

Discrete Random Variables and Their Probability Distributions

Chapter

5

Section 5.6

Example 5-18, pg. 213 Calculating a Binomial Probability

In this example, 5% of all DVD players manufactured by a large electronics company are defective. A quality control inspector randomly selects 3 VCRs from the production line. Find the probability that exactly one of the three VCRs is defective. Thus, you want to find the binomial probability $P(X=1)$ for $n = 3$ and $p = .05$. Although binomial probability calculations are very tedious by hand, Minitab handles them easily. Click on **Calc** → **Probability Distributions** → **Binomial**. Since you want the probability that $X=1$, select **Probability**. This tells MINITAB what type of calculation you want to do. The **Number of Trials** is 3 and the **Probability of Success** is .05. Enter 1 beside **Input Constant**. Leave all other fields blank. Click on **OK**.

Binomial Distribution

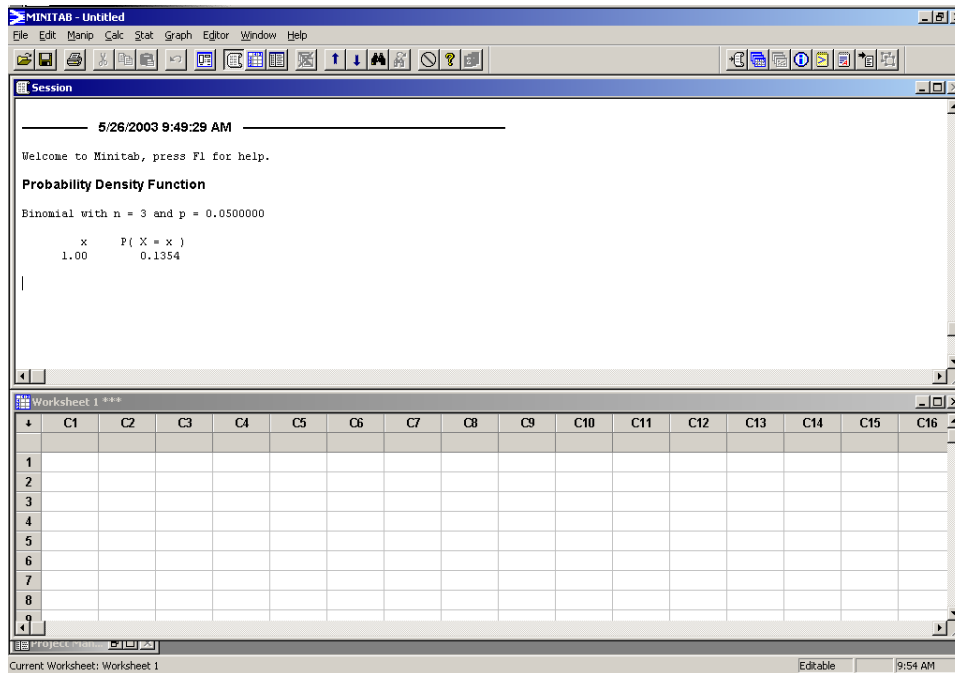
☒ **Probability**
☐ **Cumulative probability**
☐ **Inverse cumulative probability**

Number of trials: 3
Probability of success: .05

☐ **Input column:**
Optional storage:
☒ **Input constant:** 1
Optional storage:

Select
 Help
 OK
 Cancel

The binomial probability $P(X=1)$ will be displayed in the Session Window. Notice that the probability that there is 1 defective VCR in a random sample of size 3 is .1354.



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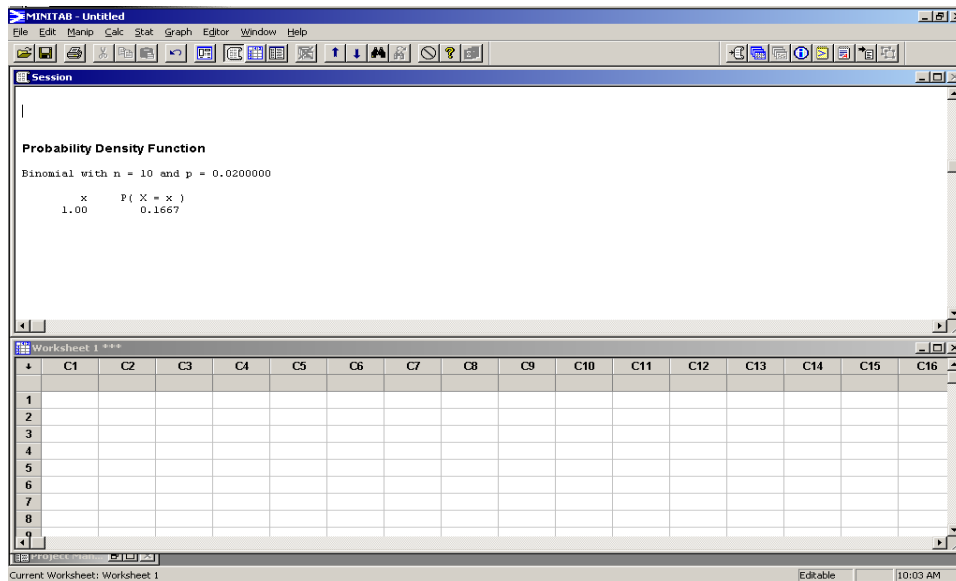
Example 5-19, pg. 215 Using the Binomial Distribution

In this example, 2% of all packages mailed by Express Delivery Service do not arrive within the specified time. Suppose 10 packages are mailed. Find a) the probability that exactly 1 will not arrive on time, and b) the probability that at most 1 will not arrive on time. Thus $n = 10$ and $p = .02$. Click on **Calc** → **Probability Distributions** → **Binomial**.

