Minitab

Supplement

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Contents

Introductory Exercises

Example:

The Cancer Data will be used to introduce the basics of MINITAB.

The MINITAB Environment

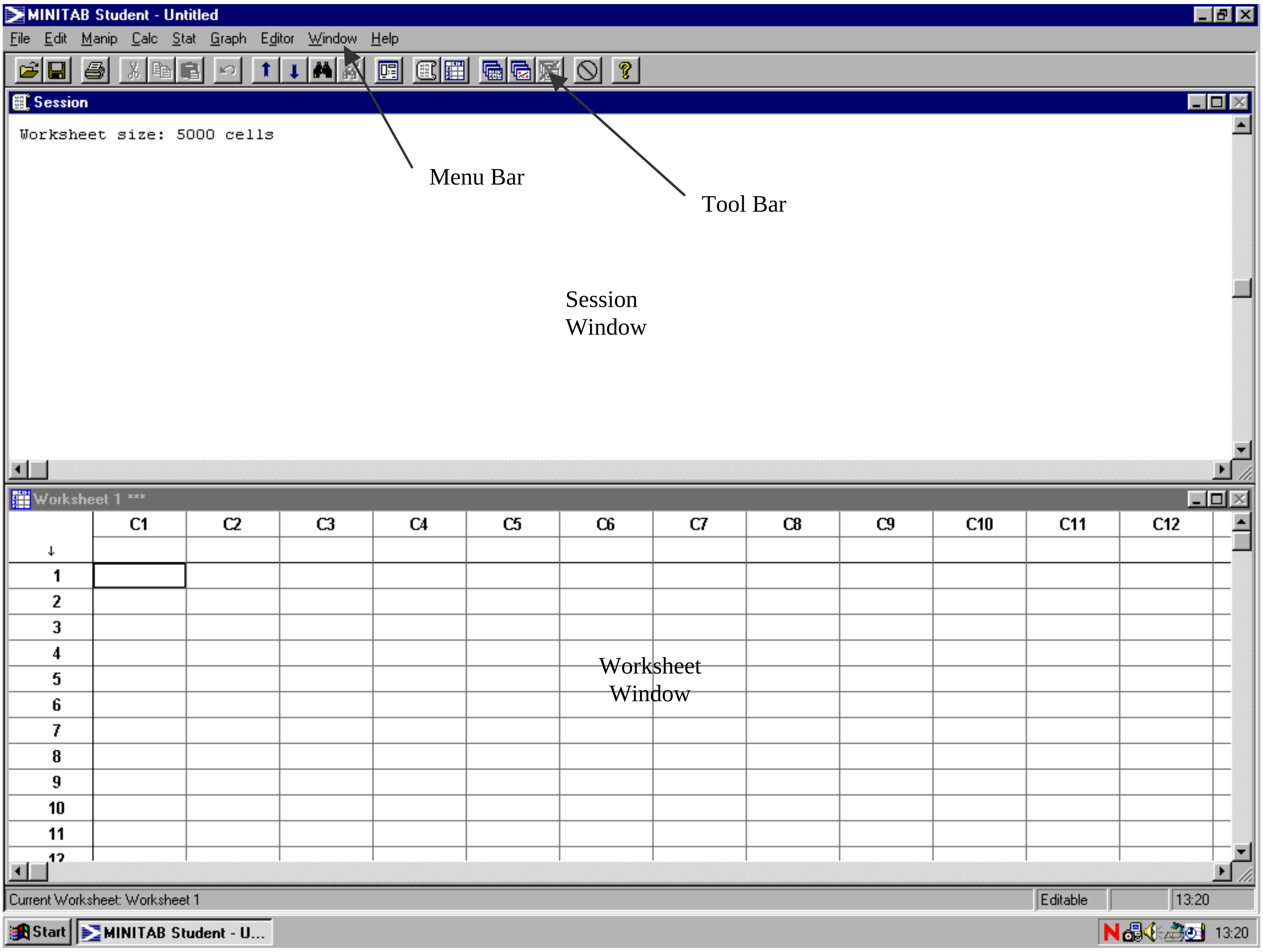


Figure 1

Entering Data

1. To make a cell in the **Worksheet** active click in it with the **mouse** or move to it using the **arrow** keys.

2. Enter the names **Stomach**, **Bronchus, Other,** and **Colon** into the name cells. The name cells are found just below the column references **C1**, **C2**, **C3**…etc. Type what is needed to be typed then press **Enter** and the cell below becomes the active cell, or press any **arrow** key and the corresponding direction becomes the active cell. See Figure 2.

Worksheet 1 ***

	C1	C2	C3	C4
↓	Stomach	Bronchus	Other	Colon
1				

Figure 2

3. Enter the rest of the data as shown in Figure 3.

Worksheet 1 ***

	C1	C2	C3	C4
↓	Stomach	Bronchus	Other	Colon
1	1.18	0.81	3	2.01
2	-0.41	3.16	6	0.51
3	-0.64	-0.22	10	1.07
4	1.32	2.05	7	4.31
5	1.39	1.90	6	1.00
6	0.14	0.85	8	3.51
7	2.29	0.27	5	3.00
8	-0.10	0.73	4	1.79
9	2.20	1.84	11	1.67
10	*	3.86	9	2.16

Figure 3

Editing Data

1. It the last entry of **Stomach** was found to be **3.83**. Go to the cell (make it the active cell) by using the **mouse** or the **arrow** keys. Type in the correct value **3.83**. It has now been changed. The **Worksheet** should now look like Figure 4.

Stomach
1.18
-0.41
-0.64
1.32
1.39
0.14
2.29
-0.10
2.20
3.83

Figure 4

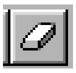
Note: The asterisk (*) is MINITAB's missing value code.

2. It was discovered that the variable **Other** should not be there. Click in the name cell and hold the **mouse** button down, then drag the **mouse** down to row 10. The cells have now been highlighted. The **Worksheet** should look like Figure 5.

Worksheet 1 ***

	C1	C2	C3	C4
↓	Stomach	Bronchus	Other	Colon
1	1.18	0.81	3	2.01
2	-0.41	3.16	6	0.51
3	-0.64	-0.22	10	1.07
4	1.32	2.05	7	4.31
5	1.39	1.90	6	1.00
6	0.14	0.85	8	3.51
7	2.29	0.27	5	3.00
8	-0.10	0.73	4	1.79
9	2.20	1.84	11	1.67
10	3.83	3.86	9	2.16
11				

Figure 5

3. Click the **Clear Cells** button on the tool bar.  The cells should now be cleared.

4. Highlight the 11 cells of the **Colon** variable in the same manner describe above. On the menu bar choose **Edit** Ł **Cut**. Make the name cell of column **C3** the active cell. Choose from the menu bar **Edit** Ł **Paste**. The **Worksheet** now appears like that in Figure 6.

Worksheet 1 ***

	C1	C2	C3
↓	Stomach	Bronchus	Colon
1	1.18	0.81	2.01
2	-0.41	3.16	0.51
3	-0.64	-0.22	1.07
4	1.32	2.05	4.31
5	1.39	1.90	1.00
6	0.14	0.85	3.51
7	2.29	0.27	3.00
8	-0.10	0.73	1.79
9	2.20	1.84	1.67
10	3.83	3.86	2.16

Figure 6

Sorting Data

1. From the menu bar choose **Manip** Ł **Sort**. In the **Sort column(s)** box type **Stomach**. Enter **Stomach** into the **Store sorted column(s) in** box, and enter **Stomach** into the first **Sort by column** box. Click **OK**.

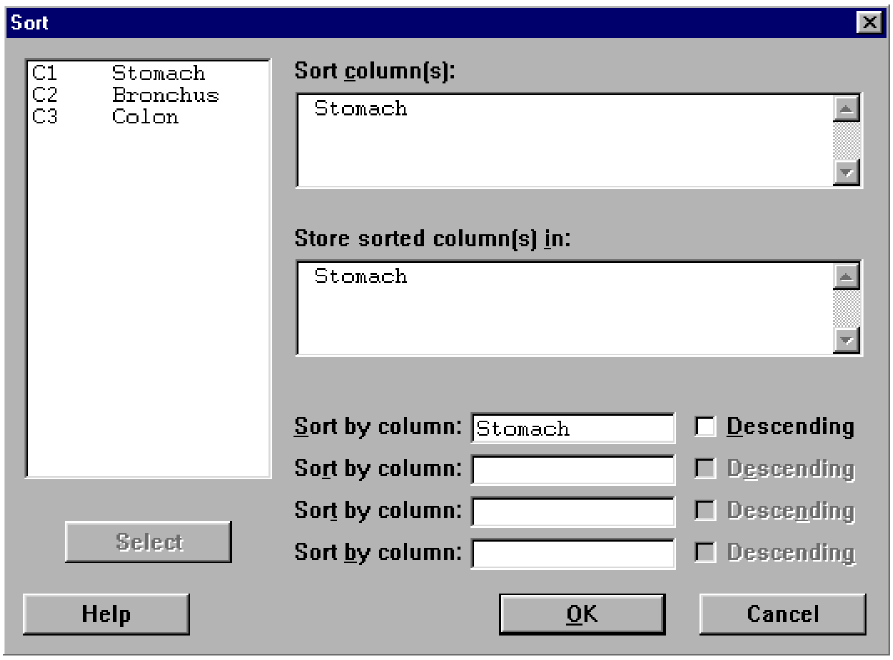


Figure 7

2. Repeat for the variables **Bronchus** and **Colon**.

3. The data should now appear as in Figure 8.

Worksheet 1 ***

	C1	C2	C3
↓	Stomach	Bronchus	Colon
1	-0.64	-0.22	0.51
2	-0.41	0.27	1.00
3	-0.10	0.73	1.07
4	0.14	0.81	1.67
5	1.18	0.85	1.79
6	1.32	1.84	2.01
7	1.39	1.90	2.16
8	2.20	2.05	3.00
9	2.29	3.16	3.51
10	3.83	3.86	4.31

Figure 8

Summary Statistics

1. From the menu bar choose **Stat** Ł **Basic Statistics** Ł **Display Descriptive Statistics**. In the **Variables** box type **Stomach-Colon**. The window should appear as in Figure 9. Click **OK**.

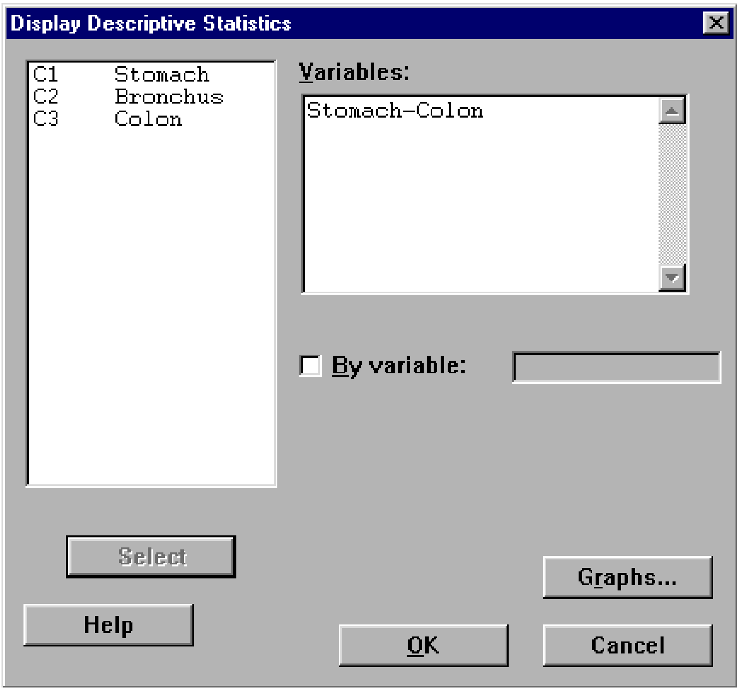


Figure 9

2. The summary statistics are outputted to the **Session** window, which can be seen below.

Session

Descriptive Statistics

Variable	N	Mean	Median	TrMean	StDev	SE Mean
Stomach	10	1.120	1.250	1.001	1.410	0.446
Bronchus	10	1.525	1.345	1.451	1.285	0.406
Colon	10	2.103	1.900	2.026	1.191	0.377

Variable	Minimum	Maximum	Q1	Q3
Stomach	-0.640	3.830	-0.177	2.222
Bronchus	-0.220	3.860	0.615	2.327
Colon	0.510	4.310	1.052	3.128

Figure 10

Stacking/Unstacking Variables

1. On the menu bar choose **Manip** Ł **Stack/Unstack** Ł **Stack Columns**. Enter **Stomach-Colon** into the **Stack the following columns** box. **Store the stacked data in** the variable **values** and **Store subscripts in** the variable **factors**. See Figure 11.

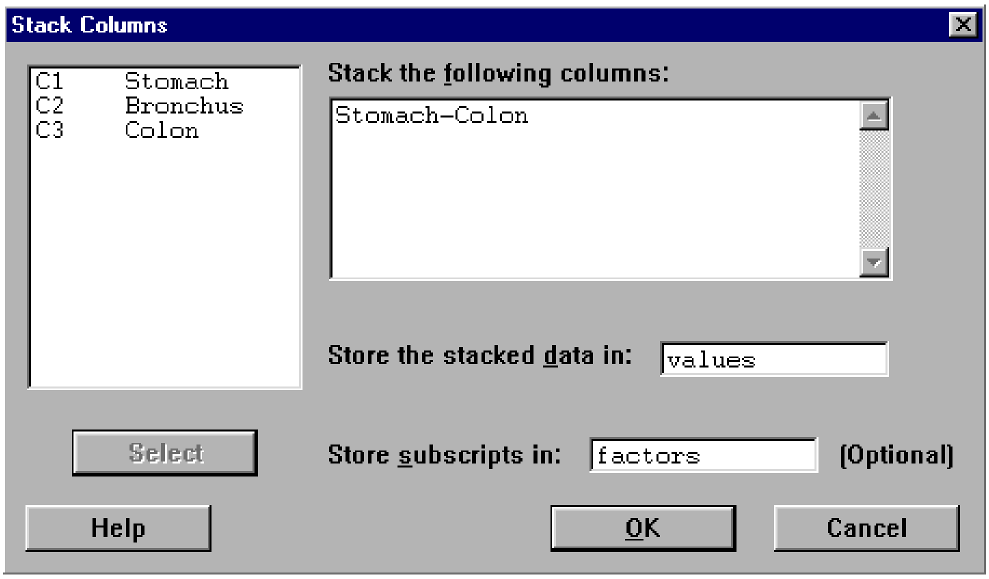


Figure 11

2. Click **OK**. The stacked columns will appear in the **Worksheet**. See Figure 12.

C4	C5
values	factors
-0.41	1
-0.10	1
0.14	1
1.18	1
1.32	1
1.39	1
2.20	1
2.29	1
3.83	1
-0.22	2
0.27	2

Figure 12

3. If the data was given in the form seen in Figure 13. Then it would need to be unstacked.

Worksheet 1 ***

↓	C4 values	C5-T factors
1	7	a
2	8	c
3	4	b
4	2	a
5	3	b
6	6	c
7	5	c
8	7	b
9	9	a
10	1	c
11	2	a

Figure 13

4. From the menu bar choose **Manip** Ł **Stack/Unstack** Ł **Unstack One Column**. The **Unstack One Column** window appears. Enter **values** into the **Unstack the data in** box. **Store the unstacked data in** the variables **a**, **b**, and **c**. Type **factors** in the **Using subscripts in** box, so that the window will look like Figure 14.

