Chapter 16
Probability Models

Bernoulli Trials

- only two possible outcomes
  (success and failure)
- probability of success remains
  constant
- trials are independent

also…

- probability of failure is denoted *q*
- $p + q = 1$

Geometric Probability

Repeating a trial until you first achieve a success.

p = probability of success
q = probability of failure
X = number of trials until the first success occurs

P(X) = $\left(q^{x-1}\right)(p)$ **EV** = $\mu = \frac{1}{p}$ **SD** = $\sigma = \sqrt{\frac{q}{p^2}}$

When finding the probability P(X), let the calculator do it for you…

geometpdf(p , x) finds the probability of an individual outcome.

geometcdf(p , x) finds the sum of the probabilities up to and including an individual outcome.

Binomial Probability

Counting the number of successes
in a specific number of trials.

n = number of trials
p = probability of success
q = probability of failure
X = number of successes in *n* trials

$$\mathbf{P(X)} = \binom{n}{x}\left(p^{x}\right)\left(q^{n-x}\right)$$

$$= \left(\frac{n!}{x!(n-x)!}\right)\left(p^{x}\right)\left(q^{n-x}\right)$$

$$= \left({}_{n}C_{x}\right)\left(p^{x}\right)\left(q^{n-x}\right)$$

$\mathbf{EV} = \mu = np$ $\qquad$ $\mathbf{SD} = \sigma = \sqrt{npq}$

When finding the probability P(X), let the calculator do it for you…

binompdf(n , p , x) finds the probability of an individual outcome.

binomcdf(n , p , x) finds the sum of the probabilities up to and including an individual outcome.

The 10% Condition

Bernoulli Trials must be ***independent****.*
If that assumption is violated, is it still okay to proceed as long as ***the sample is smaller than 10% of the population****.*

Think of the Tiger Woods example:

> Suppose a cereal manufacturer puts pictures of famous athletes on cards in boxes of cereal in the hope of boosting sales. The manufacturer announces that 20% of the boxes contain a picture of Tiger Woods, 30% a picture of Lance Armstrong, and the rest a picture of Serena Williams. You want all three pictures. How many boxes of cereal do you expect to have to buy in order to get the complete set?

Choosing a box that doesn't have a Tiger card in it *technically does* change the probability of the remaining boxes. With a population of a few million and a sample of just a single box, the effect is hardly worth mentioning.

The Success / Failure Condition

A Binomial probability is approximately Normal if we expect at least ***10 successes*** *and* ***10 failures***.

$np \geq 10$ and $nq \geq 10$

When dealing with large numbers of trials the Normal model can be very helpful:

> Suppose the Tennessee Red Cross anticipates the need for at least 1850 units of O-negative blood this year. It estimates that it will collect blood from 32,000 donors. Only about 6% of people have O-negative blood. How great is the risk that they will fall short of meeting their need?

You will just have calculated the EV and SD, so use them to find the z-score in question and use **normalcdf** on your calculator to approximate the probability.

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