

## WORKING WITH THE BINOMIAL RANDOM VARIABLE

The following problem will be used to demonstrate the use of a calculator while working with binomial probability distributions:

Thirty-seven percent of women consider themselves fans of professional baseball. You randomly select six women and ask each of them if they consider themselves a fan of professional baseball.

**First, identify the parameters that apply to this distribution and write out the probability distribution function .**

First, we have to look at the binomial probability formula:

$$P(x) = {}_n C_x p^x q^{n-x}$$

This formula is the probability of exactly  $x$  successes in  $n$  trials in a binomial experiment.

In this experiment, a success is defined as a woman being a fan of professional baseball. A failure is defined as a woman not being a fan of professional baseball.

$n = 6$  ;  $p = .37$  ;  $q = 1 - .37 = .63$  ;  $x \in \{0,1,2,3,4,5,6\}$ . The formula for this experiment is:

$$P(x) = {}_6 C_x (.37)^x (.63)^{(6-x)}$$

**Example A:** Using the binomial formula to calculate the probability of exactly two women out of all six being a fan of professional baseball.

Screen 1

First, write out the formula.

$$P(2) = {}_6 C_2 (.37)^2 (.63)^{(6-2)}$$

A calculator screen displaying the formula for the probability of exactly two successes in six trials:  ${}_6 nCr 2 * (.37)^2$

To do this in the calculator enter the following sequence:

**6 > MATH > Scroll right to PRB > Scroll down to 3:nCr > ENTER >**

Screen 2

**2 \* (.37) > ^2 > \* (.63) > ^4**

A calculator screen displaying the calculation sequence:  ${}^2 * (.37)^2 * (.63)^4$

(Screen 1 and Screen 2)

Hit **ENTER**

(Screen 3)

Screen 3

This means that the probability of exactly two women out of all six being a fan of professional baseball is 0.32 or 32%.

A calculator screen displaying the final result of the calculation:  ${}_6 nCr 2 * (.37)^2 * (.63)^4 = .3234870541$

**Example B:** Find the probability distribution for  $x = 0, 1, 2, 3, 4, 5, 6$ . This may be done in two different methods using the calculator.

**Method #1:** Use the list function on the calculator to build the probability distribution for the binomial random variable.

Enter the values of the random variable 0 – 6 into L1.

(Screen 4)

(Remember that to input numbers in a list you use the **STAT > Edit** commands)

Highlight L2.

(Screen 5)

Now, type the binomial formula for the problem into L2, replacing the X with L1:

$$6 nCr L1 * (.37) ^ L1 * (.63) ^ (6 - L1)$$

(Screen 5 and Screen 6)

Hit **ENTER**.

(Screen 7)

Now, L2 contains the entire probability distribution for women who are baseball fans in a group of six women.

Screen 4

L1	□	L3	2
0	-----	-----	
1			
2			
3			
4			
5			
6			
L2 =			

Screen 5

L1	□	L3	2
0	-----	-----	
1			
2			
3			
4			
5			
6			
L2 = 6 nCr L1 * (.37) ^ L1 * (.63) ^ (6 - L1)			

Screen 6

L1	□	L3	2
0	-----	-----	
1			
2			
3			
4			
5			
6			
L2 = ... .63) ^ (6 - L1)			

Screen 7

L1	L2	L3	2
0	.0625235022	-----	
1	.22032		
2	.32345		
3	.25331		
4	.11158		
5	.02621		
6	.00257		
L2(1) = .0625235022...			

**Method #2:** Use the binomial distribution function on the calculator to find the probability distribution for the binomial random variable.

To find the probability distribution for the binomial random variable we will use the binomial distribution function on the calculator. Type the sequence below:

2<sup>nd</sup> > **DISTR** (on top of the VARS button) > Scroll down to **A:binompdf** (>  
**ENTER** > 6 > , > .37 > )

(Screen 8)

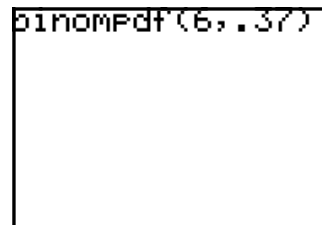
Hit **ENTER**.

(Screen 9)

(Remember we are inputting 6 because  $n = 6$  and .37 because  $p = .37$ )

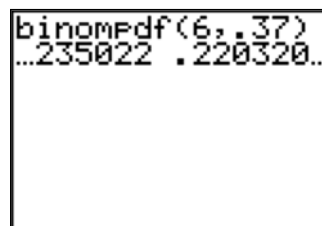
Now scroll right using the arrow (>) to identify, P(0), P(1), etc.

Screen 8



```
binompdf(6, .37)
```

Screen 9



```
binompdf(6, .37)
...235022 .220320...
```

**Lastly, find the mean and standard deviation of the binomial probability distribution.**

Although we can continue to use the formulas we have been using for mean and standard deviation, the properties of a binomial distribution allow us to use much simpler formulas. Below you can see the formulas for the mean and the standard deviation.

Mean:  $\mu(x) = np$

In our example, our  $n = 6$  and our  $p = 0.37$ , so we would get:  $6 * (.37) = 2.22$

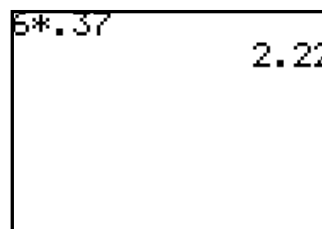
(Screen 10)

Standard deviation:  $\sigma = \sqrt{npq}$

In our example,  $n = 6$ ,  $p = 0.37$ , and  $q = 0.63$ . So the standard deviation is 1.18

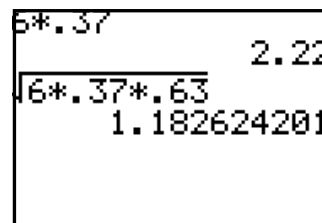
(Screen 11)

Screen 10



```
6*.37                2.22
```

Screen 11



```
6*.37                2.22
6*.37*.63           1.182624201
```