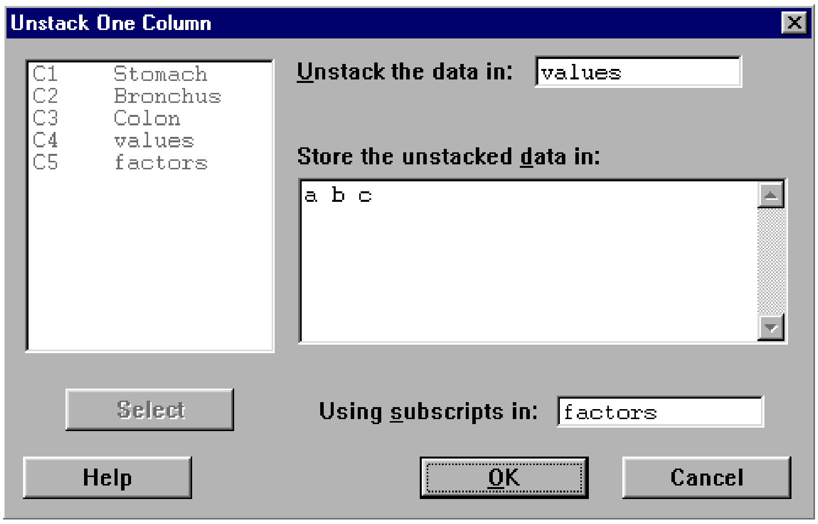


Figure 14

5. The unstacked data will be displayed in the **Worksheet** as shown in Figure 15.

Worksheet 1 ***

	C6	C7	C8
↓	a	b	c
1	7	4	8
2	2	3	6
3	9	7	5
4	2	4	1
5	7	9	5
6	3	1	6
7	9	8	4
8	3	7	5

Figure 15

Note: The **Calculator** is a very useful tool for calculations and data manipulation. It is found under the **Calc** menu. Use the Help file to find out more about it.

Using *Excel* Data in MINITAB

Example:
The Cancer Data is in an Excel Worksheet called **cancer.xls**. Use MINITAB to analyse it.

1. The Cancer Data can be seen below in Figure 1.

	A	B	C	D
1	Stomach	Bronchus	Colon	
2	1.18	0.81	2.01	
3	-0.41	3.16	0.51	
4	-0.64	-0.22	1.07	
5	1.32	2.05	4.31	
6	1.39	1.9	1	
7	0.14	0.85	3.51	
8	2.29	0.27	3	
9	-0.1	0.73	1.79	
10	2.2	1.84	1.67	
11	3.83	3.86	2.16	
12				

Figure 1

2. Open MINITAB.

3. Choose from the menu bar **File Ł Open Worksheet**. The **Open Worksheet** window pops up. Click on the arrow next to the **Files of type** box and select **Excel (*.xls)**. Navigate to the directory that contains the sought after file. In this case it is called **Data**. This will not always be so. See Figure 2.

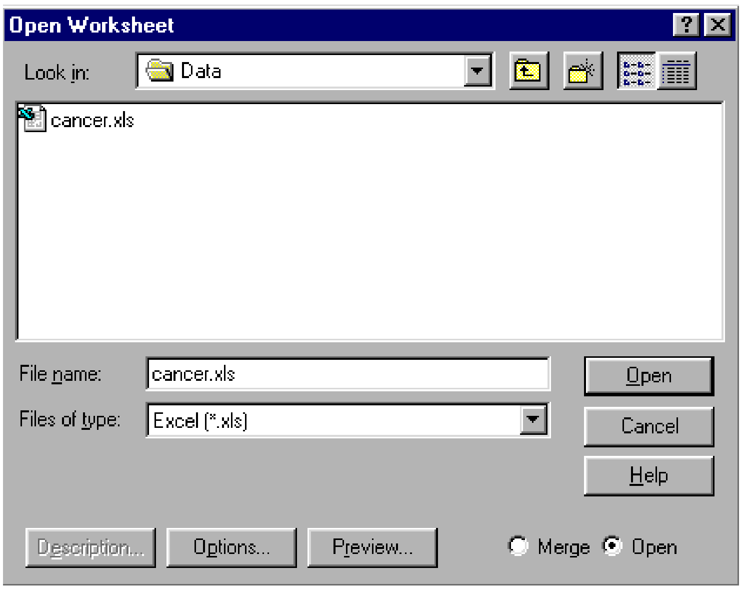


Figure 2

4. Click **Open**. The Cancer Data then appears in MINITAB as shown in Figure 3 below.

cancer.xls ***

	C1	C2	C3
↓	Stomach	Bronchus	Colon
1	1.18	0.81	2.01
2	-0.41	3.16	0.51
3	-0.64	-0.22	1.07
4	1.32	2.05	4.31
5	1.39	1.90	1.00
6	0.14	0.85	3.51
7	2.29	0.27	3.00
8	-0.10	0.73	1.79
9	2.20	1.84	1.67
10	3.83	3.86	2.16

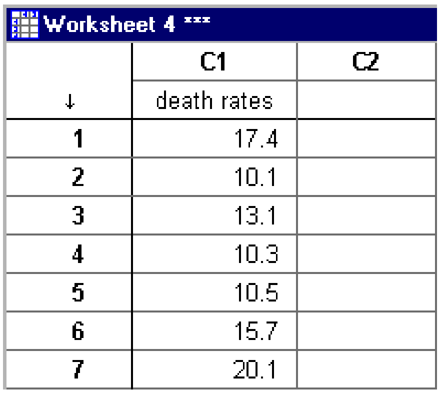
Figure 3

5. Perform the required analysis.

Constructing a Stem-and-Leaf Plot

Example:
Construct a stem-and-leaf plot of the Traffic Death Rate Data. (Refer to Example 2.3.2 in your textbook.)

1. Enter the data, found in Table 2.3.1 of your textbook, into MINITAB. The first few rows should look like those in Figure 1.



	C1	C2
↓	death rates	
1	17.4	
2	10.1	
3	13.1	
4	10.3	
5	10.5	
6	15.7	
7	20.1	

Figure 1

2. From the menu bar choose **Graph** Ł **Stem-and-Leaf**. Click in the **Variables** box, then select **C1 death rates** in the big box, and then click the **Select** button, so that the dialog box looks like Figure 2.

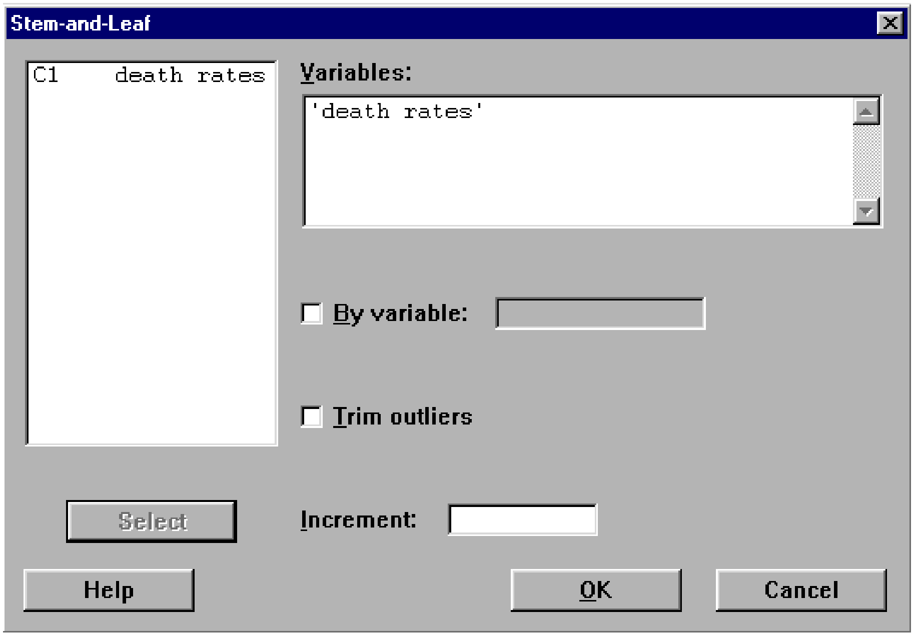


Figure 2

3. Click **OK**. The stem-and-leaf plot appears in the Session window.

Session

Character Stem-and-Leaf Display

```
Stem-and-leaf of death ra  N  = 30
Leaf Unit = 1.0


    1    0 5
    1    0
    2    0 9
    9    1 0000011
   (7)   1 2222233
   14    1 4555
   10    1 77
    8    1 89
    6    2 0001
    2    2
    2    2 5
    1    2 6
```

Figure 3

Constructing a Dot Plot

Example:

Construct a dot plot of the following data 3, 4, 4.5, 4.5, 6, 8. This example can be found on page 47 of your textbook.

1. Enter the data into MINITAB as seen in Figure 1 below.

Worksheet 1 ***

	C1	C2
↓	var1	
1	3.0	
2	4.0	
3	4.5	
4	4.5	
5	6.0	
6	8.0	
7		

Figure 1

2. From the menu bar choose **Graph ł Dotplot**. The **Dotplot** dialog box appears. Click in the **Variables** box, select **C1 var1** in the big box, and then click the **Select** button. Enter **Example of a Dot Plot** into the **Title** box (or any suitable title). The window should look like Figure 2.

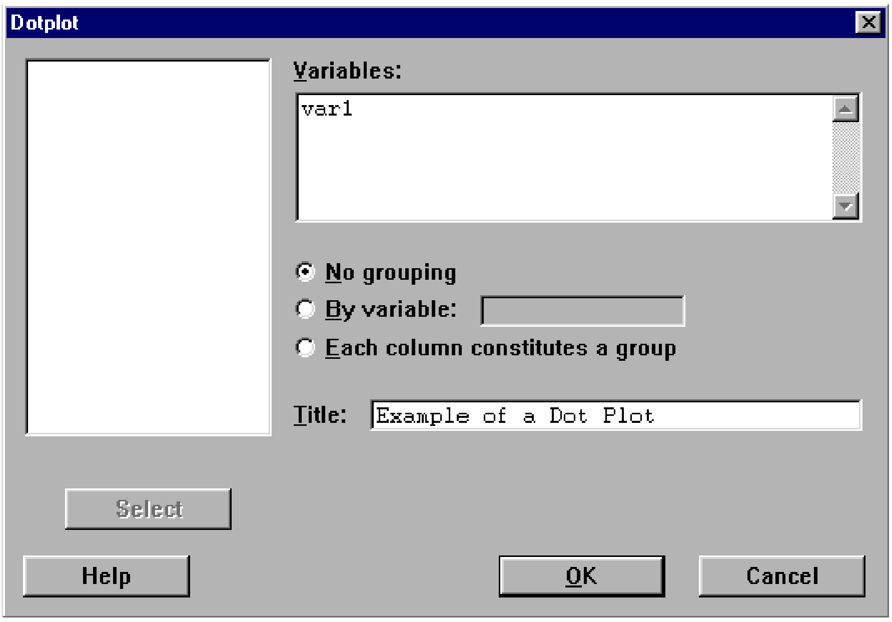


Figure 2

3. Click **OK**. A window (see Figure 3) containing the Dot plot will appear.

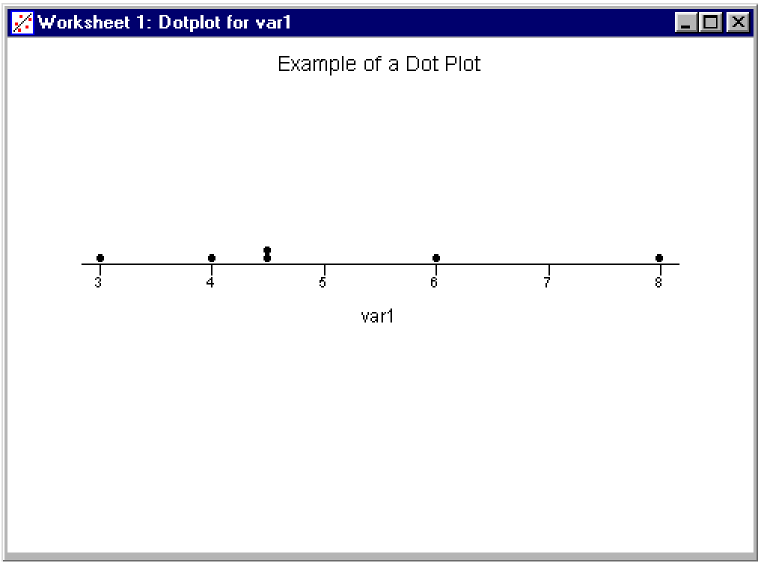


Figure 3

Constructing a Box Plot

Example:
Produce a Box Plot of the SYSVOL data. (Refer to Section 2.4.4 in your textbook.)

1. Enter the data found in Table 2.1.1 of your textbook into MINITAB the first few rows should look like Figure 1 below

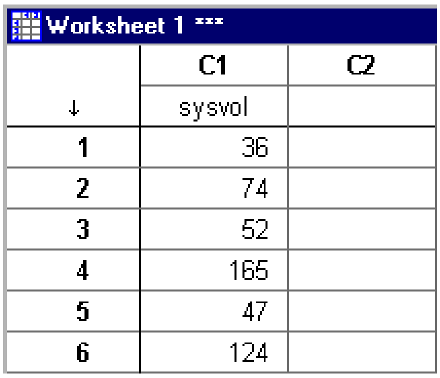


Figure 1

2. From the menu bar choose **Graph** ł **Boxplot**. The **Boxplot** window pops up. Click in the first cell of the **Graph** table under the **Y** column. Select **C1 sysvol** from the big box then click the **Select** button. The dialog box should then look like Figure 2 below.

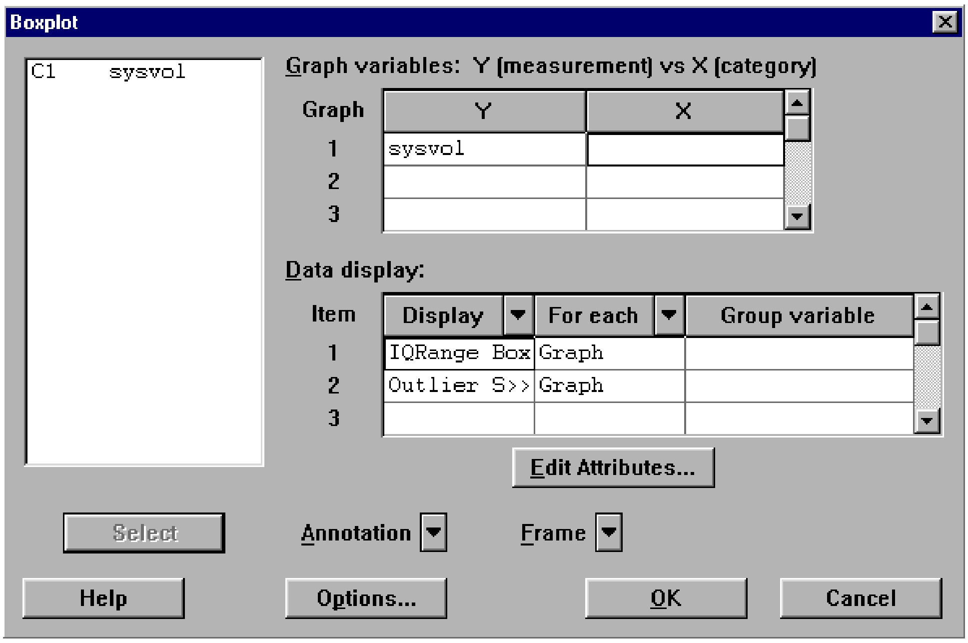


Figure 2

3. Click on the arrow next to **Annotation**, and Choose **Title**. The **Title** dialog box, shown in Figure 3, appears. In the first row of the **Title** table enter the title **Box Plot of End-systolic Volume**.