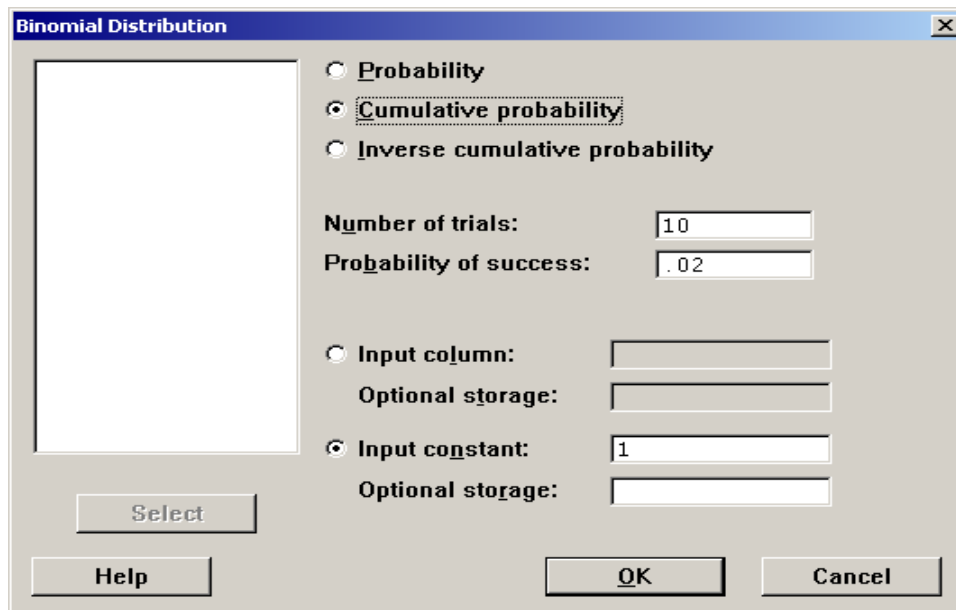
a) To find the probability that exactly 1 of the 10 packages does not arrive on time, select **Probability**. This tells MINITAB what type of calculation you want to do. The **Number of Trials** is 10 and the **Probability of Success** is .02. To find the probability of 1, enter 1 beside **Input Constant**. Leave all other fields blank. Click on **OK**.

The screenshot shows the 'Binomial Distribution' dialog box in Minitab. On the left is a large empty box with a 'Select' button below it. On the right, three radio buttons are present: 'Probability' (selected), 'Cumulative probability', and 'Inverse cumulative probability'. Below these are two input fields: 'Number of trials:' with the value '10' and 'Probability of success:' with the value '.02'. Further down are three more rows, each with a radio button and an input field: 'Input column:' (radio button not selected, empty field), 'Optional storage:' (empty field), 'Input constant:' (radio button selected, field containing '1'), and 'Optional storage:' (empty field). At the bottom are three buttons: 'Help', 'OK', and 'Cancel'.

The probability that 1 of the 10 packages does not arrive on time will be displayed in the Session Window. Notice that the probability is .1667.



For part b, you want to find the probability that at most 1 of the 10 packages does not arrive on time. One way to calculate this is to use the cumulative probability function. We will use this function to find the $P(X \leq 1)$. Click on **Calc** → **Probability Distributions** → **Binomial**. To find the probability that 1 or less of the 10 packages is late, select **Cumulative Probability**. This tells MINITAB what type of calculation you want to do. The **Number of Trials** is 10 and the **Probability of Success** is .02. To find the probability of 1 or less, enter 1 beside **Input Constant**. Leave all other fields blank. Click on **OK**.



The probability that at most 1 of the 10 packages is late will be displayed in the Session Window. Notice that the probability is .9838.

The screenshot displays the Minitab software interface. The top menu bar includes File, Edit, Manip, Calc, Stat, Graph, Editor, Window, and Help. Below the menu is a toolbar with various icons. The main window is divided into two panes. The top pane, titled 'Session', contains the following text:

```
Cumulative Distribution Function  
Binomial with n = 10 and p = 0.0200000  
  
x      P( X <= x )  
1.00   0.9838
```

The bottom pane, titled 'Worksheet 1', shows a grid with columns labeled C1 through C16 and rows labeled 1 through 9. The grid is currently empty. At the bottom of the window, the status bar indicates 'Current Worksheet: Worksheet 1', 'Editable', and the time '10:06 AM'.

