**Chapter 4 exercises**

**Concepts**

1. Comment on the likelihood of finding an extreme value in data believed to derive from either a normal or an exponential distribution. What might a researcher conclude about such a datapoint?
2. Exponential distributions have the important property of being memoryless, meaning that the probability of an event happening in the next time step does not change, no matter how many timesteps that have already passed. Is this different from the claim that the probability of an event is equal at every point in time? Why or why not?
3. Comment on the coefficient of variation (see Chapter 2) for the exponential distribution and what this implies about relative variability.

**Exercises**

1. The final examination scores of particular course are found to be normally distributed, with mean 82 and standard deviation of 10.
   1. Assume that a score of 95 is required for a student to pass with honors. What is the probability of this?
   2. Students scoring between 65 and 75 are required to take remedial classes. What percentage of the examinees will require these courses?
   3. What score would a student have to achieve to be in the top 5%?
2. The ages of the employees of a company are uniformly distributed between 25 and 64.
   1. What is the probability that an employee picked at random will be between 27 and 35?
   2. What is the 90th percentile of the ages in the company?
3. The selling price for textbooks is uniformly distributed between 20 dollars and 150 dollars.
   1. What is the price of a textbook at the 95 percentile?
   2. What is the probability your textbook will cost between 25 and 40 dollars?
   3. If you have to buy two textbooks, what is the probability both books will cost less than 50 dollars (assume the cost of the two books is independent)?
4. A raffle offers cash prizes whose value is distributed exponentially, with λ = $0.60.
   1. What is the probability of receiving a prize payout less than $6?
   2. What is the probability of receiving a prize payout of at least $10?
   3. What is the probability that the prize is between $4 and $8?
5. The distance of changes in nesting locations for a bird species is exponentially, with

λ = 0.2km.

* 1. What is the 75th percentile of nesting change distances?
  2. If a researcher observed 1,000 nesting changes, how many change distances would you expect to find that we farther than 3.5km?

1. Conference attendees may register for an additional workshop; out of a conference of 220 people, the probability of an attendee attending the workshop is 15%.
   1. Using the binomial distribution, calculate the expected number of workshop attendees and the variance.
   2. Give the probability that the workshop has fewer than 20 attendees.
   3. Is the choice to approximate the binomial with the normal distribution appropriate in this case? Why or why not?
2. A national study finds that 40% of undergraduates are enrolled in programs at the school closest to their hometown, 27% at the second closest school, 10% at the third closest school, 8% at the fourth closest school, and 15% at the fifth closest school. For the intervening opportunities model, estimate *L*, the probability of enrolling at an individual school.
3. Researchers studying immigration flows between two countries find that the probability of moving from Country A to Country B is 15% in any given year, and the probability of moving from Country B to Country A is 7%. There are 10,000 people living in Country A and 27,000 people living in Country B.
   1. Estimate the population for both the next year and the year after that.
   2. Estimate the equilibrium populations of both countries.
4. The number of complaints an airline receives is normally distributed, with mean µ = 1600 and standard deviation σ = 235. What is the probability that the airline receives:
   1. Fewer than 1000 complaints?
   2. Over 2000 complaints?
   3. Between 1250 and 1750 complaints?
5. The birth weight of reindeer calves is normally distributed, with a mean of µ = 5.86kg and a standard deviation of σ = 0.77kg. What is the probability of a new-born reindeer weighing:
   1. less than 4.5kg?
   2. between 7kg and 8kg?
   3. What is the 85 percentile for new-born calf weight?
6. A pizza shop receives an order on average every 25 minutes. What is the probability that they wait less than 5 minutes between two orders? What is the probability that they wait more than two hours?
7. Give the theoretical coefficient of variation (see Chapter 2) for the exponential distribution and comment on its properties.

**Chapter 4 Solutions**

* 1. 9.7%
  2. 19.7%
  3. 98.5
  4. 25.6%
  5. 60.1%
  6. $143.50
  7. 12.5%
  8. 6.25%
  9. 97.3%
  10. .2%
  11. 8.2%
  12. 6.93
  13. 496
  14. expected number: 33 variance: 28.1
  15. 0.7%
  16. While np is greater than 5, a p of .15 is fairly far from .5. However, the sample size of 220 is large enough that we can feel confident in the approximation.

1. L is approximately .4
   1. Next year: Country A - 10390; Country B - 26610. The year after: Country A - 10694.2; Country B - 26305.8
   2. Country A - 11772.7; Country B: 25227.3
   3. .54%
   4. 4.5%
   5. 32.9%
   6. 3.92%
   7. 6.6%
   8. 6.65kg
2. <5 minutes: 18.1%; >2 hours: .8%
3. The theoretical coefficient of variation is simply the ratio of the standard deviation to the mean, which for the exponential distribution is sqrt(1/𝜆2)/(1/𝜆) = (1/𝜆)/(1/𝜆) = 1. Thus, the variability of the standard deviation relative to the mean is constant.