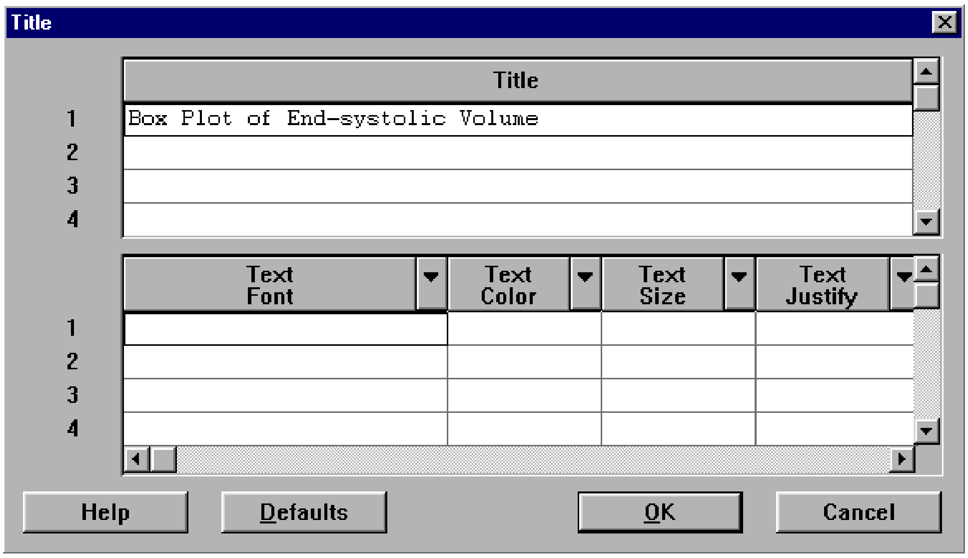


Figure 3

4. Click **OK**. Click **OK** again. A window appears that contains the Box Plot. See Figure 4.

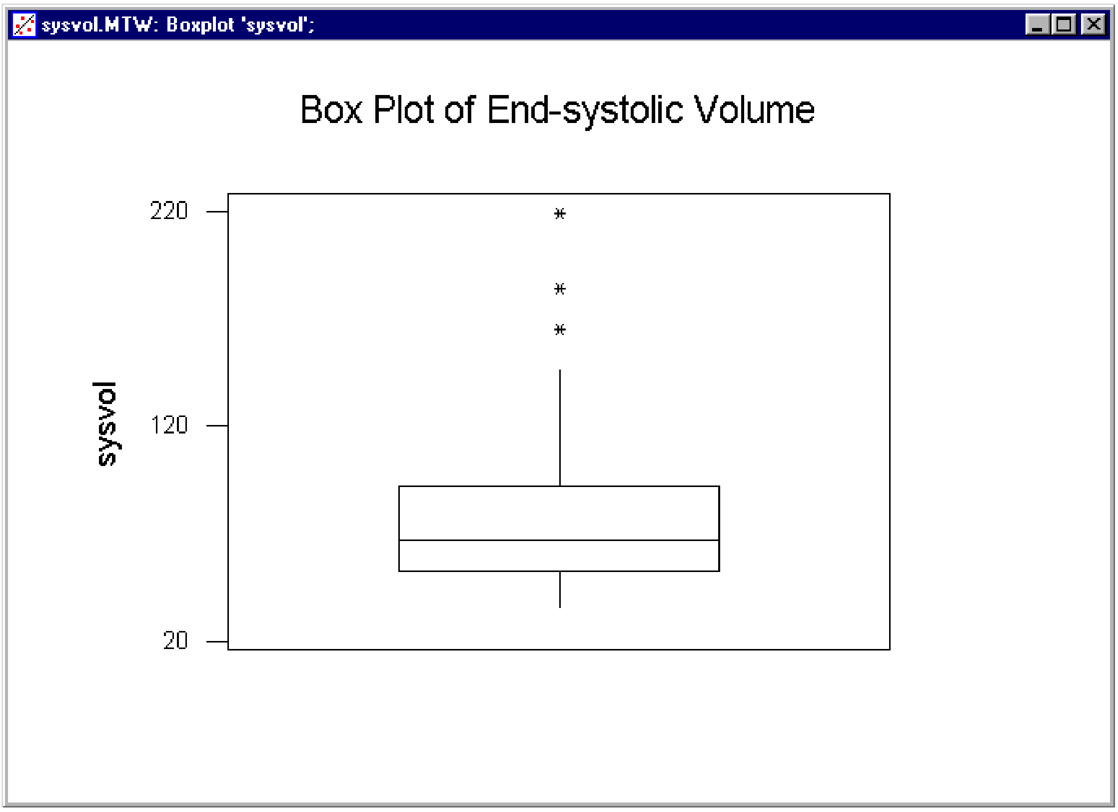


Figure 4

Constructing a Histogram

Example:

Produce a Histogram of the Female Coyote Lengths Data. (Refer to Table 2.3.2 in your textbook)

1. Enter the data into MINITAB. The first few rows will look like Figure 1.

Worksheet 2 ***

	C1	C2
↓	female lengths	
1	93.0	
2	97.0	
3	92.0	
4	101.6	
5	93.0	
6	84.5	
7	102.5	

Figure 1

2. On the menu bar click **Graph** Ł **Histogram**. The **Histogram** window will appear. Click in the first cell in the **Graph variables** table. Select **C1 female lengths** in the big box, and then click the **Select** button.

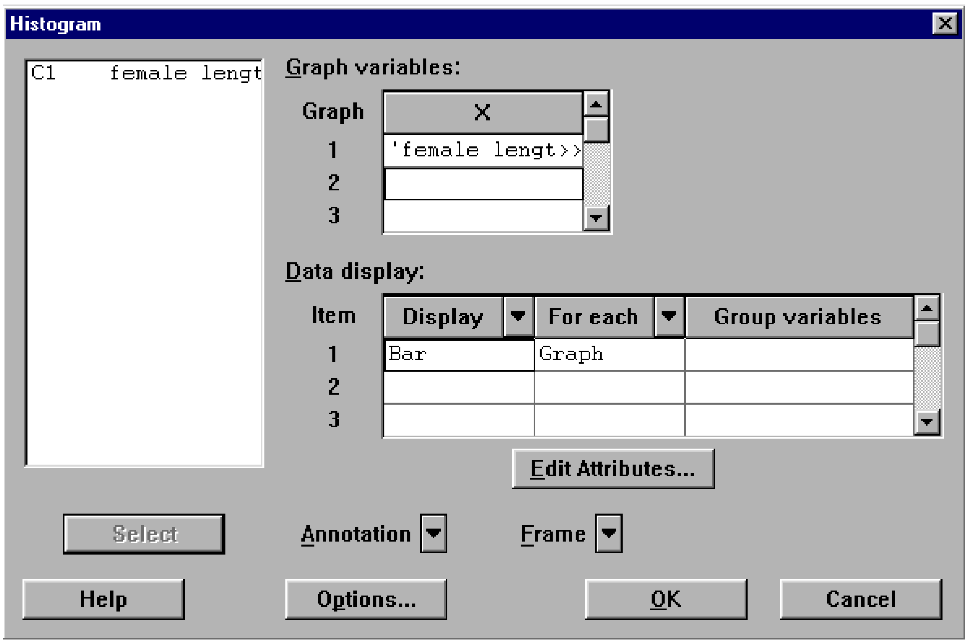


Figure 2

3. Click on the arrow next to **Annotation**, and Choose **Title**. The **Title** dialog box, shown in Figure 3, appears. In the first row of the **Title** table enter the title **Histogram of Female Coyote Lengths**.

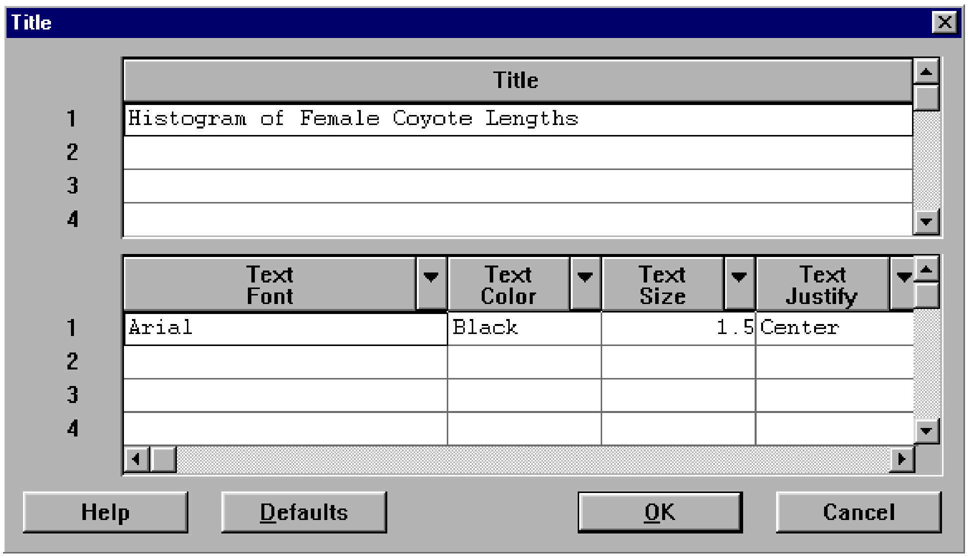


Figure 3

4. Click **OK**. Click **OK** again. A window like that in Figure 4 will pop up.

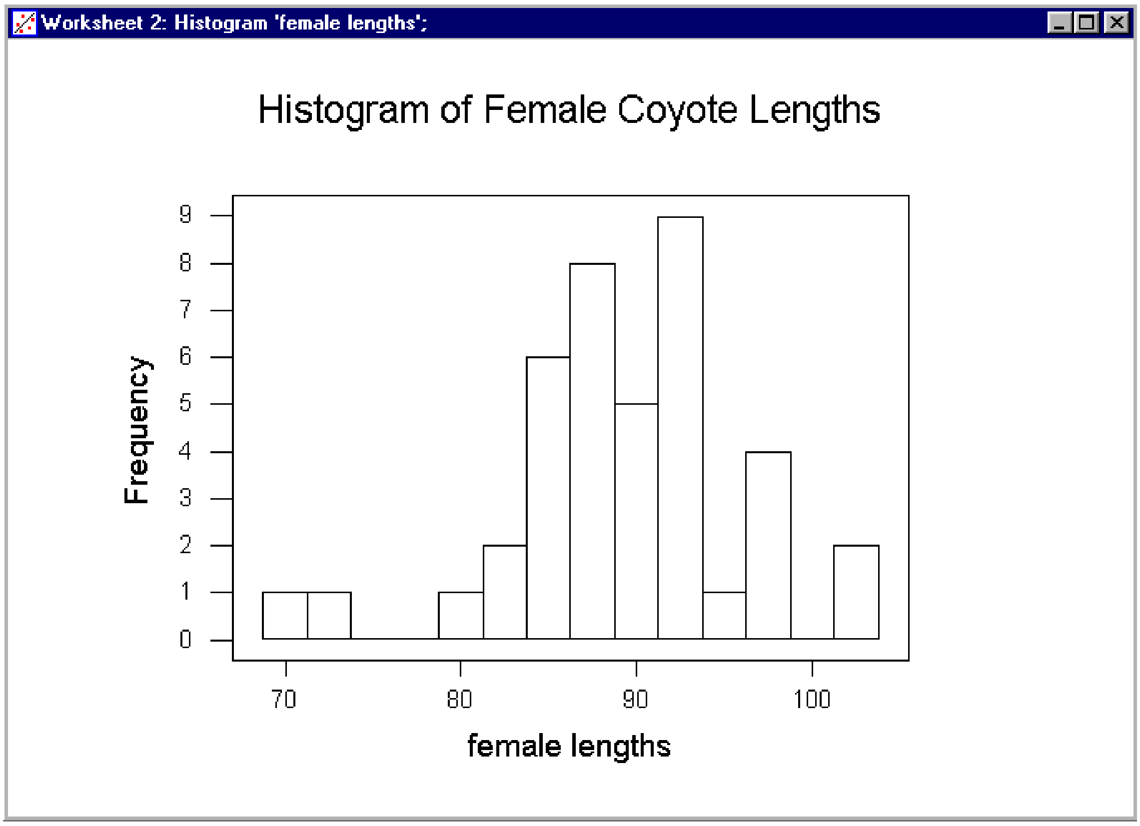


Figure 4

Constructing a Scatter Plot

Example:

Create a scatter plot of the Computer Timing Data. (Refer to Example 3.1.2 in your textbook.)

1. Enter the data into MINITAB, so that the first few rows will look like Figure 1.

Worksheet 1 ***

	C1	C2
↓	no terminals	time
1	40	9.9
2	50	17.8
3	60	18.4
4	45	16.5
5	40	11.9
6	10	5.5
7	30	11.0

Figure 1

2. From the menu bar choose **Graph** Ł **Plot**. The **Plot** dialog box appears. Click in the first cell in the **Y** column. Select **C2 time** in the big box , then click the **Select** button. Click in the first cell in the **X** column. In the big box select **C1 no terminals**, then Click the **Select** button. The window will look like Figure 2 below.

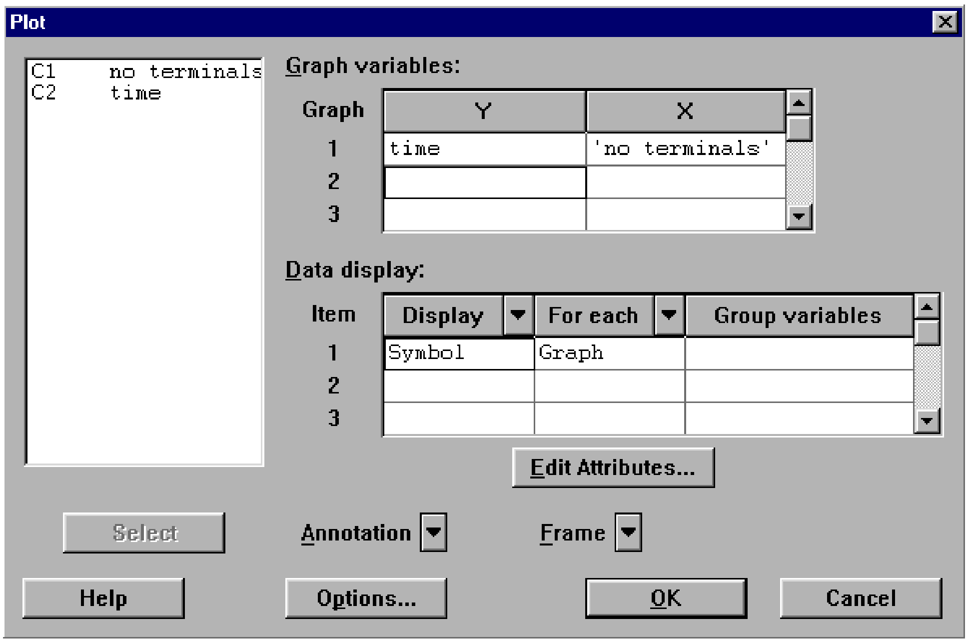


Figure 3

3. Click on the arrow next to **Annotation**, and Choose **Title**. The **Title** dialog box, shown in Figure 3, appears. In the first row of the **Title** table enter the title **Scatter Plot of Computer Timing Data**.

