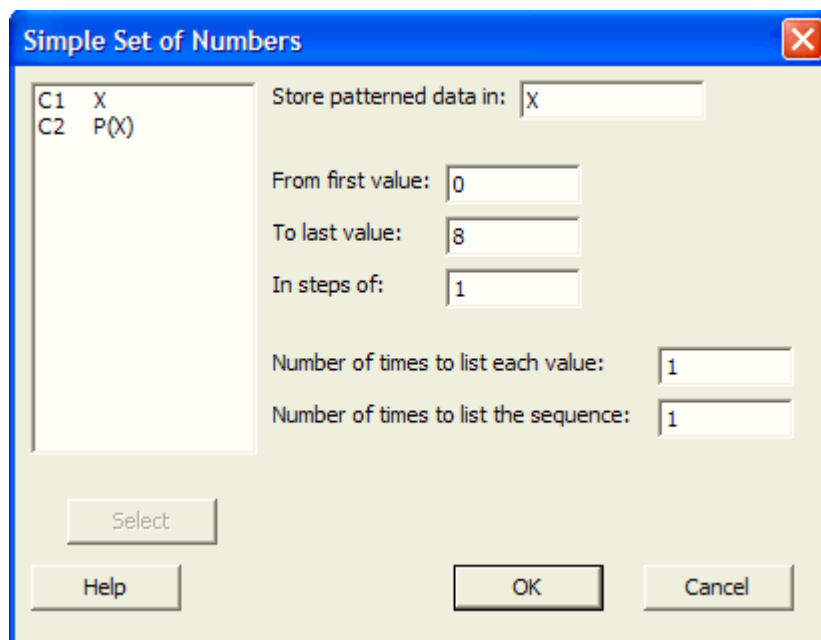


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LESSON 9 - BINOMIAL DISTRIBUTIONS

CREATING A PROBABILITY TABLE FOR $X \sim B(n, p)$

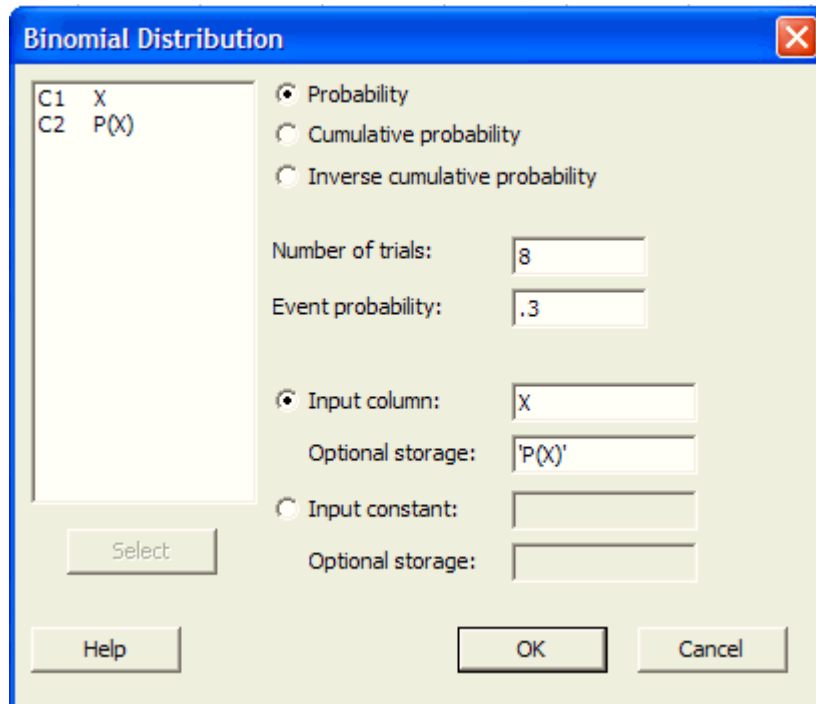
Our first task is to build a binomial table. As an example, we will build a probability table for $X \sim B(8, .3)$. First maximize the data window; then label C1 as X and C2 as P(X). To enter 0, 1, ... n into C1, click on Calc > Make Patterned Data > Simple Set of Numbers. Select X into the "Store patterned data in:" box, type 0 into the "From first value:" box, and type the value of n (n = 8 in this case) into the "To last value:" box. Your dialog box should look like the figure below. Click "OK".



Next, to compute the probabilities, click on Calc > Probability Distribution > Binomial. First click the "Probability" button. Next type the value of n (n = 8 in this case) in the "Number of trials:" box and the value of p (p = .3 in this case) in the "Event probability:" box. Now select X for the "Input Column:" and P(X) for the "Optional storage:" box. Your dialog box should now look like the figure on top of the next page. Click "OK".