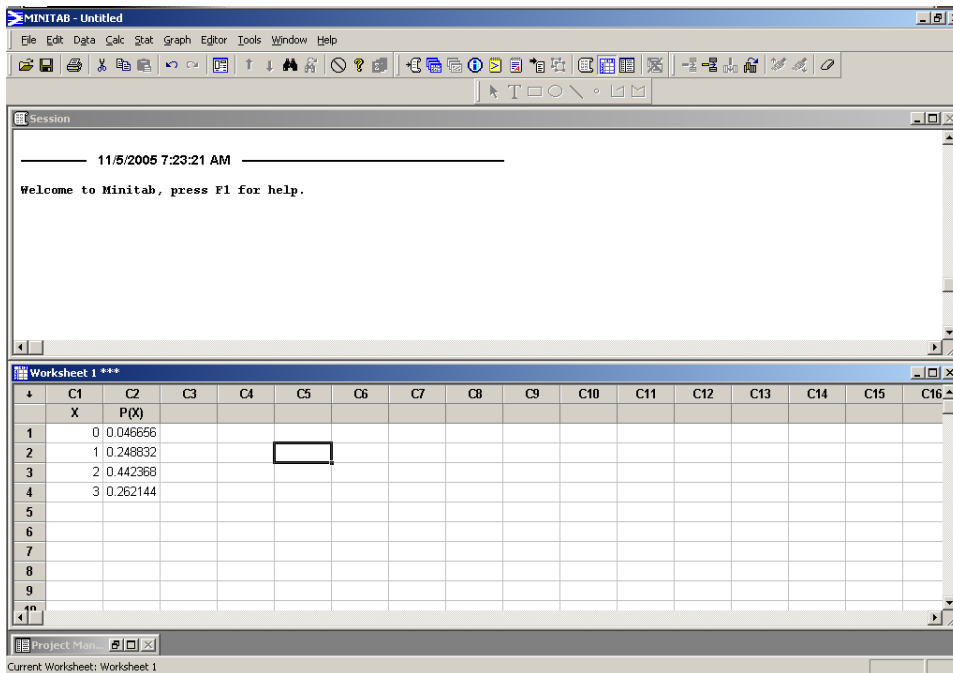


Example 5-20, pg. 216 Constructing Binomial Probability Histograms

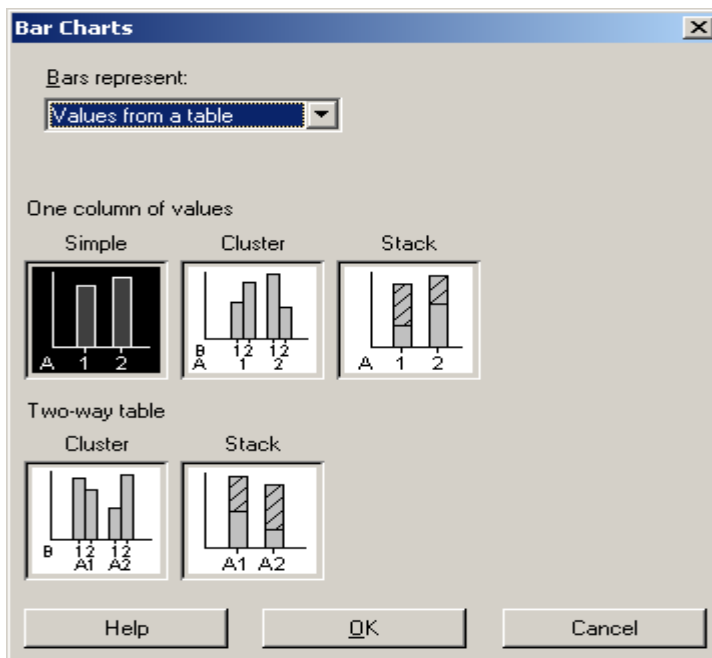
In order to graph the binomial distribution, you must first create the distribution and save it in the Data Window. First type the values of X into $C1$. Since $n=3$, the values of X are 0, 1, 2, and 3. Next, use MINITAB to generate the binomial probabilities for $n=3$ and $p=0.64$. Click on **Calc** → **Probability Distributions** → **Binomial**. Select **Probability**. The **Number of Trials** is 3 and the **Probability of Success** is .64. Now, tell MINITAB that the X values are in $C1$ and that you want the probabilities stored in $C2$. Enter $C1$ as the **Input Column** and enter $C2$ for **Optional Storage**.

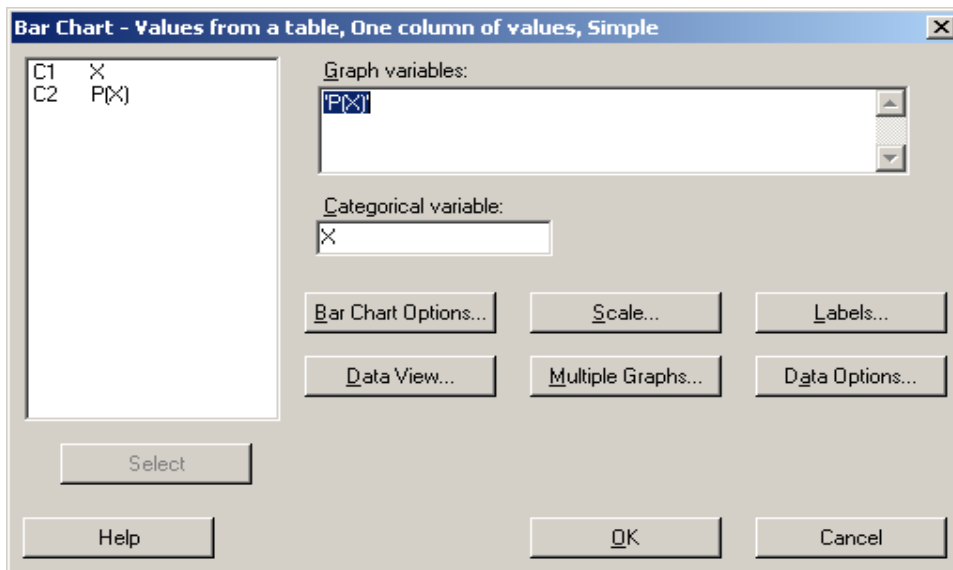
The screenshot shows the 'Binomial Distribution' dialog box in Minitab. On the left, a list of columns contains 'C1' and 'X'. The 'C1' column is selected. The 'X' column is also listed. On the right, the 'Probability' radio button is selected. Below it, the 'Cumulative probability' and 'Inverse cumulative probability' radio buttons are unselected. The 'Number of trials' is set to 3, and the 'Probability of success' is set to .64. Under the 'Input column' section, 'C1' is entered. Under the 'Optional storage' section, 'C2' is entered. The 'Input constant' section is unselected. At the bottom, there are buttons for 'Select', 'Help', 'OK', and 'Cancel'.

Click on **OK**. The probabilities should now be in $C2$. Label $C1$ as " X " and $C2$ as " $P(X)$ ". This will be helpful when you graph the distribution.

