Ch 5 Probability: “What are the Chances?”

- Randomness
- Probability
- Simulation
- Probability Rules
- Conditional Probability
- Independence
5.1 Randomness, Probability, Simulation

**Probability**: the mathematics of chance

*Chance behavior...*

... is unpredictable in the short-term

... has a regular and predictable

pattern in the long run < (law of large numbers)
\[ P(\text{outcome}) = \text{probability of an outcome of a chance process} \]

- number between 0 and 1
- the proportion of times the outcome will occur in a long series of repetitions

(according to the law of large numbers)
The myth of short-run regularity:

The idea of probability is that randomness is predictable in the long run. Our intuition tries to tell us random phenomena should also be predictable in the short run. However, probability does not allow us to make short-run predictions.

The myth of the “law of averages”:

Probability tells us random behavior evens out in the long run. Future outcomes are not affected by past behavior. That is, past outcomes do not influence the likelihood of individual outcomes occurring in the future.
Ex. At a local high school, 95 students have permission to park on campus. Each month, the student council holds a "golden ticket parking lottery" at a school assembly. The two lucky winners are given reserved parking spots next to the school's main entrance. Last month, the winning tickets were drawn by a student council member from the AP Statistics class. When both golden tickets went to members of that same class, some people thought the lottery had been rigged. There are 28 students in the AP Statistics class, all of whom are eligible to park on campus.

How can we help provide evidence that the lottery was/was not carried out fairly?

Run a simulation...

State: We want to know whether it is reasonably likely exactly 2 AP Stats would be randomly selected from 95 students.

Plan:
1st: Assign a two-digit number from 01 - 95 to each student. (Assign 01-28 to the AP Stats students)
2nd: Choose a starting line on a Random Number Table and starting with the first numbers, choose 2 two-digit numbers (ignore unassigned numbers and repeats)

Line 122 gives us 13 and 87

3rd: For each pair of winners, record YES if exactly 2 winners are AP Stats, otherwise record NO

Record NO

4th: Perform many repetitions of the simulation.

After doing 14 repetitions, we got 2 out of 14 with exactly 2 AP Stats.

[Do in blue]

Conclude: Based on our simulation, there is evidence the contest was fair since our simulation resulted in \( \frac{2}{14} \approx 14\% \) of drawings with 2 AP Stats students.
Simulation

The imitation of chance behavior, based on a model that accurately reflects the situation, is called a **simulation**.

**Performing a Simulation**

- **State**: Ask a question of interest about some chance process.
- **Plan**: Describe how to use a chance device to imitate one repetition of the process. Tell what you will record at the end of each repetition.
- **Do**: Perform many repetitions of the simulation.
- **Conclude**: Use the results of your simulation to answer the question of interest.

We can use physical devices, random numbers (e.g. Table D), and technology to perform simulations.
Ex. In an attempt to increase sales, a breakfast cereal company decides to offer a NASCAR promotion. Each box of cereal will contain a collectible card featuring one of these NASCAR drivers: Jeff Gordon, Dale Earnhardt, Jr, Tony Stewart, Danica Patrick, or Jimmie Johnson. The company says that each of the 5 cards is equally likely to appear in any box of cereal. A NASCAR fan decides to keep buying boxes of the cereal until she has all 5 drivers’ cards. She is surprised when it takes her 23 boxes to get the full set of cards. Should she be surprised?

Design and carry out a simulation to help answer this question.