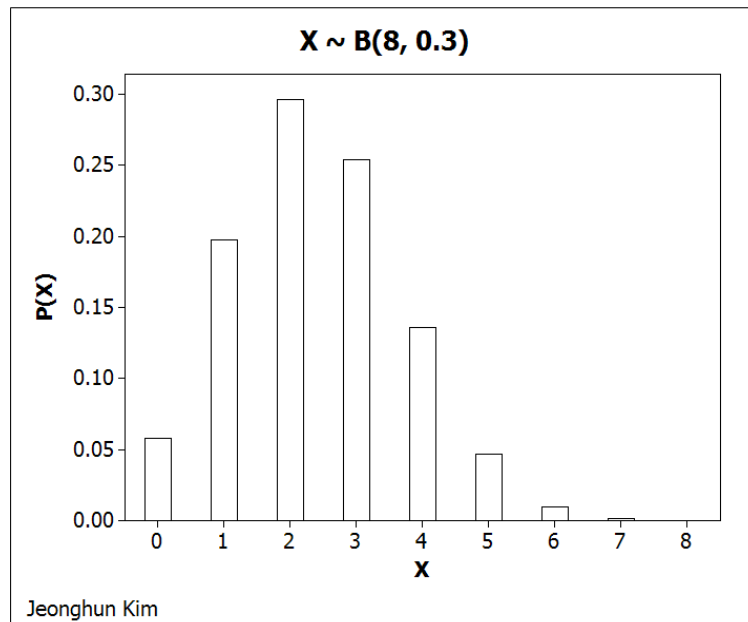
Now, activate the session window and display the data for X and P(X). Your display should look like the figure on the right. Compare this table with the appropriate section of the binomial distribution table on page A-8 of the text.

Data Display		
Row	X	P(X)
1	0	0.057648
2	1	0.197650
3	2	0.296475
4	3	0.254122
5	4	0.136137
6	5	0.046675
7	6	0.010002
8	7	0.001225
9	8	0.000066