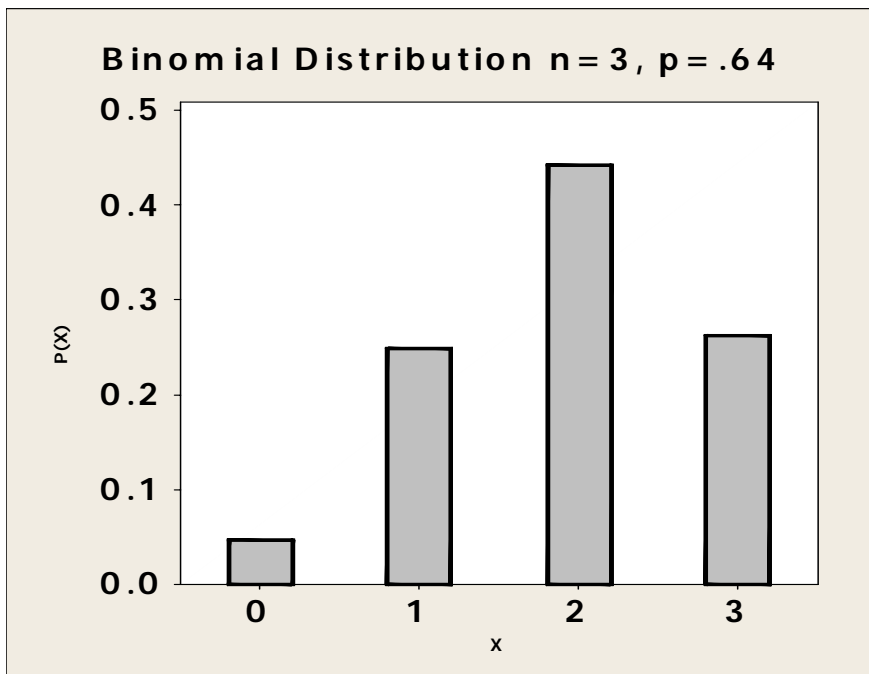


To create the graph, click on **Graph** → **Bar Chart**. In this case, the **Bars represent: Values from a table**. Select a **Simple** bar chart and click on **OK**.





Select C2 ($P(X)$) as the **Graph variable** and C1 (X) as the **Categorical variable**. Next, click on the button **Labels** and enter an appropriate **Title** for the chart. Click on **OK** twice to display the graph.



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Section 5.7

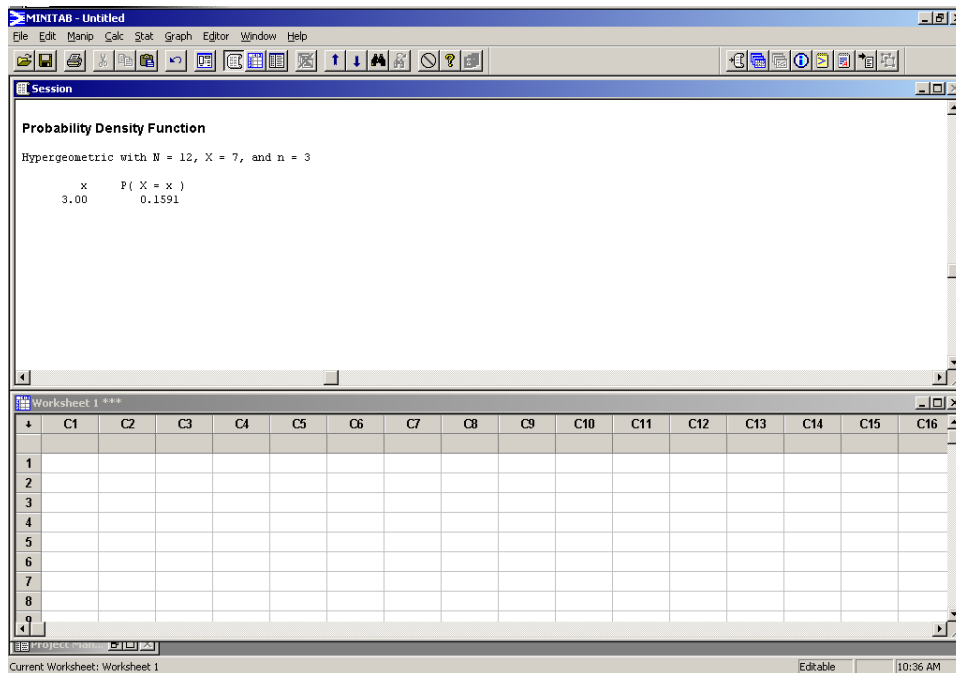
Example 5-24, pg. 225 Calculating a Hypergeometric Probability

Dawn Corporation has 12 employees who hold managerial positions. Of them, 7 are female and 5 are male. The company is planning to send 3 of the 12 to a conference. Find the probability that a) all 3 are females, and b) at most 1 is female.

The hypergeometric probability is very much like the binomial. The input screens are similar, and it is simply a matter of putting the correct numbers in the fields. However, Minitab uses a slightly different naming convention than is used in the textbook. In the text, the number of successes in the population is called 'r'. It is called 'M' in Minitab. Everything else is the same. In this example, $N=12$, $M=7$, and $n=3$. Click on **Calc** → **Probability Distributions** → **Hypergeometric**. Select **Probability**. The **Population size** is 12, the **Successes in population** is 7, and the **Sample size** is 3. Now, tell MINITAB that you want to find the probability that all 3 are females. Select **Input Constant** and enter 3.

