. Based upon numerical values, is it more likely that four or that five of the seniors participated in afterschool sports all four years of high school? Justify your answer numerically.

69. The chance of an IRS audit for a tax return with over $\$25,000$ in income is about 2\% per year. We are interested in the expected number of audits a person with that income has in a 20 -year period. Assume each year is independent.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (,)
d. How many audits are expected in a 20 -year period?
e. Find the probability that a person is not audited at all.
f. Find the probability that a person is audited more than twice.

70. It has been estimated that only about 30% of California residents have adequate earthquake supplies. Suppose you randomly survey 11 California residents. We are interested in the number who have adequate earthquake supplies.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (,)
d. What is the probability that at least eight have adequate earthquake supplies?
e. Is it more likely that none or that all of the residents surveyed will have adequate earthquake supplies? Why?
f. How many residents do you expect will have adequate earthquake supplies?

71. There are two similar games played for Chinese New Year and Vietnamese New Year. In the Chinese version, fair dice with numbers $1, 2, 3, 4, 5$, and 6 are used, along with a board with those numbers. In the Vietnamese version, fair dice with pictures of a gourd, fish, rooster, crab, crayfish, and deer are used. The board has those six objects on it, also. We will play with bets being $\$1$. The player places a bet on a number or object. The "house" rolls three dice. If none of the dice show the number or object that was bet, the house keeps the $\$1$ bet. If one of the dice shows the number or object bet (and the other two do not show it), the player gets back their $\$1$ bet, plus $\$1$ profit. If two of the dice show the number or object bet (and the third die does not show it), the player gets back their $\$1$ bet, plus $\$2$ profit. If all three dice show the number or object bet, the player gets back their $\$1$ bet, plus $\$3$ profit. Let $X =$ number of matches and $Y =$ profit per game.
a. In words, define the random variable X.
b. List the values that X may take on.
c. List the values that Y may take on. Then, construct one PDF table that includes both X and Y and their probabilities.
d. Calculate the average expected matches over the long run of playing this game for the player.
e. Calculate the average expected earnings over the long run of playing this game for the player.
f. Determine who has the advantage, the player or the house.

72. Only 9% of the population of Niger had access to the internet. Suppose we randomly sample 150 people in Niger. Let $X =$ the number of people who have access the internet.
a. What is the probability distribution for X ?
b. Using the formulas, calculate the mean and standard deviation of X.
c. Find the probability that 15 people in the sample have access to the internet.
d. Find the probability that at most ten people in the sample have access to the internet.
e. Find the probability that more than 25 people in the sample have access to the internet.

73. The literacy rate for a nation measures the proportion of people age 15 and over that can read and write. The literacy rate in a certain country is 28.1%. Suppose you choose 15 people in a certain country at random. Let $X =$ the number of people who are literate.
a. Sketch a graph of the probability distribution of X.
b. Using the formulas, calculate the (i) mean and (ii) standard deviation of X.
c. Find the probability that more than five people in the sample are literate. Is it is more likely that three people or four people are literate.

4.3 Geometric Distribution

74. A consumer looking to buy a used red Miata car will call dealerships until she finds a dealership that carries the car. She estimates the probability that any independent dealership will have the car will be 28%. We are interested in the number of dealerships she must call.
a. In words, define the random variable X.
b. List the values that X may take on.

c. Give the distribution of X. $X \sim$ (,)
d. On average, how many dealerships would we expect her to have to call until she finds one that has the car?
e. Find the probability that she must call at most four dealerships.
f. Find the probability that she must call three or four dealerships.

75. Suppose that the probability that an adult in America will watch the Super Bowl is 40%. Each person is considered independent. We are interested in the number of adults in America we must survey until we find one who will watch the Super Bowl.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (,)
d. How many adults in America do you expect to survey until you find one who will watch the Super Bowl?
e. Find the probability that you must ask seven people.
f. Find the probability that you must ask three or four people.

76. It has been estimated that only about 30% of California residents have adequate earthquake supplies. Suppose we are interested in the number of California residents we must survey until we find a resident who does not have adequate earthquake supplies.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (,)
d. What is the probability that we must survey just one or two residents until we find a California resident who does not have adequate earthquake supplies?
e. What is the probability that we must survey at least three California residents until we find a California resident who does not have adequate earthquake supplies?
f. How many California residents do you expect to need to survey until you find a California resident who does not have adequate earthquake supplies?
g. How many California residents do you expect to need to survey until you find a California resident who does have adequate earthquake supplies?

77. In one of its Spring catalogs, L.L. Bean® advertised footwear on 29 of its 192 catalog pages. Suppose we randomly survey 20 pages. We are interested in the number of pages that advertise footwear. Each page may be picked more than once.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$ (,)
d. How many pages do you expect to advertise footwear on them?
e. Is it probable that all twenty will advertise footwear on them? Why or why not?
f. What is the probability that fewer than ten will advertise footwear on them?
g. Reminder: A page may be picked more than once. We are interested in the number of pages that we must randomly survey until we find one that has footwear advertised on it. Define the random variable X and give its distribution.
h. What is the probability that you only need to survey at most three pages in order to find one that advertises footwear on it?
i. How many pages do you expect to need to survey in order to find one that advertises footwear?

78. Suppose that you are performing the probability experiment of rolling one fair six-sided die. Let F be the event of rolling a four or a five. You are interested in how many times you need to roll the die in order to obtain the first four or five as the outcome.