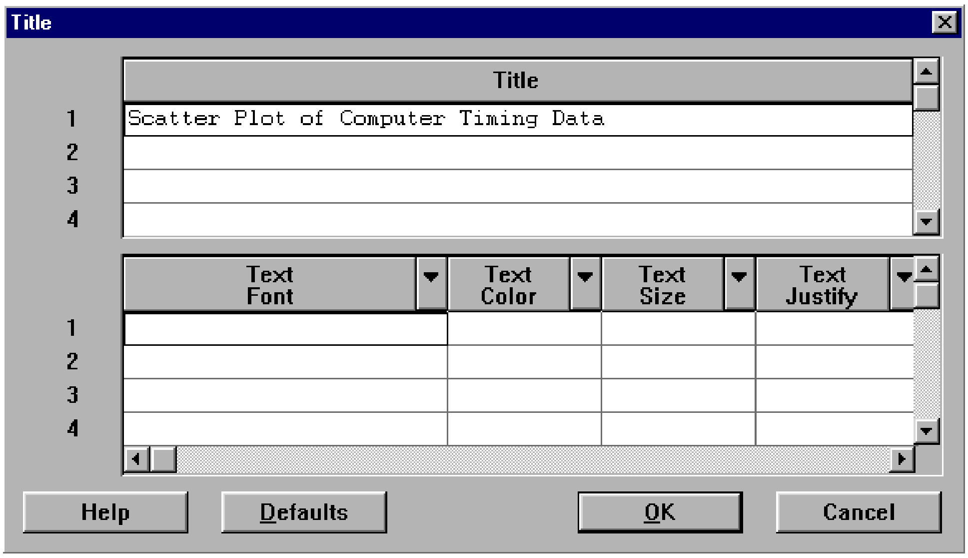


Figure 3

4. Click **OK**. Click **OK** again. The window with the scatter plot pops up

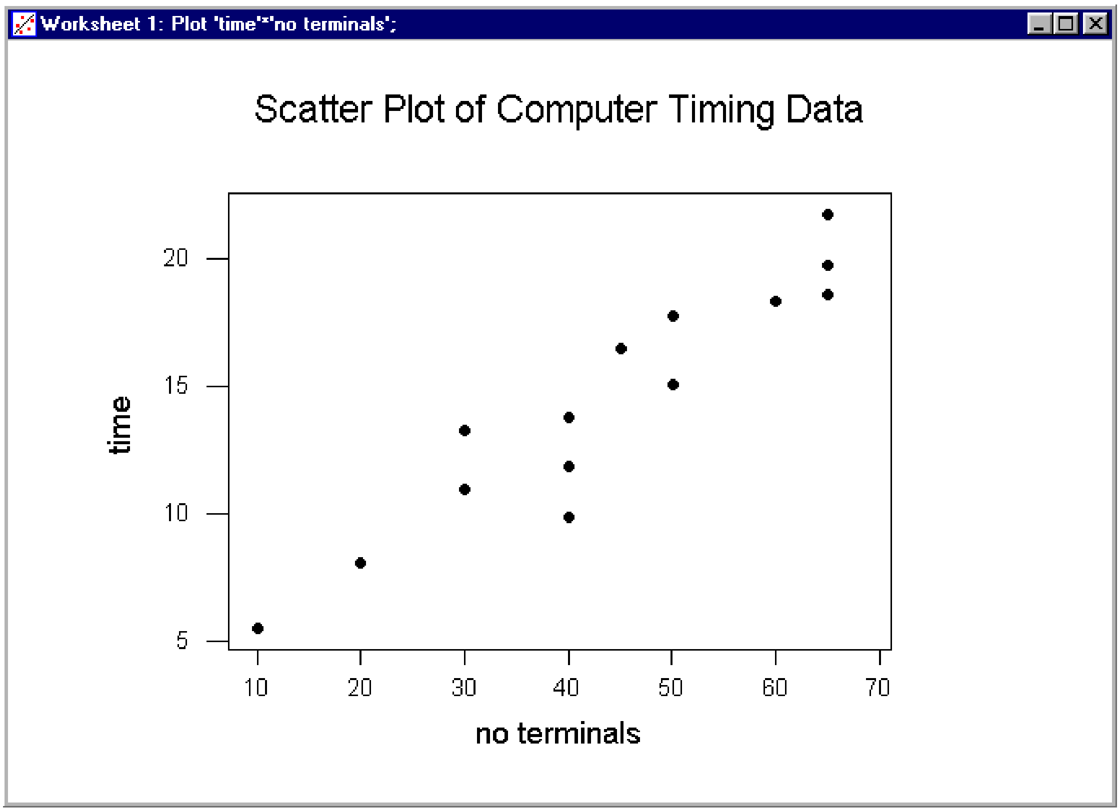


Figure 4

Calculating Binomial Probabilities

Individual Probabilities: pr(*X* = *x*)

Example:
Find pr(*X* = 5) where *X*~Binomial(11, 0.4)

1. On the menu bar click **Calc** Ł **Probability Distributions** Ł **Binomial**.

2. A dialog box, which can be seen in Figure 1 appears. Click on the circle next to **Probability**. The **Number of trials** is **11** and the **Probability of success** is **0.4**. The **Input constant** is **5**.

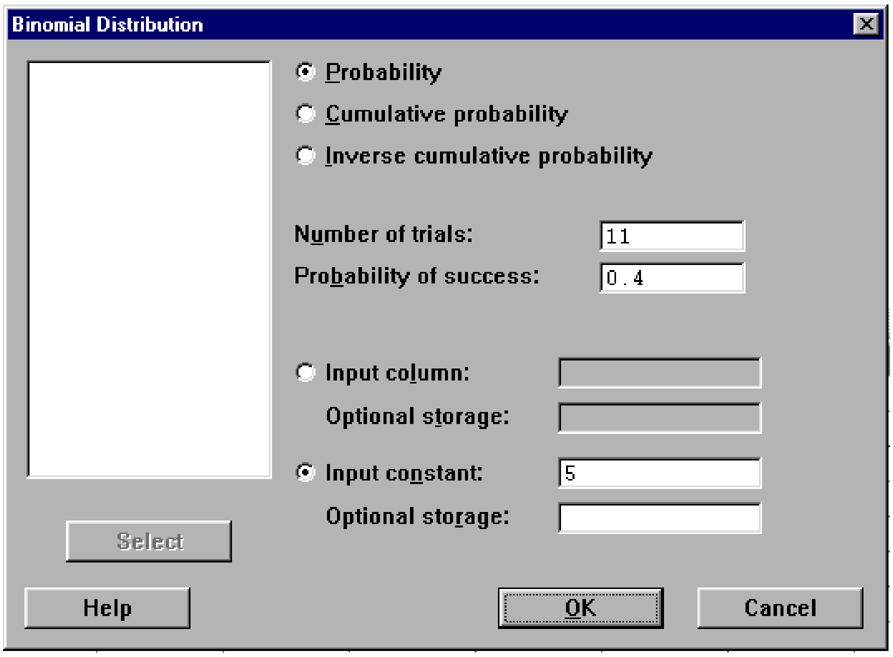


Figure 1

3. Click **OK**. The results appear in the **Session** window. See Figure 2.

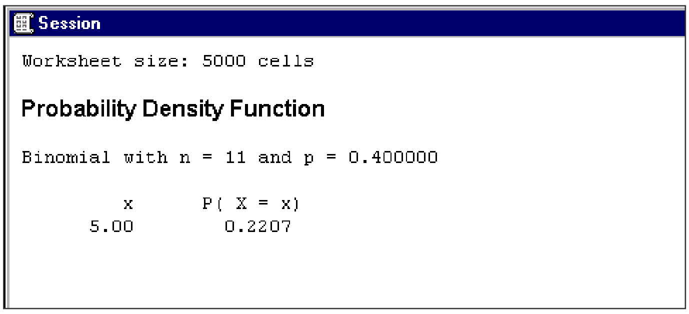


Figure 2

4. The result needed is 0.2207

Lower Tail Probabilities: pr(X ≤ x)

Example:
Find pr($X \leq 4$) where X~Binomial(11, 0.4)

1. On the menu bar click **Calc** → **Probability Distributions** → **Binomial**. The **Binomial Distribution** dialog box appears, as shown in Figure 3. Ensure that the circle next to **Cumulative probability** is marked. The **Number of trials** is **11** and the **Probability of success** is **0.4**. The **Input constant** is **4**.

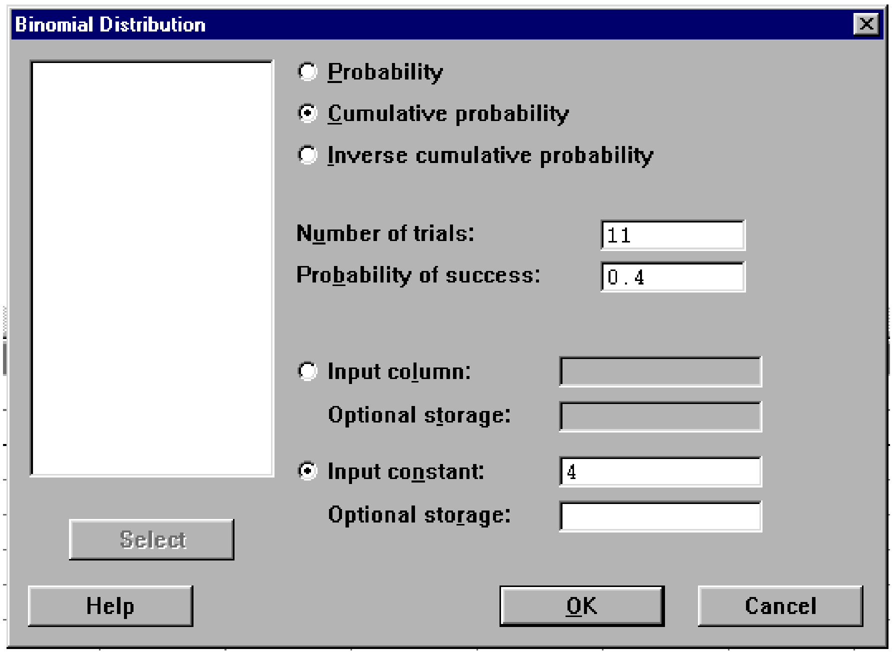


Figure 3

2. Click **OK**. The result appears in the **Session** window. See Figure 4.

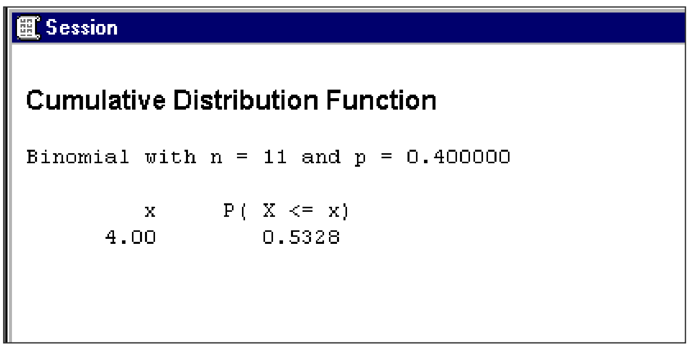


Figure 4

3. The answer required is 0.5328.

Upper Tail Probabilities: pr($X \geq x$)

Example:
Find pr($X \geq 7$) where X~Binomial(11, 0.4).

Note: pr($X \geq 7$) = 1 — pr($X \leq 6$)

1. On the menu bar choose **Calc** Ł **Probability Distributions** Ł **Binomial**.

2. The **Binomial Distribution** dialog box will appear. See Figure 5. Ensure that the circle next to **Cumulative probability** is marked. The **Number of trials** is **11** and the **Probability of success** is **0.4**. The **Input constant** is **6** and the **Optional storage** is **K1**.

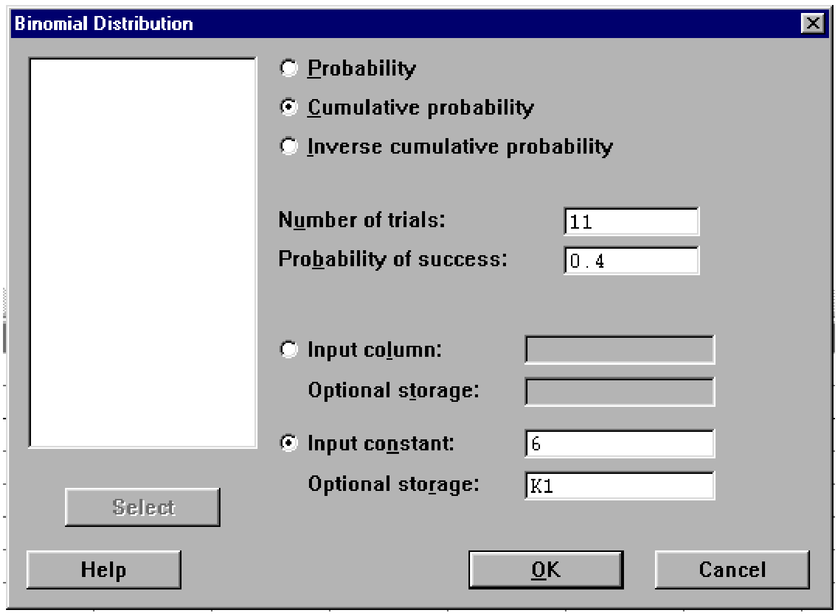


Figure 5

3. Click **OK**. Enter **var1** into the variable name cell as done in Figure 6 below.

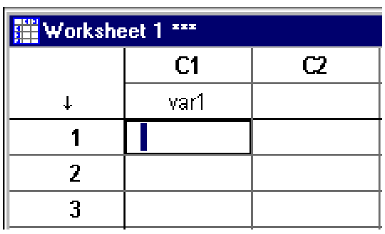


Figure 6

4. From the menu bar choose **Calc ł Calculator**. The **Calculator** dialog box pops up. Click in the **Store result in variable** box, then select **C1 var1** in the big box next to it, and then click the **Select** button. Click in the **Expression** box and type **1–** then select **K1** and click the **Select** button. The dialog should then look like Figure 7.

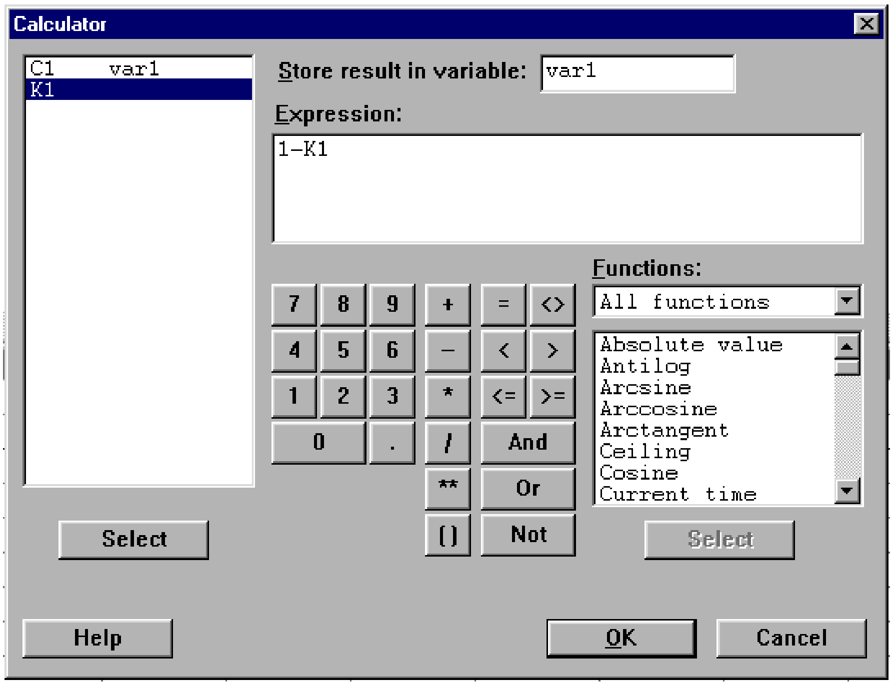


Figure 7

5. Click **OK**. The result will appear in the cell below **var1**, as seen in Figure 8.

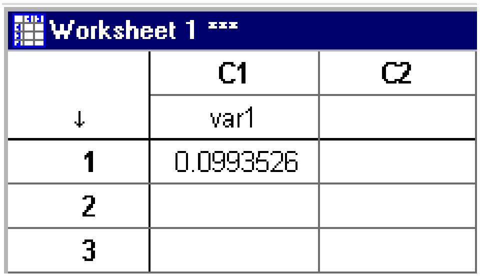


Figure 8

Calculating Poisson Probabilities

Individual Probabilities: pr(X = x)

Example:
Find pr(X = 5) where X~Poisson(6)

5. On the menu bar click **Calc** Ł **Probability Distributions** Ł **Poisson**.

6. A dialog box, which can be seen in Figure 1 appears. Click on the circle next to **Probability**. The **Mean** is **6**. The **Input constant** is **5**.

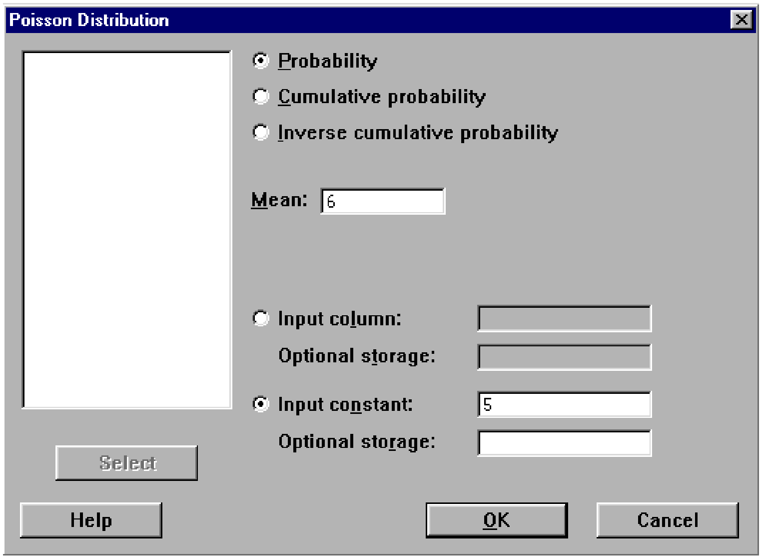


Figure 1

7. Click **OK**. The results appear in the **Session** window. See Figure 2.

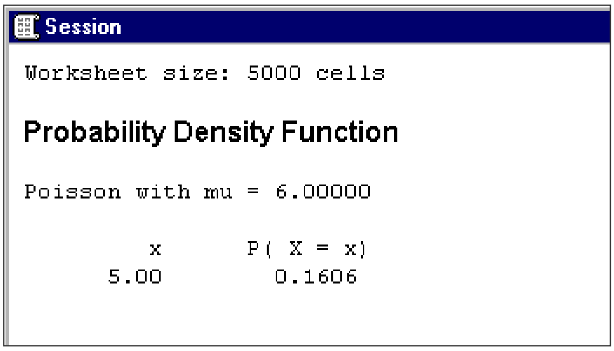


Figure 2

8. The result needed is 0.1606

Lower Tail Probabilities: pr(X ≤ x)

Example:
Find pr($X \leq 4$) where X~Poisson(6)

4. On the menu bar click **Calc** Ł **Probability Distributions** Ł **Poisson**. The **Poisson Distribution** dialog box appears, as shown in Figure 3. Ensure that the circle next to **Cumulative probability** is marked. The **Mean** is **6**. The **Input constant** is **4**.