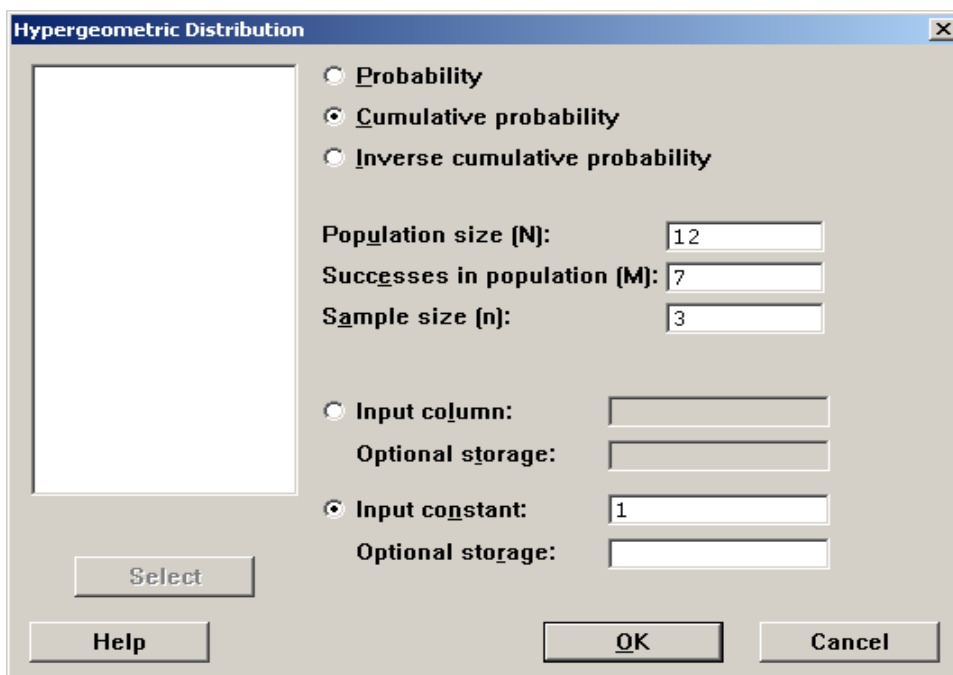
The screenshot shows the 'Hypergeometric Distribution' dialog box in Minitab. On the left is a large empty box for a graph. On the right, three radio buttons are present: 'Probability' (selected), 'Cumulative probability', and 'Inverse cumulative probability'. Below these are three input fields: 'Population size (N):' with the value 12, 'Successes in population (M):' with the value 7, and 'Sample size (n):' with the value 3. Further down, there are two more radio buttons: 'Input column:' (unselected) and 'Input constant:' (selected). The 'Input constant:' field has the value 3. There are also 'Optional storage:' fields for both radio button options. At the bottom left is a 'Select' button, and at the bottom right are 'Help', 'OK', and 'Cancel' buttons.

Click on **OK** and the probability will be displayed in the Session Window.

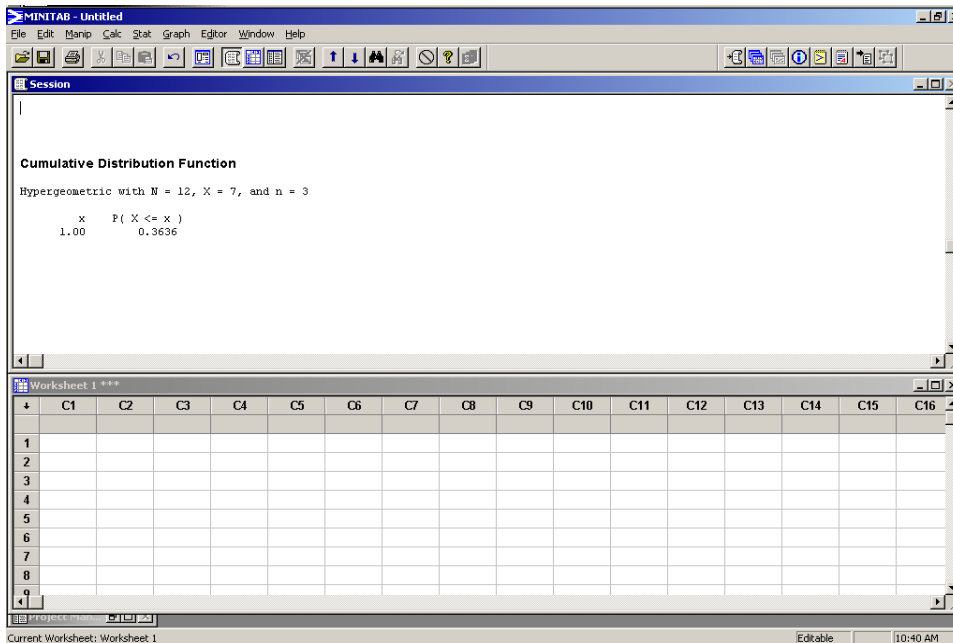


Notice that the probability that all 3 are females is .1591.

For part b, you want to find the probability that at most 1 of the 3 is a female. To find this probability, you will need to use the cumulative probability. Click on **Calc → Probability Distributions → Hypergeometric**. This time select **Cumulative Probability**. The **Population size** is 12, the **Successes in population** is 7, and the **Sample size** is 3. Now, tell MINITAB that you want to find the probability that at most 1 is female. Select **Input Constant** and enter 1.



Click on **OK**. The results are in the Session Window.



The probability that at most 1 is a female is .3636.