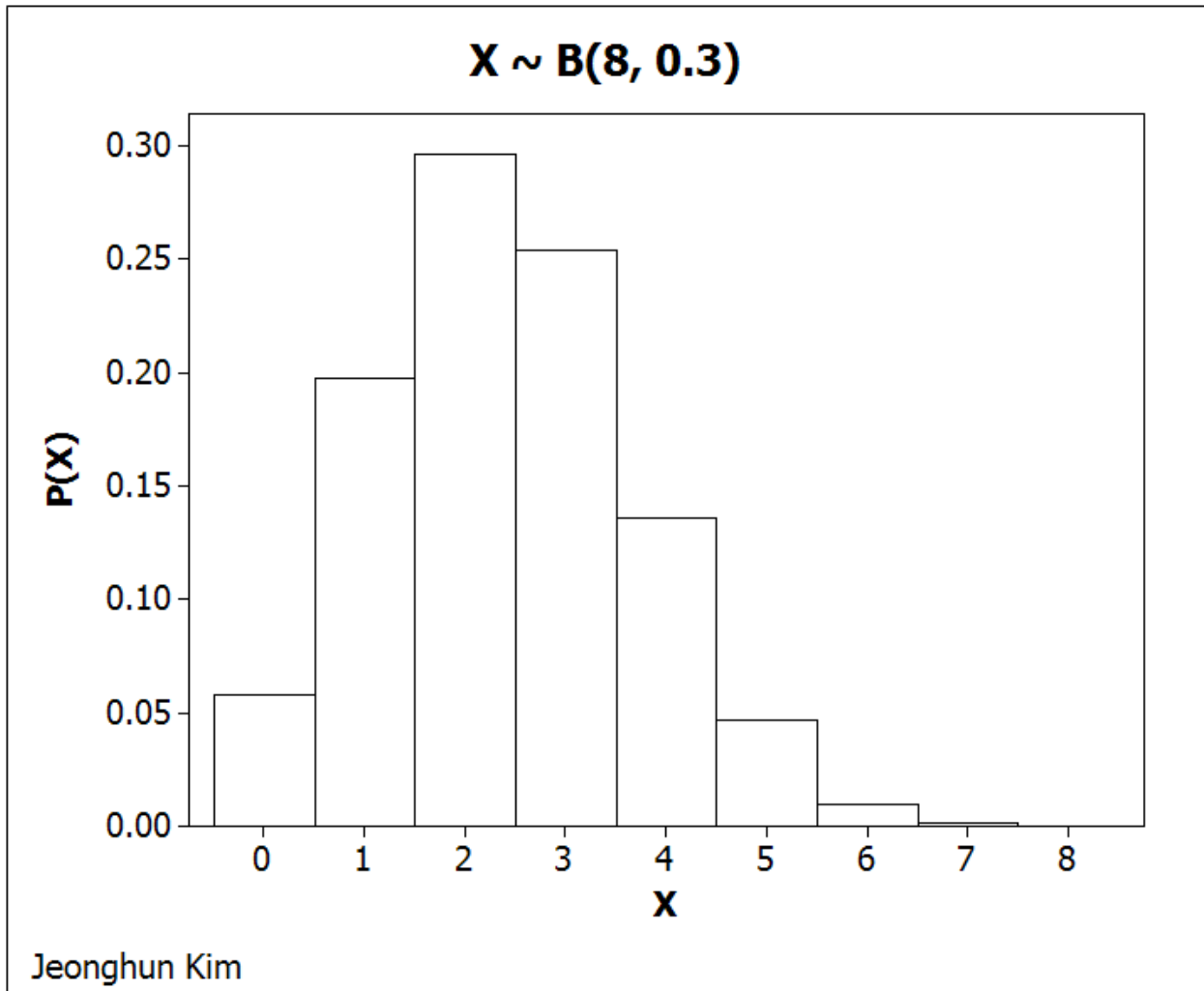


CREATING A HISTOGRAM FOR $X \sim B(n, p)$

You can create a histogram for the binomial distribution. Unfortunately, there is no direct way to get a histogram for the distribution in Minitab. Instead we will first create a bar graph. Click on **Graph > Bar Chart**. Then choose "Values from a table" from the "Bars represent:" menu. Now click "OK" and on the next dialog box select C2 P(X) into the "Graph variables:" box and C1 X into the "Categorical variable:" box. Click on "Labels" to give the graph a title $X \sim B(8, .3)$ and your name as a footnote. Click "OK" "OK" and then use the editing tools to fix up the graph. Make all of the backgrounds white, make the graph conform to the 3/4 rule. The graph should now look like the figure on the right. To transform the bar graph to a histogram, select "X Scale" as the item to edit and click on the "Edit" tool. Click



in the checkbox labeled "Gap between clusters:" to uncheck it. Change the number in the box to a 0 and click "OK". Your graph should now look like the image below