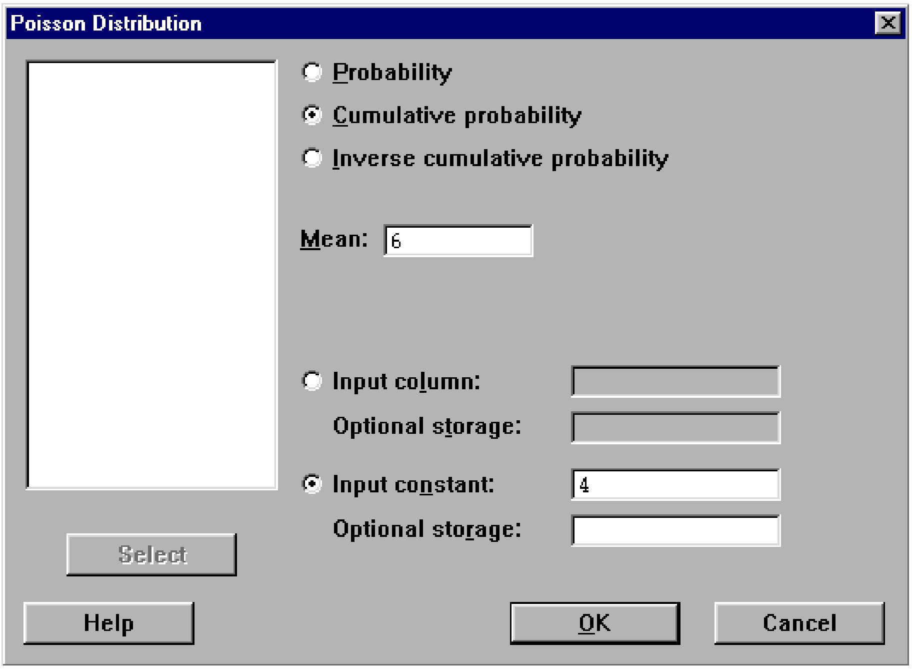


Figure 3

5. Click **OK**. The result appears in the **Session** window. See Figure 4.

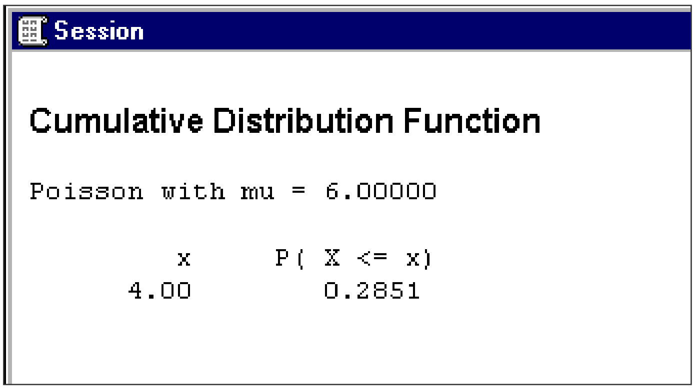


Figure 4

6. The answer required is 0.2851.

Upper Tail Probabilities: pr($X \geq x$)

Example:
Find pr($X \geq 7$) where X~Poisson(6).

Note: pr($X \geq 7$) = 1 — pr($X \leq 6$)

6. On the menu bar choose **Calc** Ł **Probability Distributions** Ł **Poisson**.

7. The **Poisson Distribution** dialog box will appear. See Figure 5. Ensure that the circle next to **Cumulative probability** is marked. The **Mean** is **6**. The **Input constant** is **6** and the **Optional storage** is **K1**.

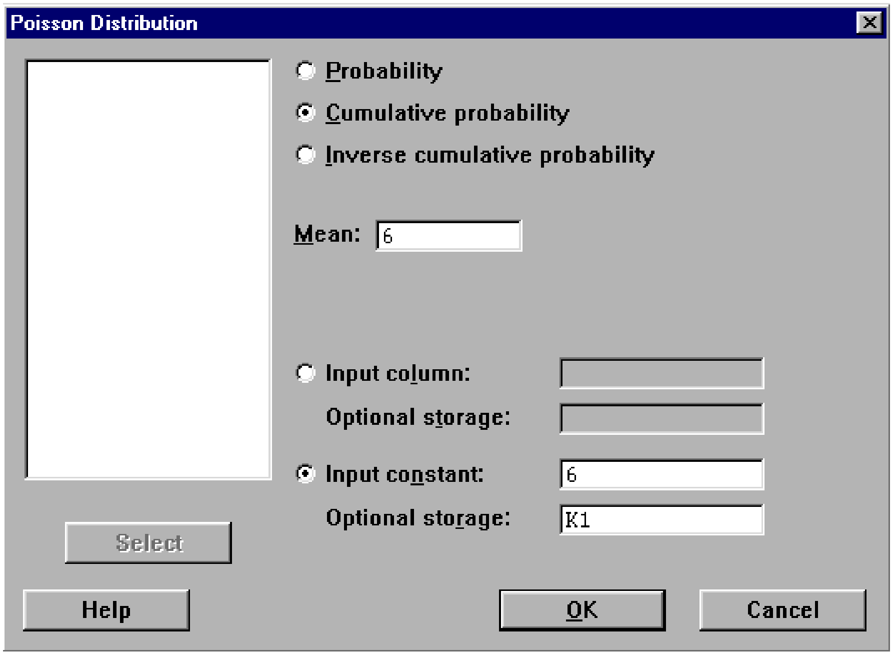


Figure 5

8. Click **OK**. Enter **var1** into the variable name cell as done in Figure 6 below.

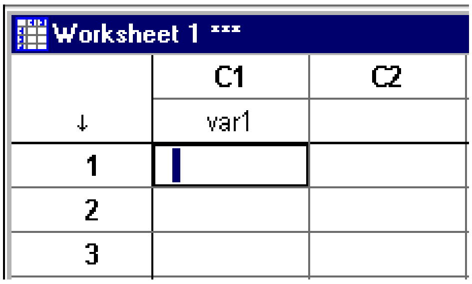


Figure 6

9. From the menu bar choose **Calc ł Calculator**. The **Calculator** dialog box pops up. Click in the **Store result in variable** box, then select **C1 var1** in the big box next to it, and then click the **Select** button. Click in the **Expression** box and type **1–** then select **K1** and click the **Select** button. The dialog should then look like Figure 7.

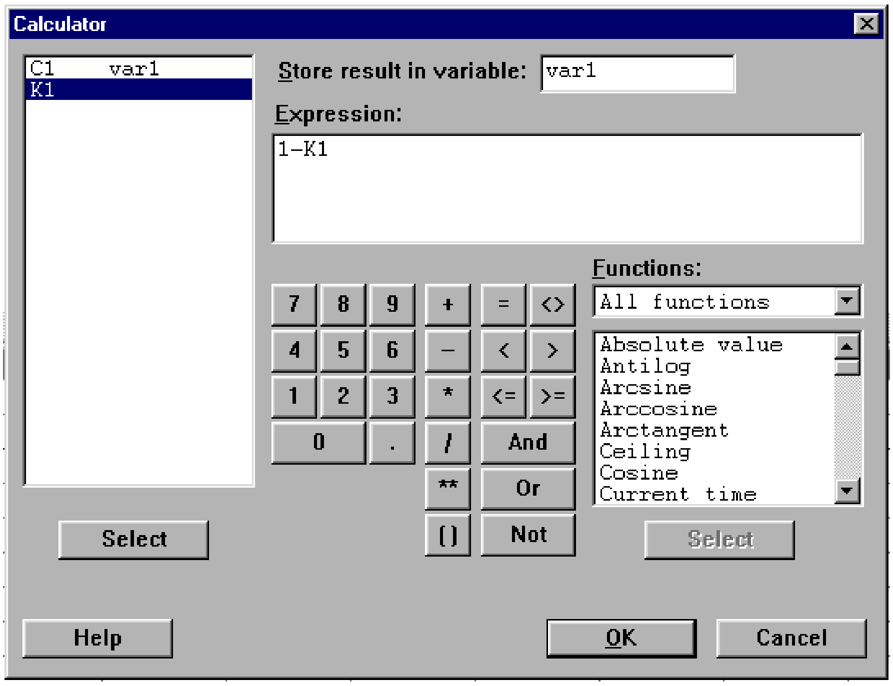


Figure 7

10. Click **OK**. The result will appear in the cell below **var1**, as seen in Figure 8.

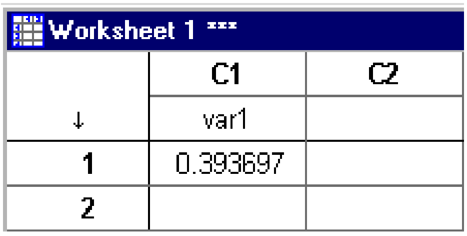


Figure 8

Calculating Normal Probabilities

Lower Tail Probabilities: pr($X \leq x$)

Example:
Find pr($X \leq 4$) where X~Normal(2, 1)

1. From the menu bar choose **Calc** → **Probability Distributions** → **Normal**.

2. The **Normal Distribution** dialog box appears. The circle next to **Cumulative probability** must be marked. The **Mean** is **2** and the **Standard Deviation** is **1**. The **Input constant** is **4**.

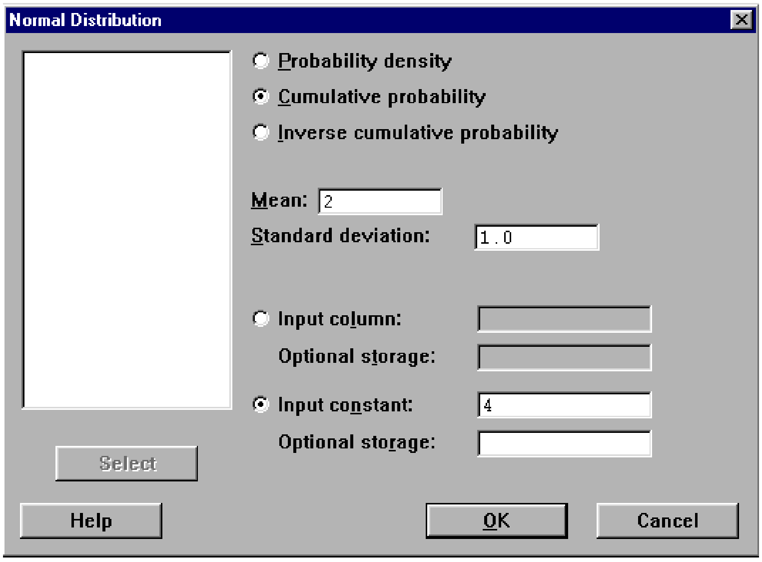


Figure 1

3. Click **OK**. The result will be in the **Session** window shown below in Figure 2.

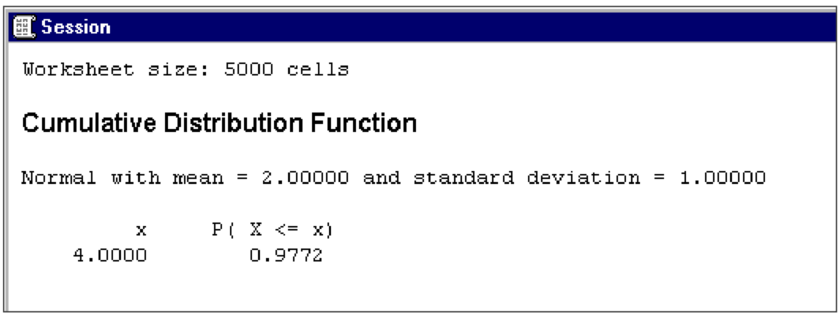


Figure 2

4. The desired result is 0.9772

Upper Tail Probabilities: pr($X \geq x$)

Example:
Find pr($X \geq 3$) where X~Normal(2, 1)

1. From the menu bar choose **Calc** Ł **Probability Distributions** Ł **Normal**.

2. A dialog box like the one below will appear. Mark the circle next to **Cumulative probability**. The **Mean** is **2** and the **Standard deviation** is **1**. The **Input constant** is **3** and the **Optional storage** is **K1**.

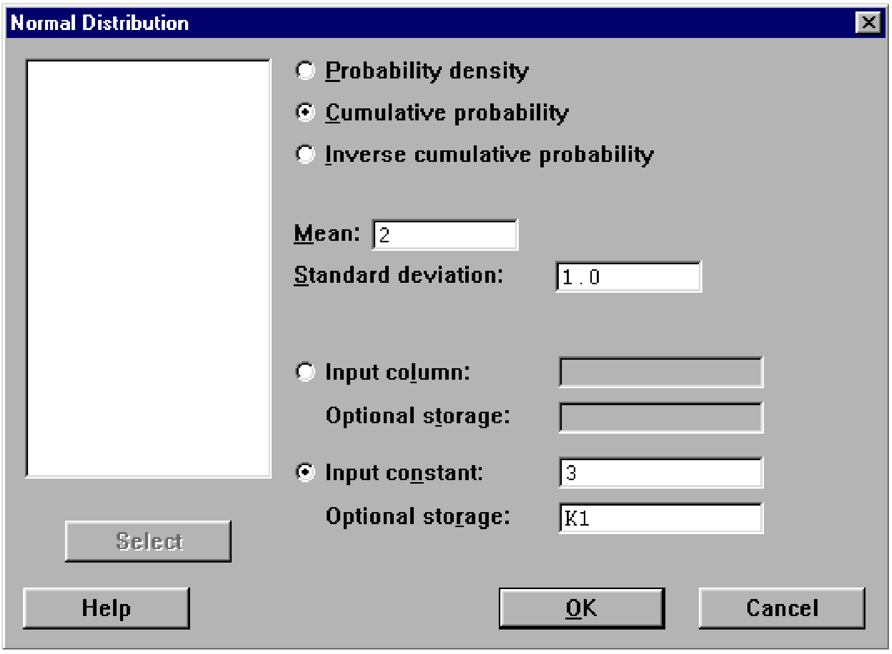


Figure 3

3. Type **result** in the cell just below **C1** as in Figure 4.

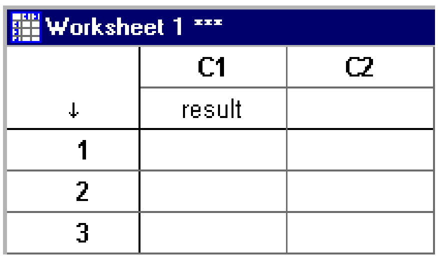


Figure 4

4. Click **OK**. Then on the menu bar click **Calc** Ł **Calculator**. Click in the **Store result in variable** box, then select **C1 result** in the big box next to it, and then click the **Select** button. Click in the **Expression** box and type **1–** then select **K1** and click the **Select** button. The dialog should then look like Figure 5.