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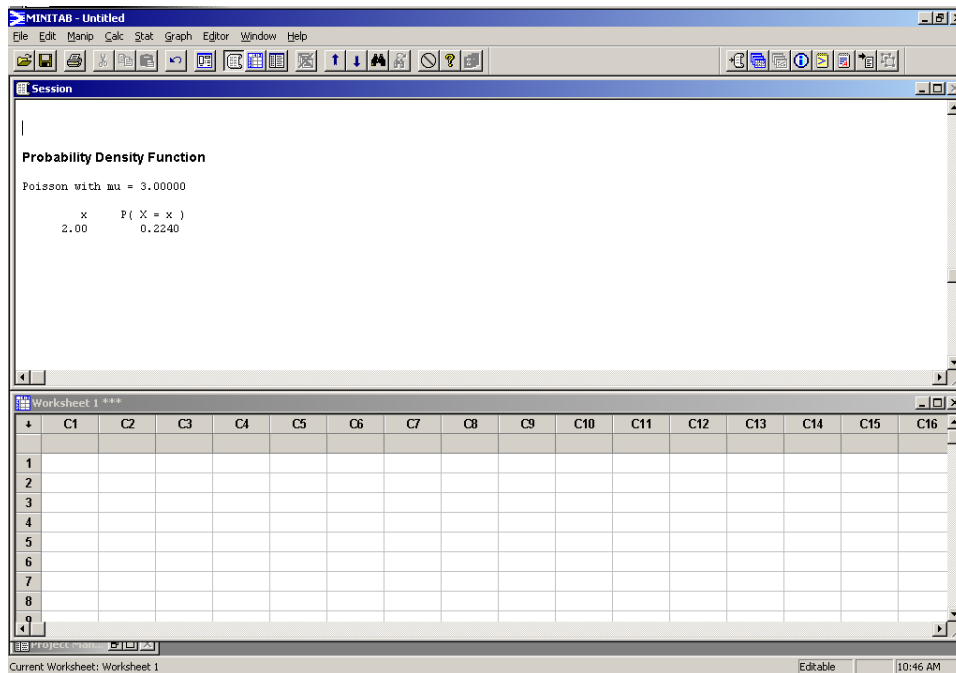
Section 5.8

Example 5-26, pg. 228 Finding Poisson Probabilities

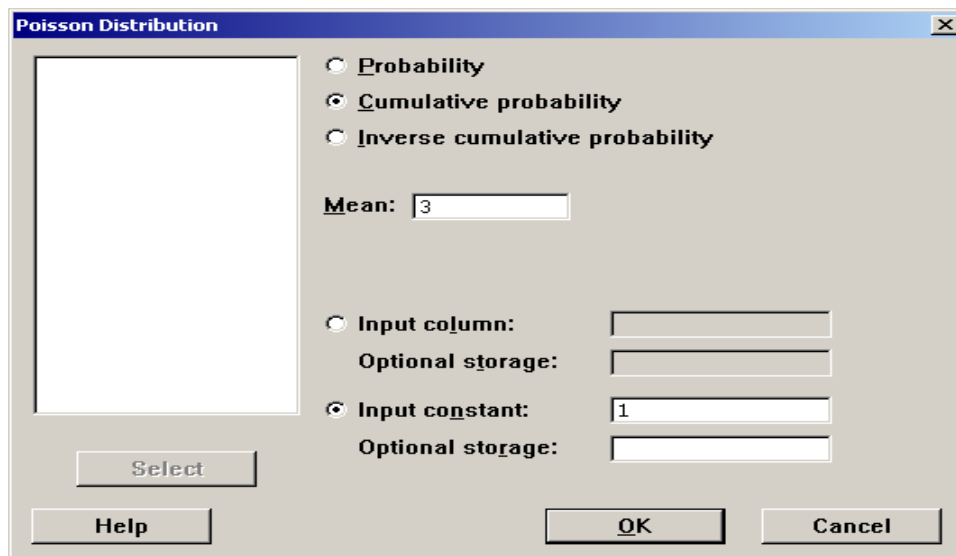
Washing machines at a Laundromat break down an average of 3 times per month, so $\lambda = 3$ for this Poisson example. To find the probability that exactly 2 break down during the next month, click on **Calc** → **Probability Distributions** → **Poisson**. Since you want a simple probability, select **Probability** and enter 3 for the **Mean**. To find the probability that $X=2$, enter 2 for the **Input constant**.

The screenshot shows the 'Poisson Distribution' dialog box in Minitab. On the left is a large empty text area. On the right, there are three radio buttons: 'Probability' (selected), 'Cumulative probability', and 'Inverse cumulative probability'. Below these is a 'Mean:' label followed by a text box containing the number '3'. Further down are three pairs of labels and text boxes: 'Input column:' with an empty box, 'Optional storage:' with an empty box, and 'Input constant:' (selected) with a text box containing the number '2'. Below the 'Input constant' section is another 'Optional storage:' label with an empty box. At the bottom left is a 'Select' button. At the bottom center are 'Help', 'OK', and 'Cancel' buttons.

