# AN INTRODUCTION TO SIMULATIONS AND EXPERIMENTAL PROBABILITY

## Experimental Probability

Experimental probability is the observed probability (sometimes called the relative frequency) of an **event**, $A$, in an experiment and is found using the following formula:

$$P(A) = \frac{\text{number of times the desired event occurred}}{\text{number of trials}}$$

Using NCTM Spinner!

| OUTCOME | TALLY | FREQUENCY | Experimental Probability |
|---|---|---|---|
| Red | | 18 | 18/50 = 36% |
| Blue | | 16 | 16/50 = 32% |
| Yellow | | 10 | 10/50 = 20% |
| Green | | 6 | 6/50 = 12% |

**Fair Game**—all players have an equal chance of winning, or each player can expect to win or lose the same number of times in the long run
**Trial**—one repetition of an experiment
**Random Variable**—a variable whose value corresponds to the outcome of a random event
**Discrete Random Variable**—a variable that assumes a unique value for each outcome
**Expected Value**— informally, the value the average of the random variable's values tends toward after many repetitions
**Event**—a set of possible outcomes of an experiment
**Simulation**—an experiment that models an actual event

**Example with Excel:**
Suppose a family plans to have four children. Use a simulation to estimate the likelihood that the family will have three girls in a row and then a boy.

How might we do a simulation without technology?

*Flip a coin four times - heads means girl*
*tails means boy*

| | | |
|---|---|---|
| 0 means girl | | |
| 1 means boy | | |
| 1 | | =INT(2*RAND()) |
| 0 | | =INT(2*RAND()) |
| 0 | | =INT(2*RAND()) |
| 0 | | =INT(2*RAND()) |

Suppose that Nicola has a batting average of 0.320. This indicates 32 hits in every 100 attempts (or 8 hits in 25 attempts). Use a simulation to estimate the likelihood that this player has no hits in a game (assuming three at-bats per game).
How might we do a simulation with technology?

In excel
=RANDBETWEEN(1,25) // if result is less than 8, NO HIT

How might we do a simulation without technology?

25 slips of paper, each numbered 1 through 25.
Draw one
Replace it, draw another
Replace it, draw another

**Practice:** pg. 209 #3, 9, 14

**3.** **Knowledge and Understanding**

**(a)** Toss a coin 100 times. Complete a chart like the one below using your results.

| Number of Repetitions | Total Number of Heads | Observed Probability |
|---|---|---|
| 10 | | |
| 20 | | |
| 30 | | |
| ⋮ | | |
| 100 | | |

**(b)** For this experiment,
- **(i)** graph the relative frequency versus the number of trials;
- **(ii)** describe what constitutes a trial;
- **(iii)** determine the simple event that is the focus of this experiment; and
- **(iv)** identify what happens to the observed probability as the number of tosses increases.

**14.** **Application** Imagine that the first traffic light you encounter on your way to school each morning has a 60-s cycle in which it is green for 20 s. Design and carry out a simulation experiment to estimate the probability that you will get a green light on the next three morning trips to school.