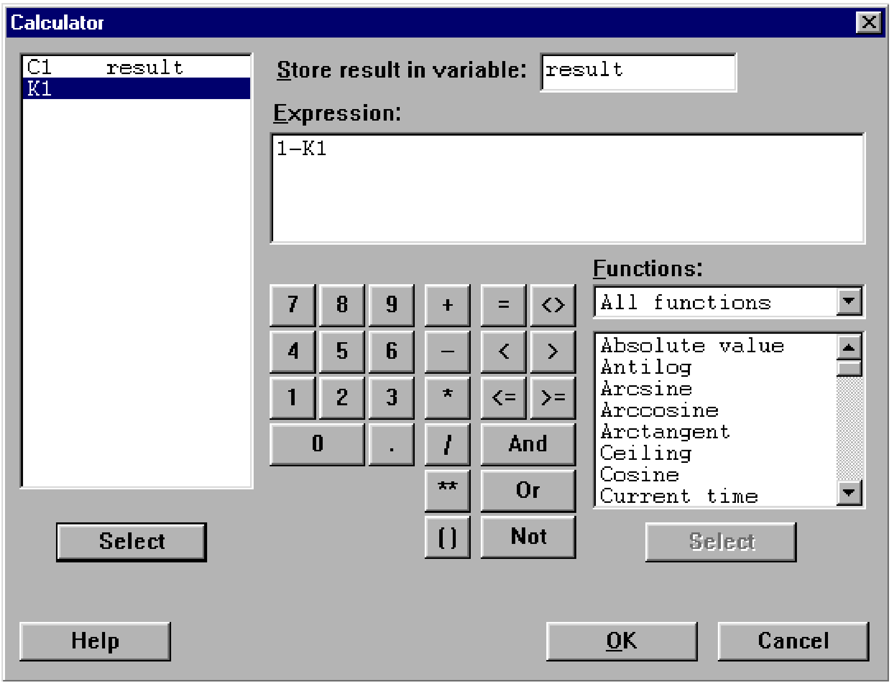


Figure 5

5. Click **OK**. The answer will be displayed in the first column. See Figure 6.

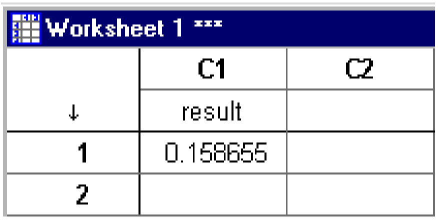


Figure 6

pr($a \le X \le b$)

Example:
Find pr($1 \le X \le 3$) where X~Normal(2, 1).

Note: pr($1 \le X \le 3$) = pr($X \le 3$) — pr($X \le 1$)

1. Find pr($X \leq 1$), in the same manner as in that described above, and make the **Optional storage K1**. Find pr($X \leq 3$) but in this case make the **Optional storage K2**.

2. As shown above, name a column **result** and the click on the menu bar **Calc** Ł **Calculator**.

3. The **Calculator** window will pop up. Click in the **Store result in variable** box, then select **C1 result** in the big box and then click the **Select** button. Click in the **Expression** box, then select **K2** in the big box and click the **Select** button. Type – then select **K1** in the big box click the **Select** button. The dialog box should look like Figure 7.

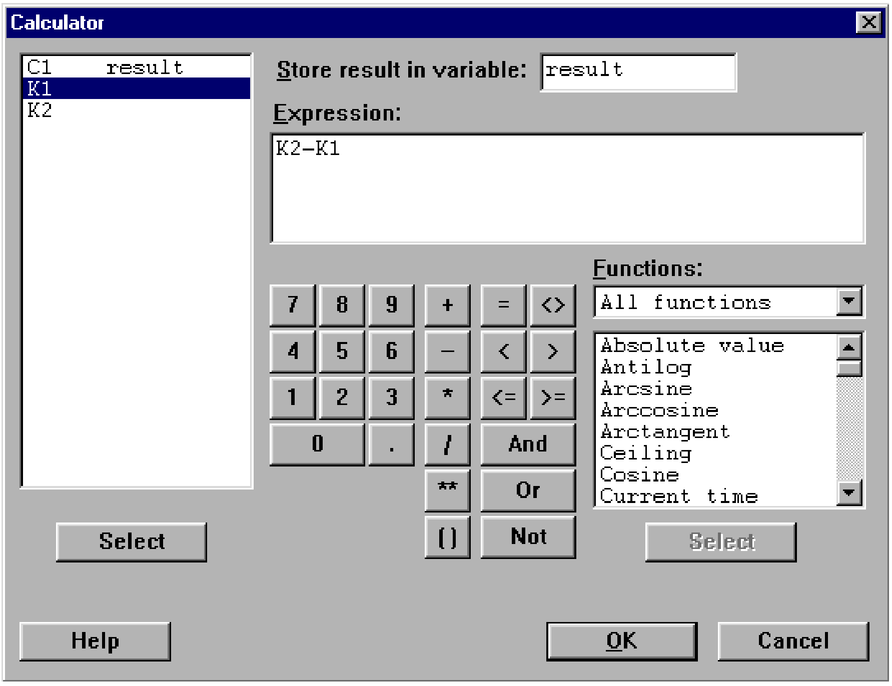
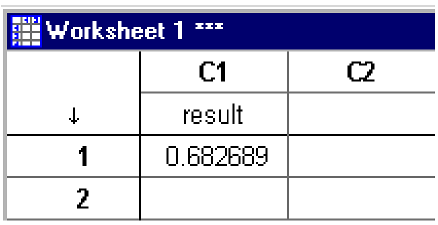


Figure 7

4. Click **OK**. The answer is shown in the cell below the column name **result**. See Figure 8.



	C1	C2
↓	result	
1	0.682689	
2		

Figure 8

Calculating the Inverse of the Normal Distribution

Example:
Find x such that pr($X \le x$) = 0.25 where X~Normal(2, 1).

1. From the menu bar choose **Calc** Ł **Probability Distributions** Ł **Normal**.

2. The **Normal Distribution** dialog box pops up. Ensure that the circle next to **Inverse cumulative probability** is marked. The **Mean** is **2** and the **Standard deviation** is **1**. The **Input constant** is **0.25**.

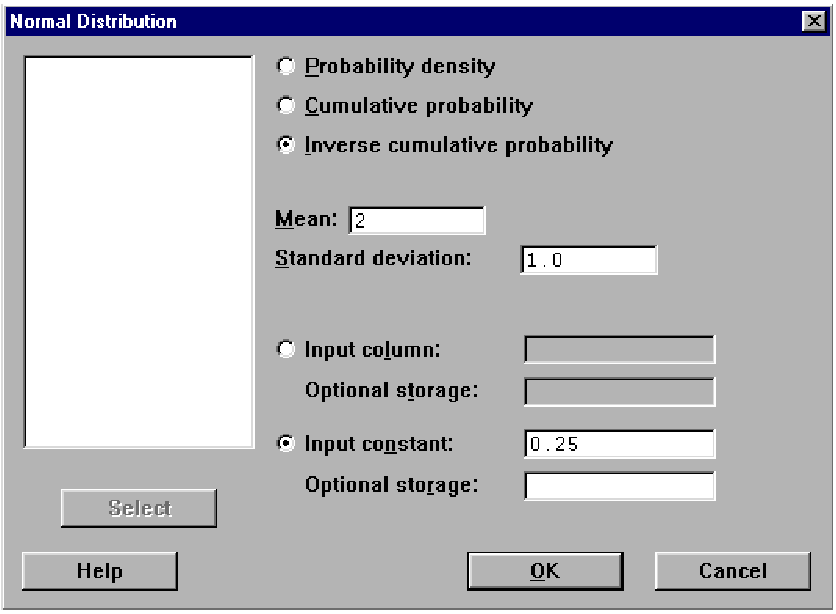


Figure 9

3. Click **OK**. The answer is displayed in the **Session** window. See Figure 10.

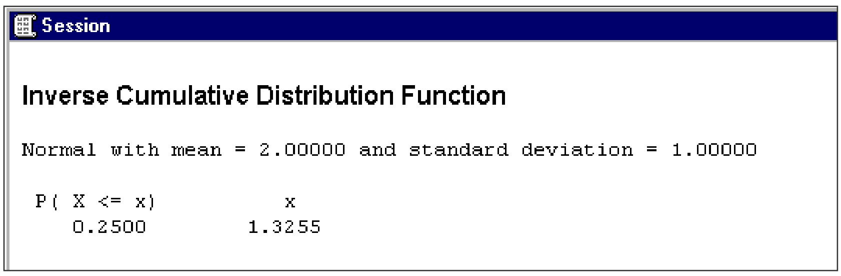


Figure 10

4. The required answer is 1.3255.

Note: If the x is required for pr($X \ge x$) = 0.25 then use (1 - 0.25) or 0.75.

Generating Random Samples

Example:

Generate a random sample of 20 values from X~Binomial(8, 0.6)

1. Enter the name **binomial sample** in the cell below **C1** as shown in Figure 1.

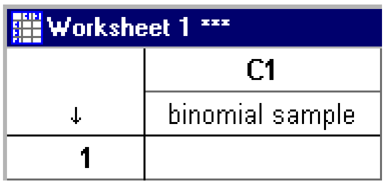


Figure 1

2. From the menu bar choose **Calc** Ł **Random Data** Ł **Binomial**. A dialog box appears. A sample of 20 values is needed, so therefore generate **20** rows of data. Click in the **Store in column(s)** box the select **C1 binomial sample** in the big box, and then click the **Select** button. The **Number of trials** is **8** and the **Probability of success** is **0.6**

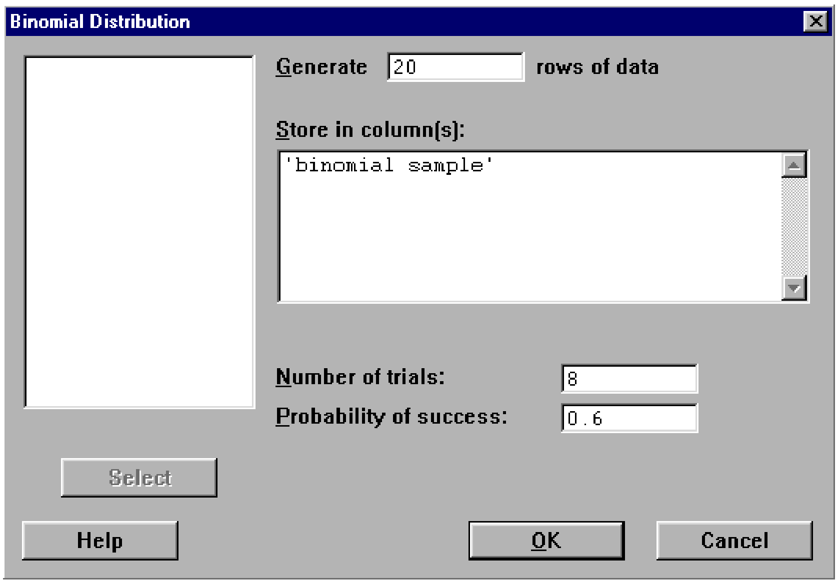


Figure 2

3. Click **OK**.

4. To obtain a random sample of 20 values from *X*~Poisson(2). Choose from the menu bar **Calc** → **Random Data** → **Poisson**, and fill in the dialog box as in Figure 3.

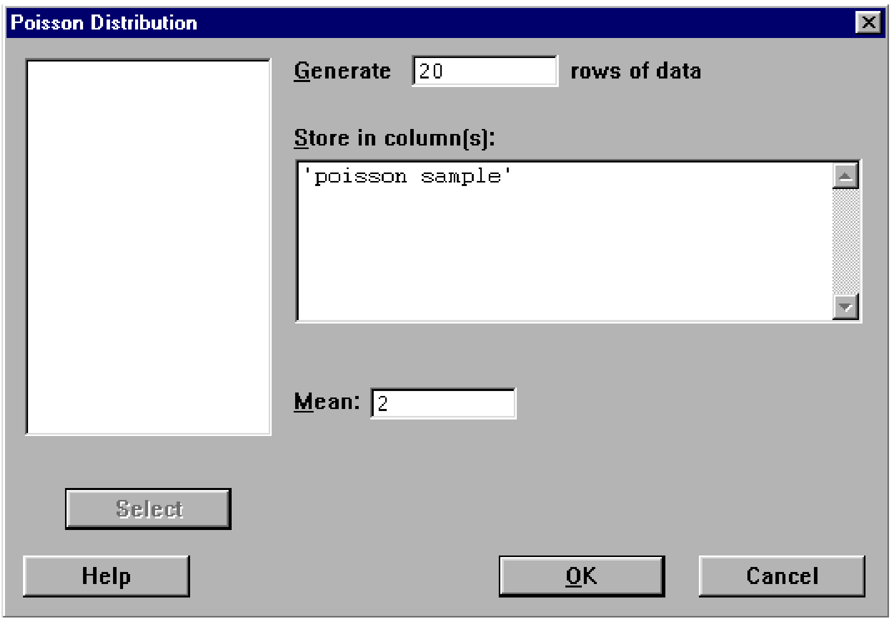


Figure 3

5. To obtain a random sample of 20 values from *X*~Normal(0, 1) i.e. Standard Normal. Choose from the menu bar **Calc** → **Random Data** → **Normal**, and fill in the dialog box as in Figure 4.

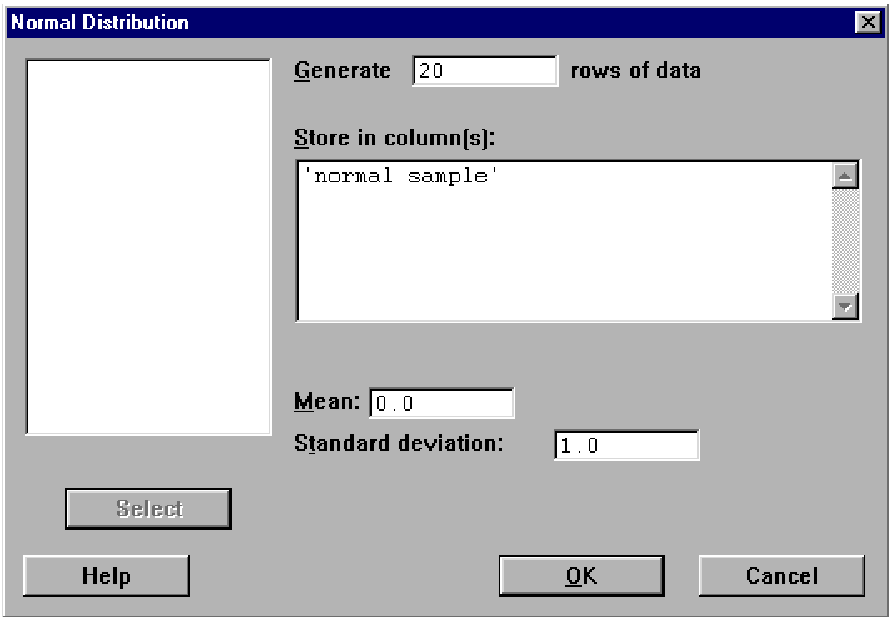


Figure 4

Calculating Student's *t*-Probabilities

Lower Tail Probabilities: pr($T \le t$)

Example:
Find pr($T \le 4$) where T~Student(33)

5. From the menu bar choose **Calc** → **Probability Distributions** → **t**.

6. The **t-Distribution** dialog box appears. The circle next to **Cumulative probability** must be marked. The **Degrees of freedom** is **33**. The **Input constant** is **4**.

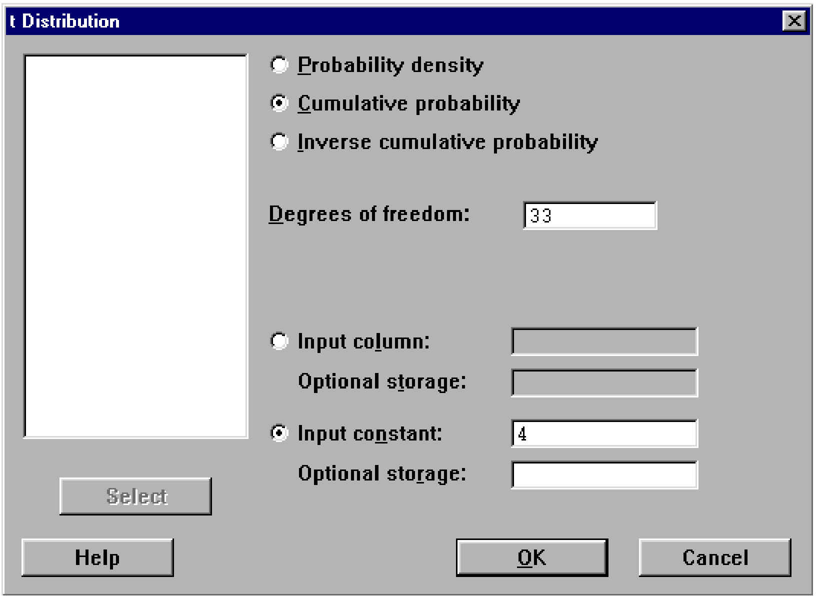


Figure 1

7. Click **OK**. The result will be in the **Session** window shown below in Figure 2.

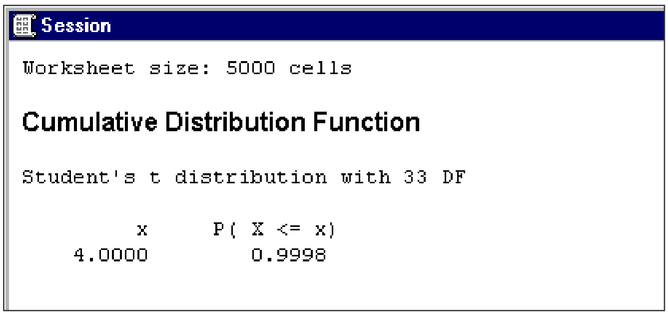


Figure 2

8. The desired result is 0.9998

Upper Tail Probabilities: pr($T \geq t$)

Example:
Find pr($T \geq 2$) where T~Stutent(33)

3. From the menu bar choose **Calc** → **Probability Distributions** → **t**.

4. A dialog box like the one below will appear. Mark the circle next to **Cumulative probability**. The **Degrees of freedom** is **33**. The **Input constant** is **2** and the **Optional storage** is **K1**.