- $p =$ probability of success (event F occurs)
- $q =$ probability of failure (event F does not occur)

a. Write the description of the random variable X.
b. What are the values that X can take on?
c. Find the values of p and q.
d. Find the probability that the first occurrence of event F (rolling a four or five) is on the second trial.

79. Ellen has music practice three days a week. She practices for all of the three days 85% of the time, two days 8% of the time, one day 4% of the time, and no days 3% of the time. One week is selected at random. What values does X take on?

80. Medical researchers in a certain country have documented that the percentage of people ages 15 to 49 who are infected with a certain respiratory virus is 17.3%. Let $X =$ the number of people you test until you find a person infected with the virus.
a. Sketch a graph of the distribution of the discrete random variable X.
b. What is the probability that you must test 30 people to find one with the virus?
c. What is the probability that you must ask ten people?
d. Find the (i) mean and (ii) standard deviation of the distribution of X.

81. According to a recent Pew Research poll, 75% of millennials (people born between 1981 and 1995) have a profile on a social networking site. Let $X =$ the number of millennials you ask until you find a person without a profile on a social networking site.
a. Describe the distribution of X.
b. Find the (i) mean and (ii) standard deviation of X.
c. What is the probability that you must ask ten people to find one person without a social networking site?
d. What is the probability that you must ask 20 people to find one person without a social networking site?
e. What is the probability that you must ask at most five people?

4.4 Poisson Distribution

82. The switchboard in a Minneapolis law office gets an average of 5.5 incoming phone calls during the noon hour on Mondays. Experience shows that the existing staff can handle up to six calls in an hour. Let $X =$ the number of calls received at noon.
a. Find the mean and standard deviation of X.
b. What is the probability that the office receives at most six calls at noon on Monday?
c. Find the probability that the law office receives six calls at noon. What does this mean to the law office staff who get, on average, 5.5 incoming phone calls at noon?
d. What is the probability that the office receives more than eight calls at noon?

83. The maternity ward at Dr. Jose Fabella Memorial Hospital in Manila in the Philippines is one of the busiest in the world with an average of 60 births per day. Let $X =$ the number of births in an hour.
a. Find the mean and standard deviation of X.
b. Sketch a graph of the probability distribution of X.
c. What is the probability that the maternity ward will deliver three babies in one hour?
d. What is the probability that the maternity ward will deliver at most three babies in one hour?
e. What is the probability that the maternity ward will deliver more than five babies in one hour?

84. A manufacturer of Christmas tree light bulbs knows that 3% of its bulbs are defective. Find the probability that a string of 100 lights contains at most four defective bulbs using both the binomial and Poisson distributions.

85. The average number of children a Japanese woman has in her lifetime is 1.37. Suppose that one Japanese woman is randomly chosen.
a. In words, define the random variable X.
b. List the values that X may take on.
c. Find the probability that she has no children.
d. Find the probability that she has fewer children than the Japanese average.
e. Find the probability that she has more children than the Japanese average.

86. The average number of children a Spanish woman has in her lifetime is 1.47. Suppose that one Spanish woman is randomly chosen.
a. In words, define the Random Variable X.
b. List the values that X may take on.
c. Find the probability that she has no children.
d. Find the probability that she has fewer children than the Spanish average.
e. Find the probability that she has more children than the Spanish average .

87. Fertile, female cats produce an average of three litters per year. Suppose that one fertile, female cat is randomly chosen. In one year, find the probability she produces:
a. In words, define the random variable X.
b. List the values that X may take on.
c. Give the distribution of X. $X \sim$

d. Find the probability that she has no litters in one year.
e. Find the probability that she has at least two litters in one year.
f. Find the probability that she has exactly three litters in one year.

88. The chance of having an extra fortune in a fortune cookie is about 3%. Given a bag of 144 fortune cookies, we are interested in the number of cookies with an extra fortune. Two distributions may be used to solve this problem, but only use one distribution to solve the problem.
a. In words, define the random variable X.
b. List the values that X may take on.
c. How many cookies do we expect to have an extra fortune?
d. Find the probability that none of the cookies have an extra fortune.
e. Find the probability that more than three have an extra fortune.
f. As n increases, what happens involving the probabilities using the two distributions? Explain in complete sentences.

84. A manufacturer of Christmas tree light bulbs knows that 3% of its bulbs are defective. Find the probability that a string of 100 lights contains at most four defective bulbs using both the binomial and Poisson distributions.

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b. List the values that X may take on.
c. How many cookies do we expect to have an extra fortune?
d. Find the probability that none of the cookies have an extra fortune.
e. Find the probability that more than three have an extra fortune.
f. As n increases, what happens involving the probabilities using the two distributions? Explain in complete sentences.

Use the following information to answer the next two exercises: The average number of times per week that Mrs. Plum's cats wake her up at night because they want to play is ten. We are interested in the number of times her cats wake her up each week.

93. In words, the random variable $X =$
a. the number of times Mrs. Plum's cats wake her up each week.

b. the number of times Mrs. Plum's cats wake her up each hour.
c. the number of times Mrs. Plum's cats wake her up each night.
d. the number of times Mrs. Plum's cats wake her up.

94. Find the probability that her cats will wake her up no more than five times next week.
a. 0.5000
b. 0.9329
c. 0.0378
d. 0.0671

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