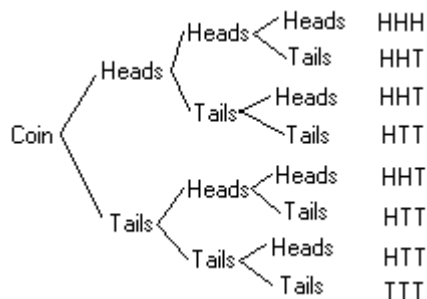


Probability With Coins:

- A. Coins are a good beginning for learning probability since you are faced with only 2 choices: heads or tails.
- B. Below is a diagram of a coin after it is tossed 3 times. This will be used as an example to explain how to use probability in relation to coins:



- C. There are several things that we can gather from looking at this diagram.
1. The number of possible combinations after 3 flips is 2^3 or 8. In general, the number of possible combinations after n flips is 2^n .
 2. The probability of getting heads or tails on each successive flip is $\frac{1}{2}$.
 3. The probability of getting all heads (or all tails) after 3 flips is $\frac{1}{2^3}$ which is $\frac{1}{8}$. In general, the probability of getting all heads (or all tails) after n flips is $\frac{1}{2^n}$.
 4. A more complicated concept is how to determine the probability of getting 2 heads and 1 tails (or 2 tails and 1 heads). From counting we know the answer is $\frac{3}{8}$, but what if we had more than 3 flips? In general, we can calculate the probability of getting x heads and y tails after r flips by using the following formula:

$$P = \frac{C(r,x)}{2^r} \text{ or } \frac{C(r,y)}{2^r}$$

- D. Let's look at some examples. You will need to be familiar with [combinations](#).

Ex [1] A coin is flipped 5 times. Find the probability of getting 3 heads and 2 tails.

- a. First, we know the denominator is $2^5 = 32$.
- b. To find the numerator, we need to calculate $C(5,3)$ [or $C(5,2)$].
- c. $C(5,3) = 10$.
- d. The answer is $\frac{10}{32} = \frac{5}{16}$.

Ex [2] A coin is tossed 4 times. Find the probability of getting at least 2 heads.

- a. This example is a little harder as we can have 2 heads and 2 tails, 3 heads and 1 tail, or 4 heads and no tails.
- b. This means we will have to calculate each probability and add it together.
- c. The probability of each one successively is: $\frac{C(4,2) + C(4,3) + C(4,4)}{2^4}$.
- d. This is $\frac{6+4+1}{16} = \frac{11}{16}$.
- e. The answer is $\frac{11}{16}$.