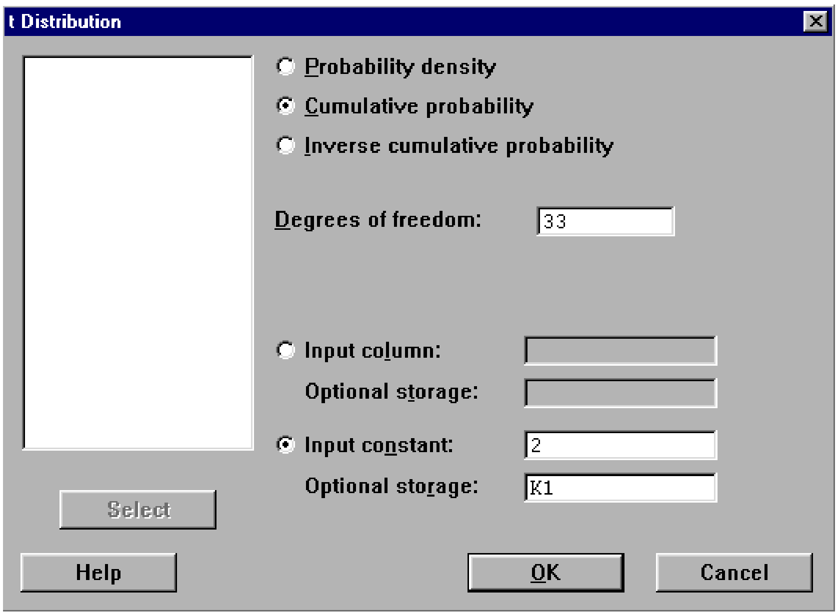


Figure 3

4. Type **result** in the cell just below **C1** as in Figure 4.

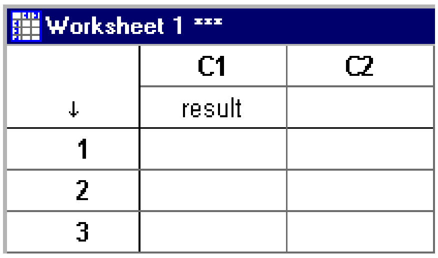


Figure 4

6. Click **OK**. Then on the menu bar click **Calc** Ł **Calculator**. Click in the **Store result in variable** box, then select **C1 result** in the big box next to it, and then click the **Select** button. Click in the **Expression** box and type **1–** then select **K1** and click the **Select** button. The dialog should then look like Figure 5.

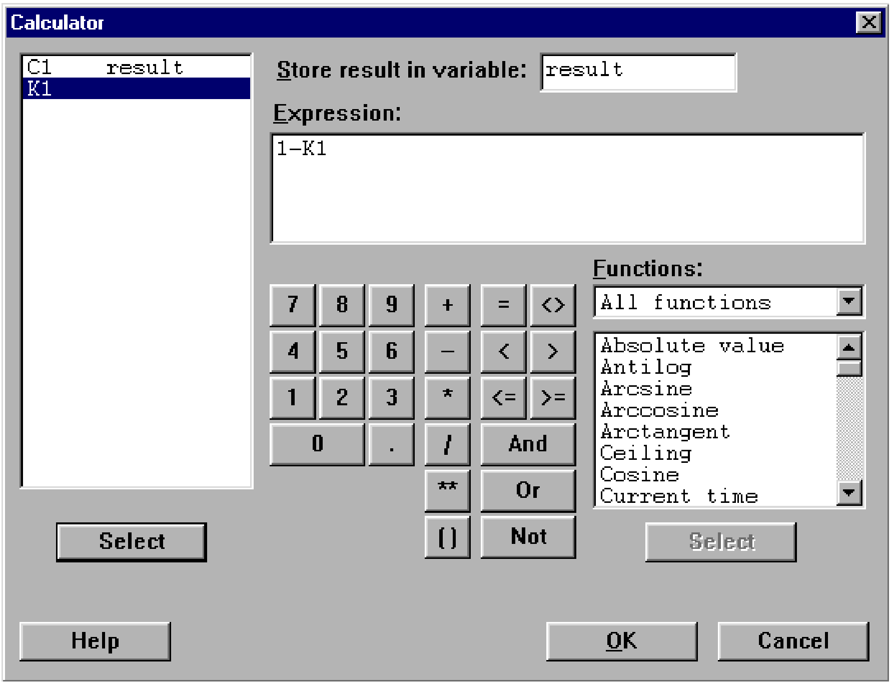


Figure 5

7. Click **OK**. The answer will be displayed in the first column. See Figure 6.

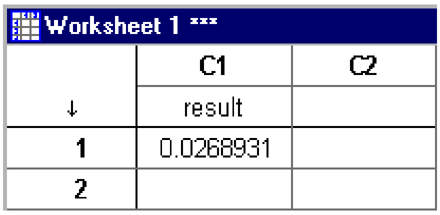


Figure 6

pr($a \le T \le b$)

Example:
Find pr($0 \le T \le 1$) where T~Student(33).

Note: pr($0 \le T \le 1$) = pr($T \le 1$) — pr($T \le 0$)

4. Find pr($T \leq 0$), in the same manner as in that described above, and make the **Optional storage K1**. Find pr($T \leq 1$) but in this case make the **Optional storage K2**.

5. As shown above, name a column **result** and the click on the menu bar **Calc** ⱡ **Calculator**.

6. The **Calculator** window will pop up. Click in the **Store result in variable** box, then select **C1 result** in the big box and then click the **Select** button. Click in the **Expression** box, then select **K2** in the big box and click the **Select** button. Type – then select **K1** in the big box click the **Select** button. The dialog box should look like Figure 7.

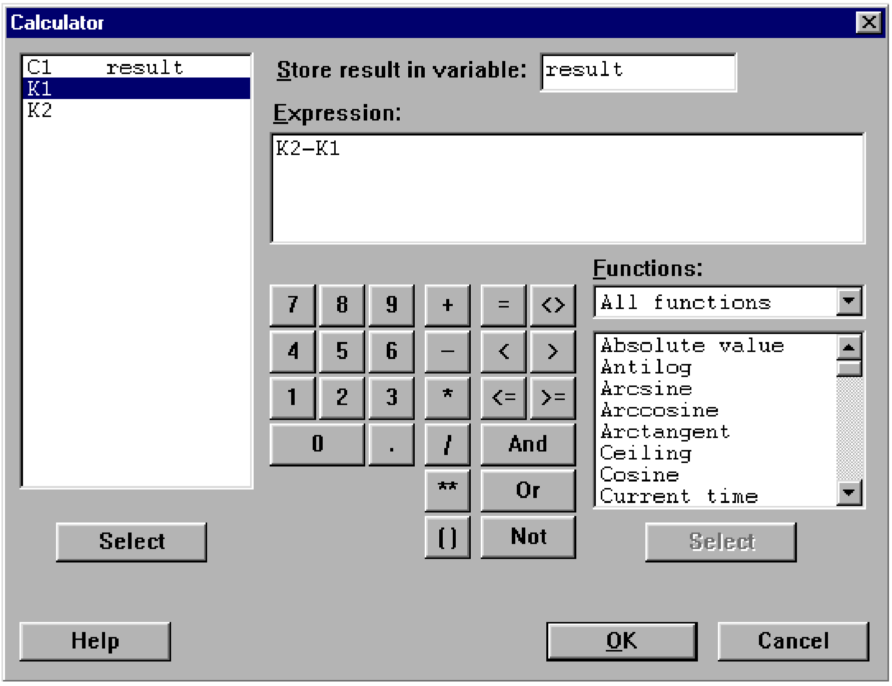


Figure 7

5. The answer is shown in the cell below the column name **result**. See Figure 8.

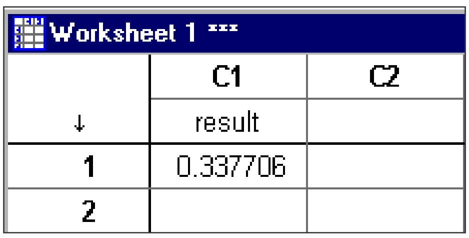


Figure 8

Calculating the Inverse of the Student *t*-Distribution

Example:
Find t such that pr($T \le t$) = 0.25 where T~Student(33).

4. From the menu bar choose **Calc** Ł **Probability Distributions** Ł **t**.

5. The **t Distribution** dialog box pops up. Ensure that the circle next to **Inverse cumulative probability** is marked. The **Degrees of fredom** is **33**. The **Input constant** is **0.25**.

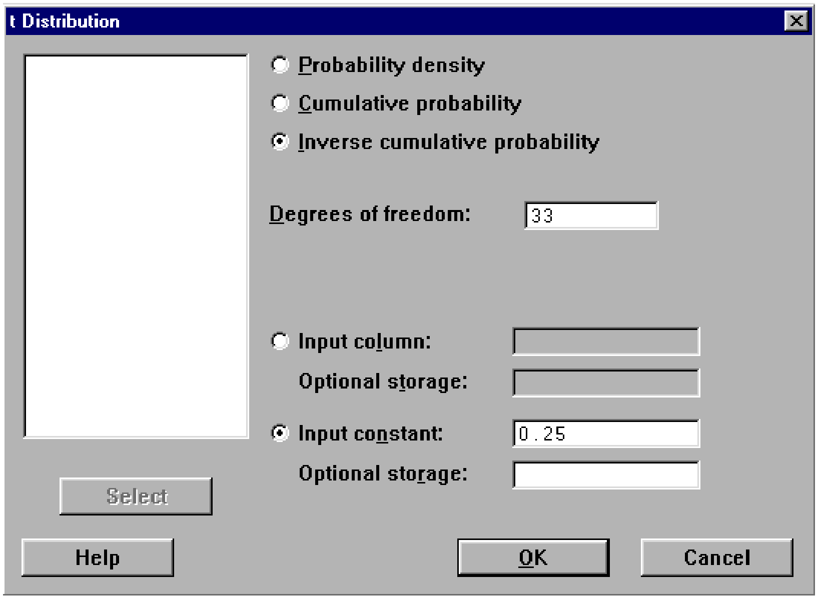


Figure 9

6. Click **OK**. The answer is displayed in the **Session** window. See Figure 10.

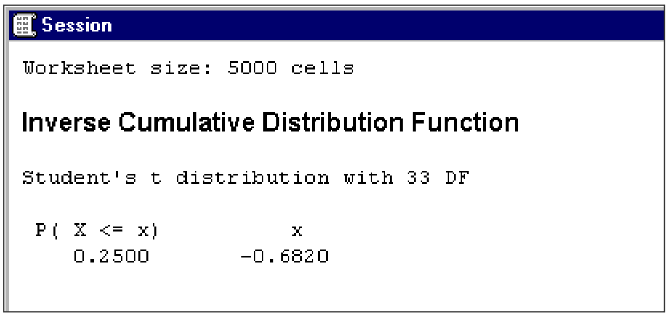


Figure 10

4. The answer needed is —0.6820.

Note: If the x is required for pr($T \ge t$) = 0.25 then use (1 - 0.25) or 0.75.

t-Test of a Mean

Example:

Perform a *t*-test on the Nitrate Ion Concentration Data to determine whether the concentration has changed from 0.492. (Refer to Example 10.1.1 in your textbook.)

1. Enter the data into MINITAB, as shown in Figure 1.

Worksheet 1 ***

↓	C1 concentration
1	0.513
2	0.524
3	0.529
4	0.481
5	0.492
6	0.499
7	0.518
8	0.490
9	0.494
10	0.501

Figure 1

2. From the menu bar choose **Stat** → **Basic Statistics** → **1-Sample t**. In the big box select **C1 concentration**, then click the **Select** button. Mark the circle next to **Test mean,** which is **0.492**.

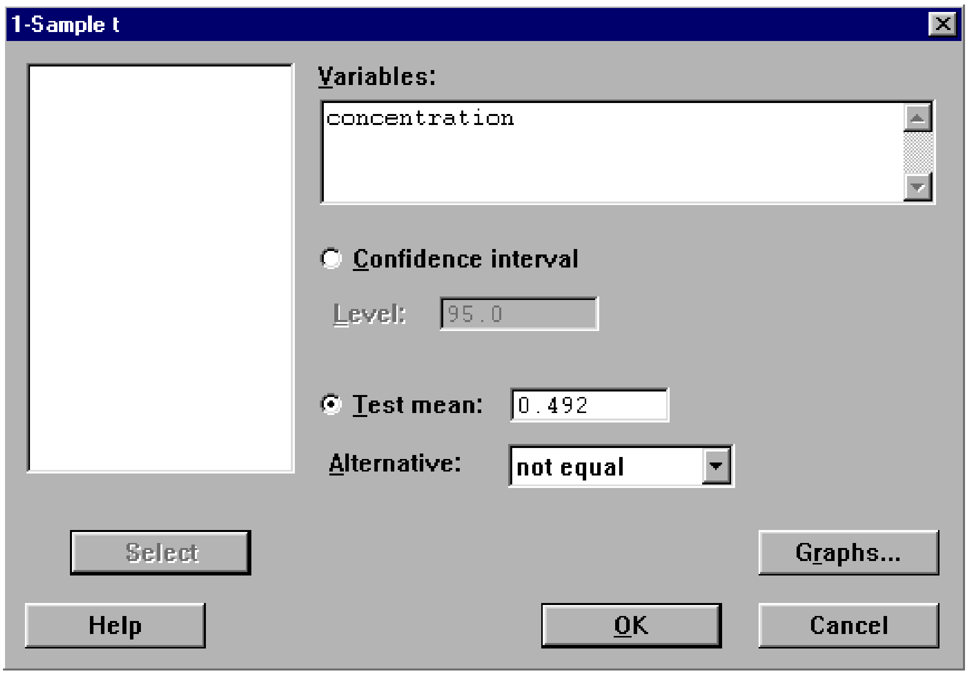


Figure 2

3. Click **OK**. The results from the *t*-test appear in the **Session** window, which is shown in Figure 3 below.

```
Session

Worksheet size: 5000 cells

T-Test of the Mean


Test of mu = 0.49200 vs mu not = 0.49200

Variable     N      Mean    StDev   SE Mean        T          P
concentr    10   0.50410  0.01600   0.00506     2.39      0.040
```

Figure 3

4. The *P*-value is 0.04.

t-Test of Means for Two Independent Samples

Example:

Perform a *t*-test on the Urinary Androsterone Data. (Refer to Example 10.2.1 in your textbook.)

1. Enter the data into MINITAB. The first few rows will look like Figure 1 below.

Worksheet 1 ***

	C1	C2
↓	homosexual	heterosexual
1	2.5	3.9
2	1.6	4.0
3	3.9	3.8
4	3.4	3.9
5	2.3	2.9
6	1.6	3.2
7	2.5	4.6

Figure 1

2. On the menu bar click **Stat** → **Basic Statistics** → **2-Sample t**. The **2-Sample t** window pops up. Mark the circle next to **Samples in different columns**. Click in the **First** box. Select **C1 homosexual** in the big box and click the **Select** button. Click in the **Second** box and do the same steps that were done for the **First** box, but select **C2 heterosexual** instead. The **Alternative** is **not equal**.

