Objectives:

- To become familiar with the term ***probability*** and the idea that it is a random process based on an expected relative frequency of "successes" per events.
- To understand the use of ***simulations*** to approximate a probability by obtaining an ***empirical Estimate***.
- To become familiar with use of ***sample spaces*** to represent the equally likely outcomes of an event.
- To understand the calculations of ***Expected values*** for an event to obtain a value for what would happen in the ***long-run*** or on ***average*** when performing a certain event.
- To understand the role of sample size on estimating probabilities using simulations and samples.

Probability: The long-run proportion of number "successes" to number of events for a ***random*** event if the event were to be performed numerous times.

Relative Frequency: The number of times a success occurs per number of events performed.

Simulation: A process that tries to mimic the numerical results of a long-run event. Often actually performing an event is either impossible or cost prohibitive yet we still need to calculate a probability of "success". This may be done by computer, random number tables, shuffling and dealing cards, etc.

Empirical Estimate: the result obtained from a simulation to estimate a probability. An Empirical result is one derived from performing an event numerous times and finding the proportion from it.

Theoretical Estimate: A result obtained through mathematical calculation. A theoretical probability is calculated completely on paper with no need to perform any trials.

Sample Space: An exhaustive list of equally likely outcomes of a random event. Allows the calculation of a theoretical probability based on the number of possible successes divided by the total number of possible outcomes.

Expected value: The long-run average result of a process. For example if we have a game that involves rolling dice, the possible outcomes are 1 thru 6, costing you $2.00 to play. The payoffs are listed in the following table:

Result	1	2	3	4	5	6
Payoff	$0	$0	$1	$1	$2	$5
probability	.167	.167	.167	.167	.167	.167

So the average payoff would be calculated by multiplying the probability by the payoff and adding these results together:

$$E(x) = \sum_{i=1}^{n} f(i)P(i)$$

E(x) = Payoff(1)xProb (1) + Payoff(2)xProb (2) + Payoff(3)xProb(3) + Payoff(4)xProb (4) + Payoff(5)xProb (5)+ Payoff(6)xProb (6)

E(x) = ($0 X .167) + ($0 X .167) + ($1 X .167) + ($1 X .167) + ($2 X .167) + ($5 X .167)
E(x) = $1.50

But you paid $2.00 to play the game, so if the expected winnings is $1.50 over the long run you end up losing $0.50 per game if you were to play this game over and over.