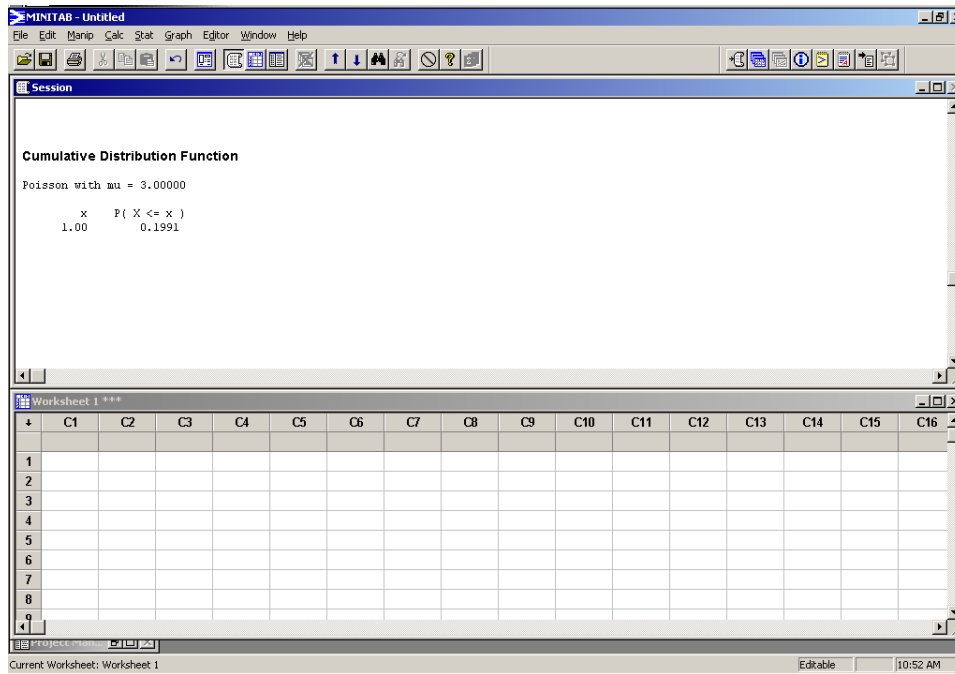
Click on **OK** and the probability will be in the Session Window. The probability that exactly 2 breakdowns will occur during the next month is .2240.



Now, to find the probability that at most 1 will break down during the next month, repeat the steps above. Click on **Calc** → **Probability Distributions** → **Poisson**. This time you want a cumulative probability, so select **Cumulative Probability** and enter 3 for the **Mean**. To find the probability that $X \leq 1$, enter 1 for the **Input constant**.



When you click on **OK**, the results will be in the Session Window.



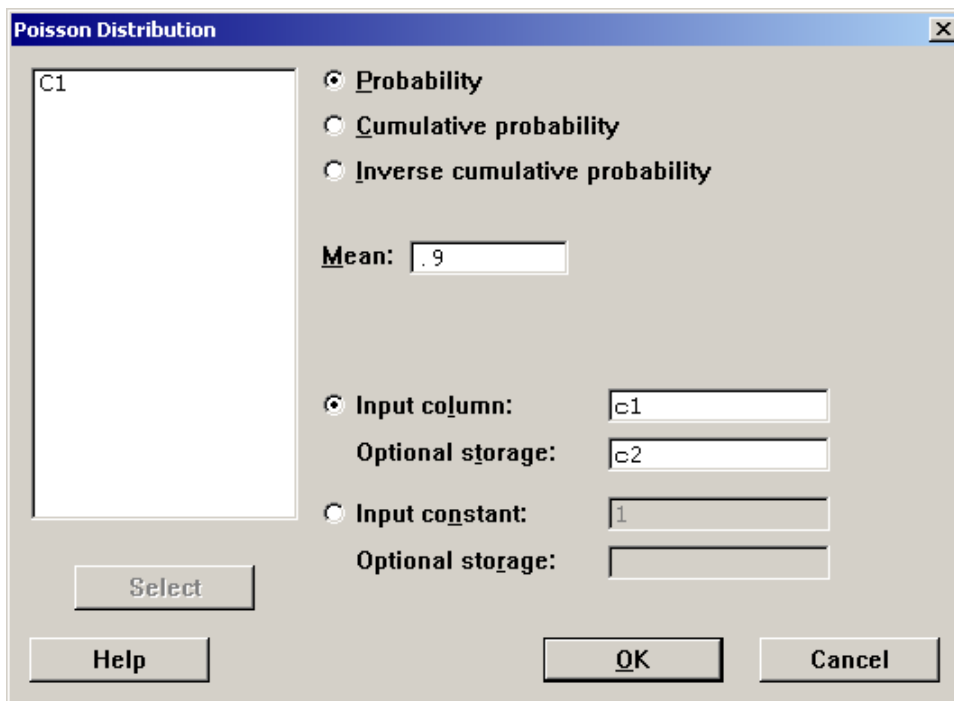
The probability that there will be at most 1 break down in the next month is .1991.

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Example 5-29, pg. 241 Constructing a Poisson Histogram

An auto salesperson sells an average of .9 cars per day. Using the Poisson probability distribution, draw a histogram of the probability distribution.

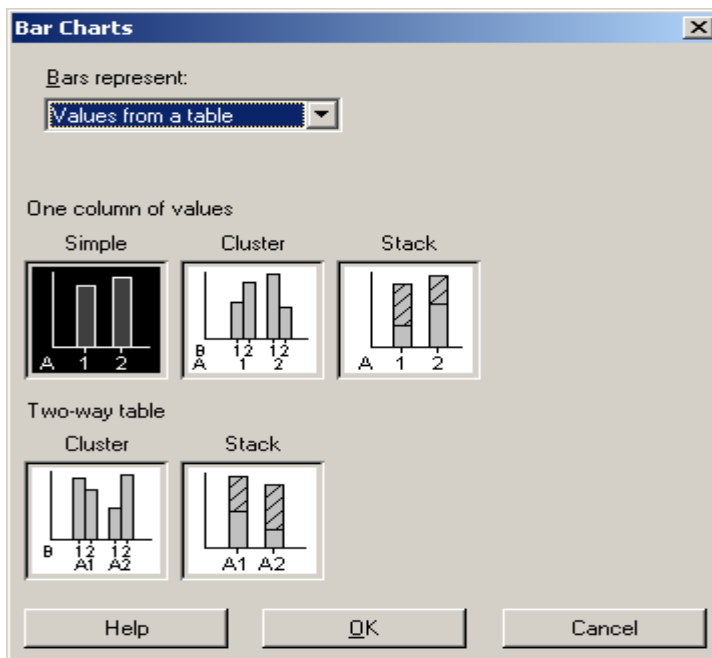
In order to graph the Poisson distribution, you must first create the distribution and save it in the Data Window. First type the values of X into C1. The textbook tells you that the chances of selling 7 or more cars are very small, so use the values of X from 0 to 6. Next, use MINITAB to generate the Poisson probabilities for $\lambda=.9$. Click on **Calc** → **Probability Distributions** → **Poisson**. Select **Probability**. The **Mean** is .9. Now, tell MINITAB that the X values are in C1 and that you want the probabilities stored in C2. Enter C1 as the **Input Column** and enter C2 for **Optional Storage**.

