**Chapter 3 Exercises**

**Concepts**

1. Suggest the most appropriate distribution(s) for calculating the probability of:
   1. finding a certain number of people with an extremely rare disease in a particular population
   2. a particular book being requested from a library a particular number of times in a week
   3. having to roll a die eight times before getting an even number
   4. six out of ten people ordering the vegetarian option at lunch, assuming that their decisions do not influence one another and vegetarian preferences are constant across the group.
2. In certain situations, binomial and Poisson distributions can be used to estimate the same probability. What assumptions are made about time when using a binomial distribution, and how do these differ from those associated with a Poisson distribution?
3. Is it always the case that low probability events are evidence of a violated assumption or a relationship among the variables being measured?

**Exercises**

1. Give the probability of each possible outcome of rolling a die based on:
   1. the assumption of equally probable sample points (i.e. P(X=x) = 1/n)
   2. the belief that the die is weighted so that the number 6 comes up three times as often as any of the other numbers
   3. the relative frequency based on the following table of past results:

|  |  |
| --- | --- |
| Roll Result | Count |
| 1 | 5 |
| 2 | 2 |
| 3 | 7 |
| 4 | 4 |
| 5 | 4 |
| 6 | 3 |
| Total | 25 |

1. Give the probability of rolling a pair of fair dice such that:
   1. both dice come up odd
   2. at least one die comes up odd
   3. exactly one die comes up odd
   4. the sum of the dice is odd.
2. Some board games have dice that have more than six sides. Imagine you are playing a game with a pair of 12-sided die. Give the probability that:
   1. At least one of the die comes up 10
   2. Both die come up odd
   3. The die have a summed value of 18 or larger
   4. The die have a summed value over 20.
3. A committee is being assembled, and its membership is expected to proportionally represent two political parties, the Blues and the Yellows. Assume that the pool of committee candidates is 70% Blue and 30% Yellow.
   1. What is the probability that, on a ten person committee, there will be no Yellows? Five Yellows? Nine Yellows?
   2. What is the expected number of Blue committee members on a 30 person committee? What is the theoretical variance?
4. A mechanical part has a 76% chance of being defective.
   1. What is the probability that a technician tests two units before finding one that works? Five units? Ten units?
   2. What is the probability that the first three units a technician tests all work?
   3. What is the mean number of units the technician must test before finding a unit that works?
5. A company typically receives an order for a particular product once every five days. What is the probability that there are two orders in 12 days? In 30 days? In one day?
6. Assume that individuals have a 3% chance of suffering from a specific allergy.
   1. Out of a population of 100, what is the chance that fewer than 2 people suffer from the allergy?
   2. Approximate the number of allergy sufferers in part a) using the Poisson distribution.
7. A particular species of endangered bird can be found at random points in a forest, with one animal being found per 7 square kilometers. What is the chance of finding six birds within a 20 square kilometer area?
8. A jury of 16 individuals includes three jurors who belong to a particular group. The jury was selected from a population of 50 individuals. What is the probability of this assuming that five of the 50 were members of the group? That 20 were group members?
9. Suppose you are monitoring a population of *N*= 25 sexually mature male birds in a forest.   
   Of those birds *r=*8 have been infected with a disease that impacts their lung capacity, but does not affect their appearance in a way that human can notice. You want to know if this disease impacts their mating chances. Suppose you observe *n*=15 of these birds mating, and you observe *x*=3 of them has the disease. Determine how likely it is to have observed at most 3 of these birds mating.
10. A researcher is exploring whether instances of burglary tend to cluster in space and time. The following table shows a classification of pairs of reported burglaries in a particular city in terms of closeness in distance and time:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Close in time | Not close in time | Total |
| Close in space | 9 | 9 | 18 |
| Not close in space | 2 | 25 | 27 |
| Total | 11 | 34 | 45 |

Give the probability of this distribution of burglaries having happened by chance.

1. Assume a town has 9 equally sized policing zones and an observed average major crime rate of 5 crimes in a zone per month. Use the Poisson distribution to:
   1. find the probability a zone would experience 7 crimes in one month
   2. find the probability of a zone experiencing no more than 2 crimes in one month.

**Chapter 3 Solutions**

* 1. 1: 16.6% 2: 16.6% 3: 16.6% 4: 16.6% 5: 16.6% 6: 16.6%
  2. 1: 12.5% 2: 12.5% 3: 12.5% 4: 12.5% 5: 12.5% 6: 37.5%
  3. 1: 20.0% 2: 8.0% 3: 28.0% 4: 16.0% 5: 16.0% 6: 12.0%
  4. 25%
  5. 75%
  6. 50%
  7. 50%
  8. 23/144 = 0.1597 = 15.97%
  9. 36/144 = 0.25 = 25.0%
  10. 28/144 = 0.1944 = 19.44%
  11. 10/144 = 0.0694 = 6.94%
  12. No Yellows: 2.8%; 5 Yellows: 10.3%. 9 Yellows: .01%
  13. Expected number of Blue members: 21. Theoretical variance: 6.3
  14. 2: 13.9% 5: 6.1% 10: 1.5%
  15. 1.4%
  16. Mean: 4.2

1. .2%, .005%, 1.6%
   1. 19.5%
   2. 19.9%
2. 4.3%
3. 5 members: 14.8%; 20 members: 2.8%
4. .2%

a.

b.