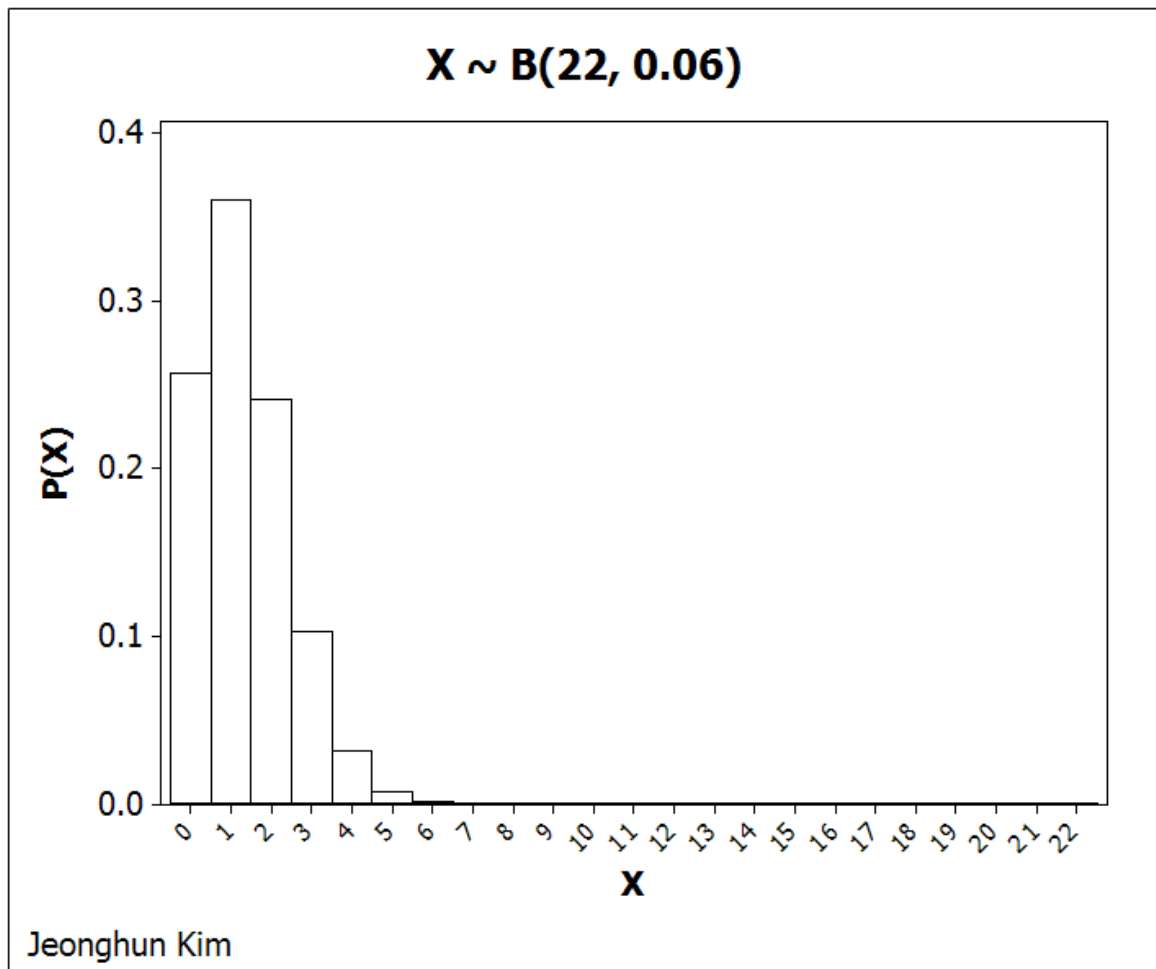


SAMPLE PROBLEM

Suppose there are 22 students in this class and about 6% of Thiel's student population is in the Honors Program. We want to investigate the probabilities of having certain numbers of students from the Honors Program in this class. We will assume that this class is a random sample of Thiel's student population (not necessarily a valid assumption, but OK for the purposes of this example). We will define the variable X is the number of students in this class of 22 who are in the Honors Program. Answer the following questions. Give answers to three decimal places.

- What is the expected value of X ?
- What is the variance of X ?
- What is the standard deviation of X ?
- What is the probability that there are exactly three Honors students in this class?
- What is the probability that there are at least two Honors students in this class?

First close the data window, then clear everything below the date/time stamp on the session window and type your name, Lesson 9, and Example. Skip a line then type the definition of the variable and the shorthand notation for the distribution you will be using. Now use the procedure outlined above to create and display the probability table for $X \sim B(22, 0.06)$ and create a bar graph of the distribution. Notice that in this case, the numbers on the X-axis have been turned 45 degrees to keep them from running together. Your graph should look like the image below. Next, use the table to answer the questions. Type your answers in the session window. Your output should look like the figure on the next page.



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Jeonghun Kim
Lesson 9
Example

X = number of students in this class of 22 who are in the Honors Program
 $X \sim B(22, 0.06)$

Data Display

Row	X	P(X)
1	0	0.256338
2	1	0.359964
3	2	0.241252
4	3	0.102661
5	4	0.031126
6	5	0.007152
7	6	0.001294
8	7	0.000189
9	8	0.000023
10	9	0.000002
11	10	0.000000
12	11	0.000000
13	12	0.000000
14	13	0.000000
15	14	0.000000
16	15	0.000000
17	16	0.000000
18	17	0.000000
19	18	0.000000
20	19	0.000000
21	20	0.000000
22	21	0.000000
23	22	0.000000

a) Expected value = $np = 22 * 0.06 = 1.320$

b) Variance = $npq = 22 * 0.06 * 0.94 = 1.241$

c) Standard deviation = $\sqrt{\text{variance}} = 1.114$

d) $P(X = 3) = 0.103$

e) $P(X \geq 2) = 1 - [P(X = 0) + P(X = 1)] = 1 - [0.256 + 0.360] = 0.384$

MINITAB ASSIGNMENT 9

See instructions on page 8.

Do the following problem the same way you did the above example, including a **histogram** for the distribution. **Display** the binomial distribution in the session window and give answers to three decimal places.

1. A certain state instant lottery claims that $\frac{1}{4}$ of the tickets are winners. Suppose you buy 12 tickets and you are interested in counting how many winners you have bought. Describe the appropriate variable X in words and using our shorthand notation.
 - a) What is the expected value of X ?
 - b) What is the variance of X ?
 - c) What is the standard deviation of X ?
 - d) What is the probability that you bought exactly 3 winners?
 - e) What is the probability that you bought at least 3 winners?

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