5.1 Discrete Probability Distributions

1. Refer to the "sum of two dice" exercise as an example of such a probability distribution.
2. Discuss **expected value** and **standard deviation** of a probability distribution. Using the example of the two dice is helpful. Note that $E(X) = 7$, $\text{Var}(X) = \frac{105}{18} \approx 5.83$, and $\sigma \approx 2.415$.

   - Point how the formulas are like the formulas we already know for mean, variance and standard deviation but also what makes them different.

   $$E(X) = \mu = \sum xP(X = x)$$

   $$\text{Var}(x) = \sum (x - \mu)^2 P(X = x) = \sum x^2 P(X = x) - \mu^2 = E(X^2) - E(x)^2.$$

   - These last two formulas for variance are not in the book, but are easier to use if someone were to compute them by hand.
   - Note that 1-Var Stats can still get the job done for us, like a weighted average or frequency table. Use the probabilities in the "frequency table".
3. It is worth pointing out, just for completeness, that $E(X)$ is a linear function, meaning $E(\alpha X + \beta Y) = \alpha E(X) + \beta E(Y)$. Also, $\text{Var}(\alpha X) = \alpha^2 \text{Var}(X)$. It is not true that $\text{Var}(X + Y) = \text{Var}(X) + \text{Var}(Y)$ in general, but it is true when X and Y are independent. Covariance is somewhat talked about in this class when we talk about linear correlation. Maybe it is worth mentioning off-hand that $\text{Var}(X + Y) = \text{Var}(X) + \text{Var}(Y)$ whenever X and Y are uncorrelated.

5.2 & 5.3 Binomial Distribution

1. Describe the features of a binomial experiment. Begin with the example of flipping a coin 10 times in a row and counting the number of heads (which we consider a success).

   - A **fixed number** n of trials.
   - Each trial is independent of all others.
   - Each trial has two outcomes: a success (with probability p) and failure (with probability $1-p = q$).
   - The goal is to count the number of successes r in n trials.
2. Present the formula, $P(X = r) = \binom{n}{r} p^r (1 - p)^{n-r} = \binom{n}{r} p^r q^{n-r}$.

   Because we didn't cover Section 4.3 about counting, the reference to $C_{n,r} = \binom{n}{r}$ will be to state that it is the number of ways that the r successes could have fallen in those n trials. I do list all the ways to get 2 heads in 4 flips, just to emphasize the point.
3. Note that the TI calcs have binompdf and binomcdf. Refer them to the screencasts if they don't know how to use those functions already, but make a point to review them right before the worksheet next Wednesday.

   Specifically (on Wednesday) review the syntax and application of `binompdf(n,p,r)` which computes the probability of EXACTLY r successes out of n trials, $P(X = r)$, while `binomcdf(n,p,r)` computes the probability of at most r success out of n trials, $P(X \leq r)$.

4. Discuss how we can compute the probability of at least r successes (say) when neither function is explicitly designed to do that by using compliments. Namely, $P(X > r) = 1 - P(X \leq r)$.

   Drawing a chart and emphasizing the events and their compliments is very helpful. This is one of the more confusing topics for the students.

5. A quick note of the formulas for expected value and standard deviation for a binomially distributed random variable. They won't use 1-Var Stats, most likely, because the formulas are so much simpler.

$$E(X) = np$$

$$Var(x) = npq = np(1-p)$$