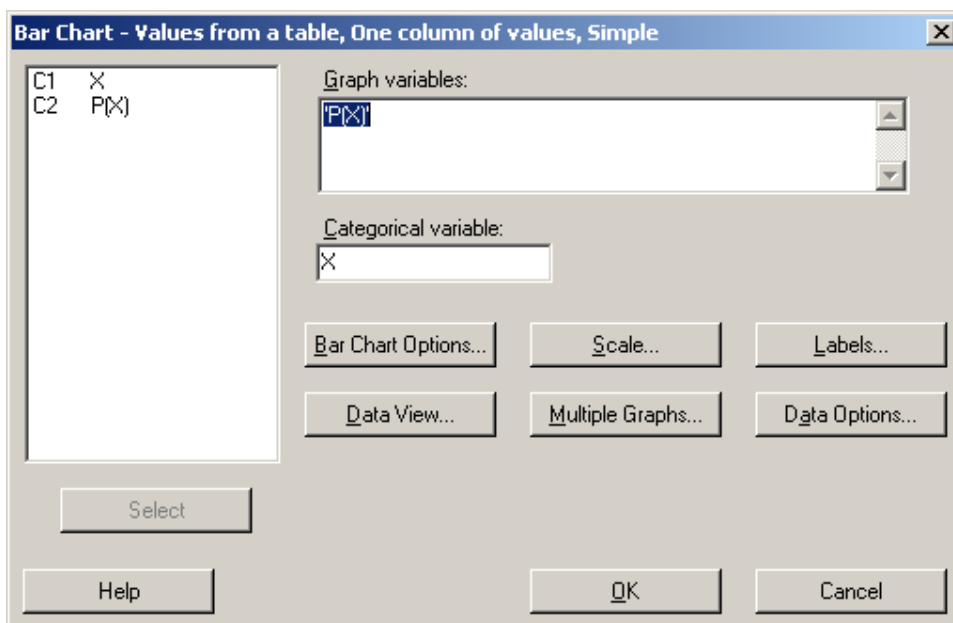


Click on **OK**, and the probabilities should be in C2. Label C1 as "X" and C2 as "P(X)". This will be helpful when you graph the distribution.

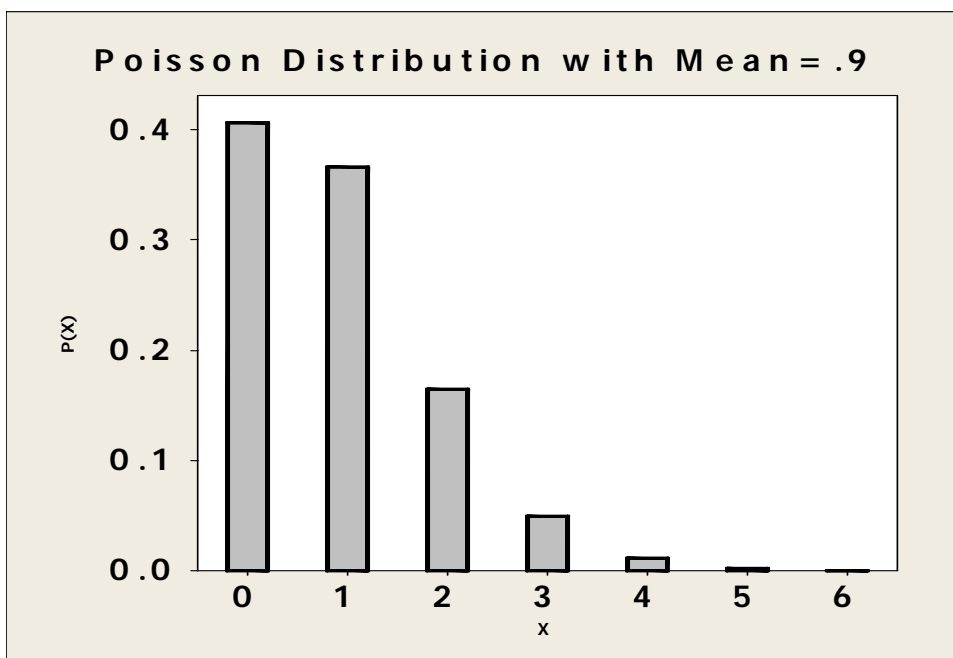
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
	X	P(X)														
1	0	0.406570														
2	1	0.366913														
3	2	0.164861														
4	3	0.049398														
5	4	0.011115														
6	5	0.002001														
7	6	0.000300														
8																

To create the graph, click on **Graph** → **Bar Chart**. In this case, the **Bars** represent: **Values from a table**. Select a **Simple** bar chart and click on **OK**.





Select C2 ($P(X)$) as the **Graph variable** and C1 (X) as the **Categorical variable**. Next, click on the button **Labels** and enter an appropriate **Title** for the chart. Click on **OK** twice to display the graph.



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Suggested Exercises

Section 5.6

pp. 222-223: 5.60, 5.61, 5.63, 5.67

Section 5.7

pp. 226: 5.75, 5.77, 5.78

Section 5.8

pp. 234-235: 5.91, 5.93, 5.97