

## LECTURE 35: DISCRETE PROBABILITY FUNCTIONS

- I. Discrete probability distributions
  - a. A *distribution* lists all the possible results with the frequency of each result. It's typically presented in a graph form.
  - b. A *discrete probability distribution* is distribution of data made up the results from a discrete random variable (which has outcomes of a small range of whole numbers).
  - c. Some examples of a discrete random variable:
    - i. The result of a flip of a coin.
    - ii. The number of customers in a line in a minute.
    - iii. If a bullet hits its target.
- II. Binomial Distributions
  - a. As the prefix “bi” suggests, binomial distributions deal with the number two. Each observation in such a distribution can be one of two results: success or failure.
    - i. “Success” and “failure” is just nomenclature and does not suggest something good or bad happening. A “success” in a test for a disease can be a confirmation that the disease is present.
    - ii.  $p$  is the probability of a success
    - iii.  $q$  is the probability of a failure
    - iv. Because there are only two outcomes,  $p = 1 - q$ .
    - v. Examples: determining if a person needs or does not need corrective lens; testing if a peach is ripe or not; recording if a household has a pet or not.
  - b. ***Binomial distributions assume the probability of success is constant.*** That is their defining assumption. This means each trial is independent (e.g. each customer has a 10% chance of redeeming a coupon).
    - i. Another way to achieve independent trials is if you are replacing each selection after a trial (chances of pulling a poker chip from a bag and replacing it each time); or
  - c. Mean
$$\mu = np$$
    - i.  $n$  is the number of trials
    - ii.  $p$  is the probability of success
  - d. When we've determined probabilities, it's good to know how often you'll get three, four, or any other number of successes.

### III. How Awesome Excel Is

- a. The most practical aspect of the binomial distribution function is the probability that a particular number of things will happen.
- b. But the equations for the various probability functions look, well, terrifying. The good news is that each of these equations are *already* in Excel.
- c. The main contribution you have is to know which equation to use. But first let's master how to make Excel tell you the result.
- d. There's no data file for this lesson; just open Excel.

### IV. Binominal

- a. The command for binomial distribution is “=BINOM.DIST and it will tell you the chance something will happen given a particular set of values you put it. It requires four different pieces of information. In order they are:
  - i. *Number\_s*: the number of successes (called x in the notes).
  - ii. *Trials*: the number of attempts (called n in the notes).
  - iii. *Probability\_s*: the chance of success, expressed as a decimal (called p in the notes).
  - iv. *Cumulative*: type in either a 1 or a 0 for this value. (Or type TRUE or FALSE.)
    1. A “0” (or FALSE) means Excel will tell you the probability of getting exactly x successes.
    2. A “1” (or TRUE) means Excel will tell you the probability of getting exactly x *or fewer* successes.
- b. Using Cumulative
  - i. The cumulative function is very useful, especially since the chance of any number of successes is 1.
  - ii. Want to know the chance of getting at least 2 successes but no more 6 successes? Find the probability of getting 6 or fewer and subtract off the probability of getting 1 or fewer.
  - iii. Want to know the chance of getting 4 or more successes? Find the probability of getting 3 or fewer and subtract that value from 1.
- c. Suppose I distributed 1,000 coupons for my business and I know from past experience that each coupon has a 5% chance of being redeemed. How likely is it that exactly 60 coupons will be redeemed?
  - i. First note that this is binomial: the chance of any coupon being redeemed is independent from other and there are only two options: the coupon will be redeemed or it won't be.
  - ii. Type “=BINOM.DIST(60,1000,0.05,0)” and press ENTER.

- iii. The result will be 0.01967, or just under a 2% chance.
- d. The average number of redeemed coupons will be 50 (1,000 times 0.05); what is the chance 45 to 55 coupons will be redeemed?
  - i. Try it for yourself. You should get 0.52896, or a 52.896% chance.