

1. A model airplane has two engines. It can fly if one engine fails but is in serious trouble if both engines fail. The engines function independently of one another. On any given flight, the probability of a failure is 0.10 for each engine. Design a simulation to estimate the probability that the airplane will be in serious trouble the next time it goes up.
 - a. How would you simulate the status of an engine?
 - b. What constitutes a trial for this simulation?
 - c. What constitutes a success for this simulation?
 - d. Carry out 50 trials of your simulation, list your results, and calculate an estimate of the probability that the airplane will be in serious trouble the next time it goes up.

2. In an effort to increase sales, a cereal manufacturer created a really neat toy that has six parts to it. One part is put into each box of cereal. Which part is in a box is not known until the box is opened. You can play with the toy without having all six parts, but it is better to have the complete set. If you are really lucky, you might only need to buy six boxes to get a complete set. But if you are very unlucky, you might need to buy many, many boxes before obtaining all six parts.
 - a. How would you represent the outcome of purchasing a box of cereal, keeping in mind that there are six different parts? There is one part in each box.
 - b. What constitutes a trial in this problem?
 - c. What constitutes a success in a trial in this problem?
 - d. Carry out 15 trials, list your results, and compute an estimate of the probability that it takes the purchase of 10 or more boxes to get all six parts.

3. Suppose that a type A blood donor is needed for a certain surgery. Carry out a simulation to answer the following question: If 40% of donors have type A blood, what is an estimate of the probability that it will take at least four donors to find one with type A blood?
- How would you simulate a blood donor having or not having type A?
 - What constitutes a trial for this simulation?
 - What constitutes a success for this simulation?
 - Carry out 15 trials, list your results, and compute an estimate for the probability that it takes at least four donors to find one with type A blood.

Liang wants to form a chess club. His principal says that he can do that if Liang can find six players, including him. How would you conduct a simulated model that estimates the probability that Liang will find at least five other players willing to join the club if he asks eight players who have a 70% chance of agreeing to join the club? Suggest a simulation model for Liang by describing how you would do the following parts.

- a. Specify the device you want to use to simulate one person being asked.

Answers will vary; you may want to discuss what devices can be used to simulate a 70% chance. Using single digits in a random number table would probably be the quickest and most efficient device. 1–7 could represent “yes,” and 0, 8, 9 could represent “no”.

- b. What outcome(s) of the device would represent the person agreeing to be a member?

Answers will vary based on device from part (a).

- c. What constitutes a trial using your device in this problem?

Using a random number table, a trial would consist of eight random digits.

- d. What constitutes a success using your device in this problem?

Answers will vary; based on the above, a success is at least five people agreeing to join and would be represented by any set of digits with at least five of the digits being from 1–7. Note that the random string 33047816 would represent 6 of 8 people agreeing to be a member, which is a success. The string 48891437 would represent a failure.

- e. Based on 50 trials using the method you have suggested, how would you calculate the estimate for the probability that Liang will be able to form a chess club?

Based on 50 such trials, the estimated probability that Liang will be able to form a chess club would be the number of successes divided by 50.

Important Note: You will need to provide your students with a page of random numbers. For ease of grading, you may want students to generate their outcomes starting from the same place in the table.

1. A model airplane has two engines. It can fly if one engine fails but is in serious trouble if both engines fail. The engines function independently of one another. On any given flight, the probability of a failure is 0.10 for each engine. Design a simulation to estimate the probability that the airplane will be in serious trouble the next time it goes up.

- a. How would you simulate the status of an engine?

Answers will vary; it is possible to use a random number table. The failure status of an engine can be represented by the digit 0, while digits 1–9 represent an engine in good status.

- b. What constitutes a trial for this simulation?

A trial for this problem would be a pair of random digits, one for each engine. The possible equally likely pairings would be 00, 0x, x0, xx (where x stands for any digit from 1–9). There are 100 of them. 00 represents both engines failing; 0x represents the left engine failing, but the right engine is good; x0 represents the right engine failing, but the left engine is good; xx represents both engines are in good working order.

- c. What constitutes a success for this simulation?

A success would be both engines failing, which is represented by 00.

- d. Carry out 50 trials of your simulation, list your results, and calculate an estimate of the probability that the airplane will be in serious trouble the next time it goes up.

Answers will vary; divide the number of successes by 50.

2. In an effort to increase sales, a cereal manufacturer created a really neat toy that has six parts to it. One part is put into each box of cereal. Which part is in a box is not known until the box is opened. You can play with the toy without having all six parts, but it is better to have the complete set. If you are really lucky, you might only need to buy six boxes to get a complete set. But if you are very unlucky, you might need to buy many, many boxes before obtaining all six parts.

- a. How would you represent the outcome of purchasing a box of cereal, keeping in mind that there are six different parts? There is one part in each box.

Answers will vary; since there are six parts in a complete set, the ideal device to use in this problem is a number cube. Each number represents a different part.

- b. What constitutes a trial in this problem?

Students are asked to estimate the probability that it takes 10 or more boxes to get all six parts, so it is necessary to look at the outcomes of the first 9 boxes. One roll of the number cube represents one box of cereal. A trial could be a string of 9 digits from 1–6, the results of rolling a number cube.

- c. What constitutes a success in a trial in this problem?

A success would then be looking at the 9 digits and seeing if at least one digit from 1–6 is missing. For example, the string 251466645 would count as a success since part 3 was not acquired, whereas 344551262 would be considered a failure because it took fewer than 10 boxes to get all six parts.

- d. Carry out 15 trials, list your results, and compute an estimate of the probability that it takes the purchase of 10 or more boxes to get all six parts.

Students are asked to generate 15 such trials, count the number of successes in the 15 trials, and divide the number by 15. The result is the estimated probability that it takes 10 or more boxes to acquire all six parts.

Note: This problem is taken from the Common Core Standards Grade 7.SP.8c.

3. Suppose that a type A blood donor is needed for a certain surgery. Carry out a simulation to answer the following question: If 40% of donors have type A blood, what is an estimate of the probability that it will take at least four donors to find one with type A blood?

a. How would you simulate a blood donor having or not having type A?

With 40% taken as the probability that a donor has type A blood, a random digit would be a good device to use. For example, 1, 2, 3, 4 could represent type A blood, and 0, 5, 6, 7, 8, 9 could represent non-type A blood.

b. What constitutes a trial for this simulation?

The problem asks for the probability that it will take four or more donors to find one with type A blood. That implies that the first three donors do not have type A blood. So, a trial is three random digits.

c. What constitutes a success for this simulation?

A success is none of the three digits are 1, 2, 3, or 4. For example, 605 would be a success since none of the donors had type A blood. An example of a failure would be 662.

d. Carry out 15 trials, list your results, and compute an estimate for the probability that it takes at least four donors to find one with type A blood.

Students are to generate 15 such trials, count the number of successes, and divide by 15 to calculate their estimated probability of needing four or more donors to get one with type A blood.