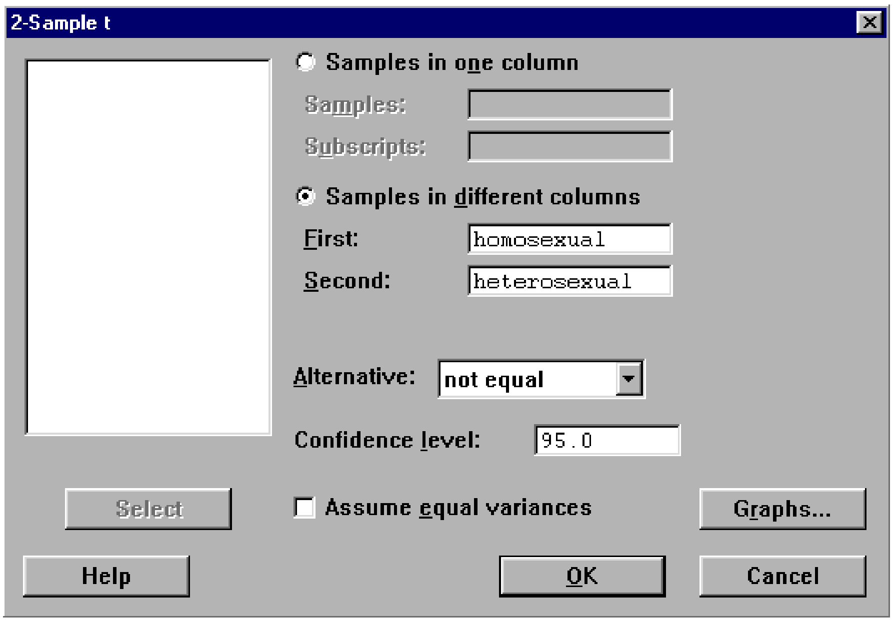


Figure 2

3. Click **OK**. The answer, shown below in Figure 3, is outputted to the Session window.

```
Session
Worksheet size: 5000 cells

Two Sample T-Test and Confidence Interval


Two sample T for homosexual vs heterosexual

            N      Mean     StDev   SE Mean
homosexu   15     2.500     0.923      0.24
heterose   11     3.518     0.721      0.22

95% CI for mu homosexu - mu heterose: ( -1.69,  -0.35)
T-Test mu homosexu = mu heterose (vs not =): T = -3.16  P = 0.0044  DF = 23
```

Figure 3

4. The *P*-value is 0.0044.

Nonparametric Test for Two Independent Samples

Example:

Perform the Mann-Whitney test on the Urinary Androsterone Data. (Refer to Example 10.2.1 in your textbook.)

1. Enter the data into MINITAB. The first few rows are shown in Figure 1.

androsterone.MTW ***

	C1	C2
↓	homosexual	heterosexual
1	2.5	3.9
2	1.6	4.0
3	3.9	3.8
4	3.4	3.9
5	2.3	2.9
6	1.6	3.2
7	2.5	4.6

Figure 1

2. On the menu bar click **Stat** → **Nonparametrics** → **Mann-Whitney**. Click in the **First sample** box, then select **C1 homosexual** in the big box. Then click the **Select** Button. Do the same for the **Second sample** box, but choose **C2 heterosexual** instead. The **Alternative** is **not equal**.

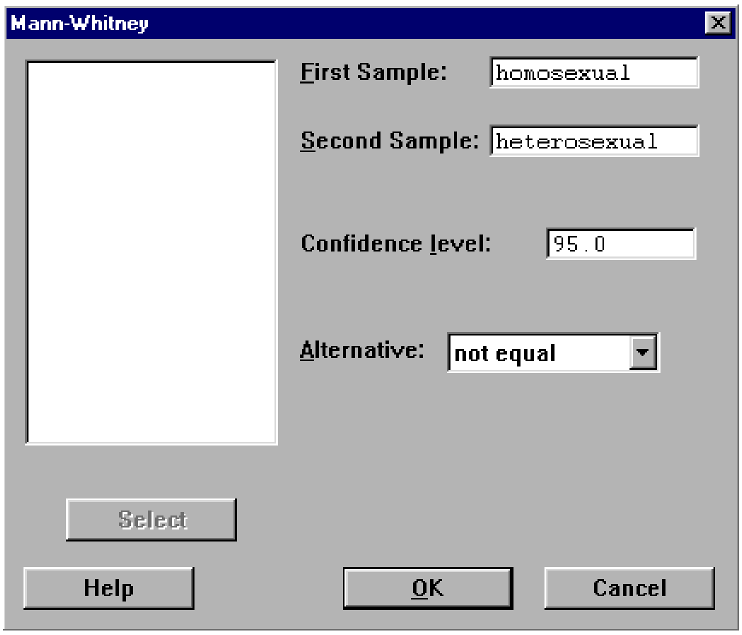


Figure 2

3. Click **OK**. The results of the Mann-Whitney test are displayed in the **Session** window seen below in Figure 3.

```
Session

Mann-Whitney Confidence Interval and Test

homosexu   N =  15     Median =       2.300
heterose   N =  11     Median =       3.800
Point estimate for ETA1-ETA2 is      -1.100
95.1 Percent CI for ETA1-ETA2 is (-1.800,-0.400)
W = 152.5
Test of ETA1 = ETA2  vs  ETA1 not = ETA2 is significant at 0.0102
The test is significant at 0.0100 (adjusted for ties)
```

Figure 3

4. The *P*-value is 0.01.

t-Test of Means for Paired Data

Example:

Do a *t*-test on the Air Force Head Size Data. (Refer to Example 10.1.3 in your textbook.)

1. Enter the data into MINITAB. The first few rows are shown below in Figure 1.

Worksheet 1 ***

	C1	C2
↓	cardboard	metal
1	146	145
2	151	153
3	163	161
4	152	151
5	151	145
6	151	150
7	149	150

Figure 1

2. On the menu bar click **Stat** Ł **Basic Statistics** Ł **Paired t**. Click in the **First sample** box, then select **C1 cardboard** in the big box, and then click the **Select** button. Do the same for the **Second sample**, but select **C2 metal** instead.

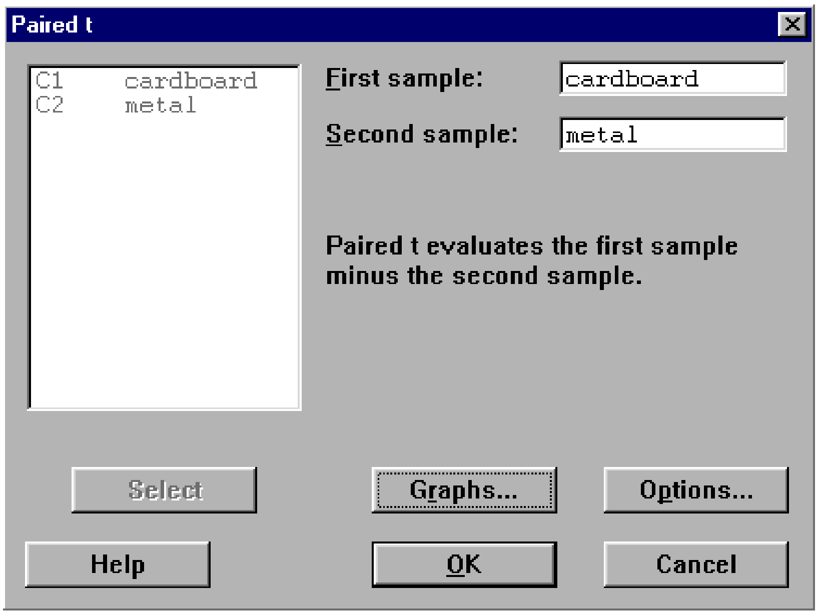


Figure 2

3. Click **OK**. The result is shown in the **Session** window, which can be seen in Figure 3.

Session

Paired T-Test and Confidence Interval

```
Paired T for cardboard - metal

                  N      Mean     StDev   SE Mean
cardboar         18    154.56      5.82      1.37
metal            18    152.94      5.54      1.30
Difference       18     1.611     2.146     0.506

95% CI for mean difference: (0.544, 2.678)
T-Test of mean difference = 0 (vs not = 0): T-Value = 3.19  P-Value = 0.005
```

Figure 3

4. The *P*-value is 0.005

Nonparametric Tests of One Sample

Example:

Use the Air force Head Size Data. (Refer to Example10.1.3 in your textbook.)

Sign Test

1. Enter the data into MINITAB. The first few rows are shown in Figure 1 below.

headsize.MTW ***

	C1	C2
↓	cardboard	metal
1	146	145
2	151	153
3	163	161
4	152	151
5	151	145
6	151	150
7	149	150

Figure 1

2. On the menu bar click **Calc → Calculator**. Click in the **Store result in variable** box and select **C3 difference** in the big box then click the **Select** button. Click in the **Expression** box. In the big box select **C1 cardboard**, then click the **Select** button, and then the **minus** button. Again in the big box select **C2 metal**, then Click the **Select** button. Click **OK**.

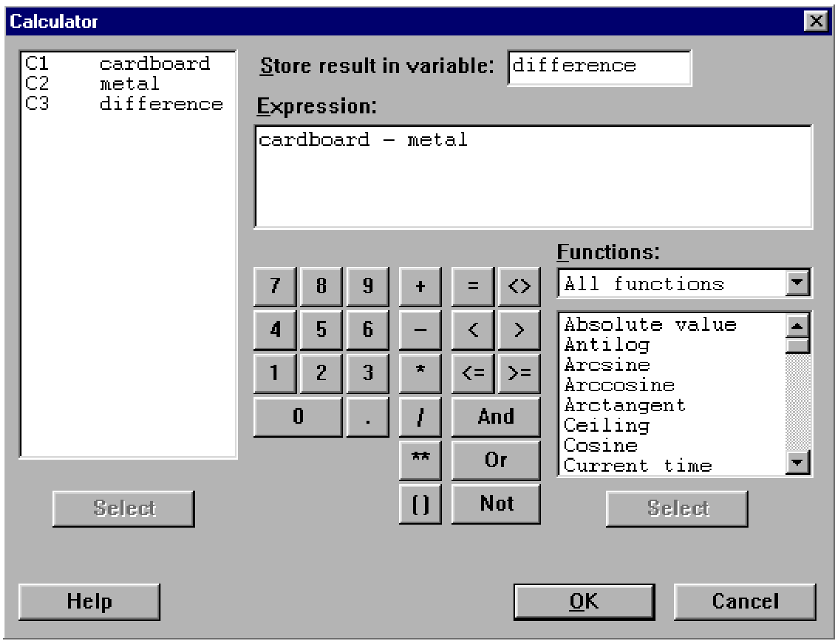


Figure 2

3. From the menu bar choose **Stat Ł Nonparametrics Ł 1-Sample Sign**. Click in the **Variables** box. Then select **C3 difference** in the big box, and then Click the **Select** button. Ensure that the circle next to **Test median** is marked. The **Test median** is **0** and the **Alternative** is **not equal**.

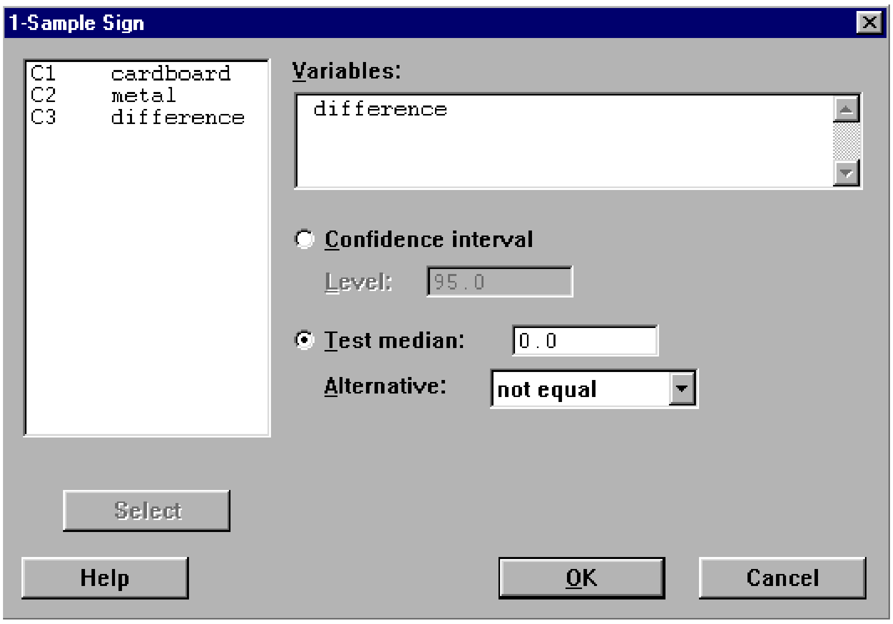


Figure 3

4. Click **OK**. The results are printed out in the **Session** window as seen below

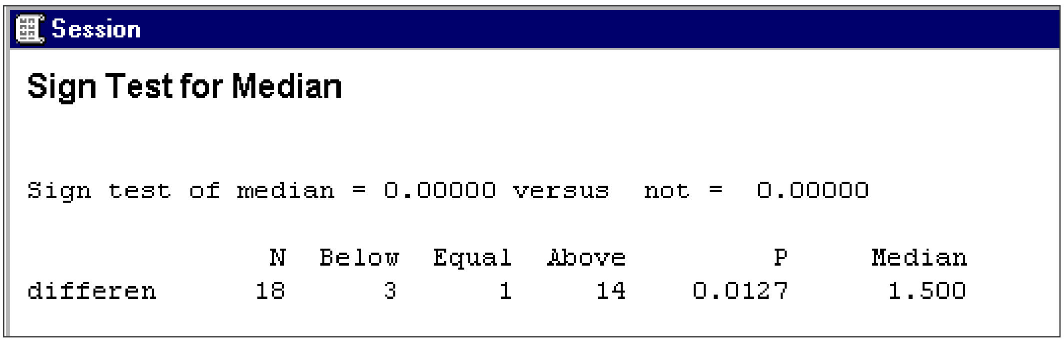


Figure 4

5. The *P*-value is 0.0127.

Wilcoxon Signed-Rank Test

1. Repeat Steps 1 and 2 above for the same data.

2. From the menu bar choose **Stat** Ł **Nonparametrics** Ł **1-Sample Wilcoxon**. Click in the **Variables** box, then select **C3 difference** in the big box, and then click the **Select** button. Ensure that the circle next to **Test median** is marked. The **Test median** is **0** and the **Alternative** is **not equal**.

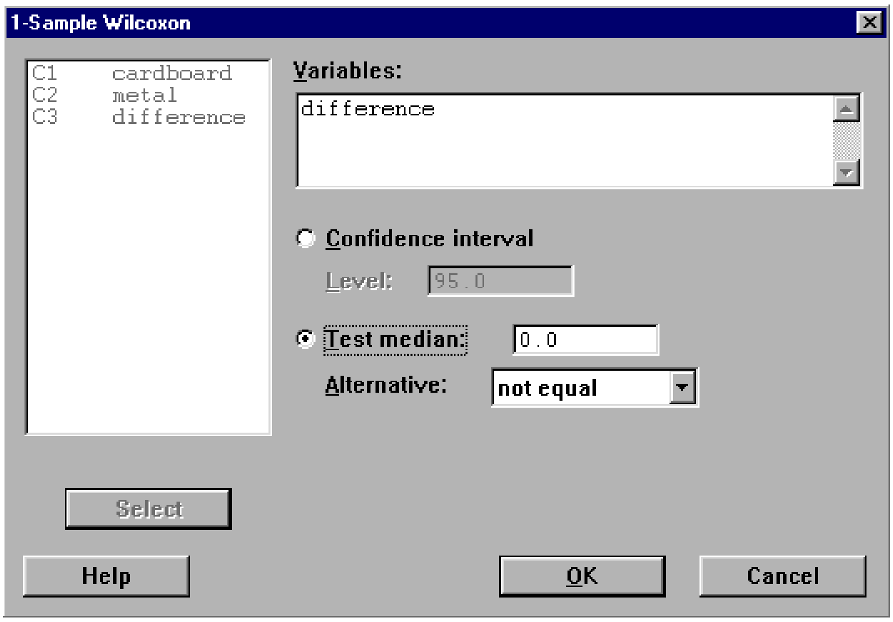
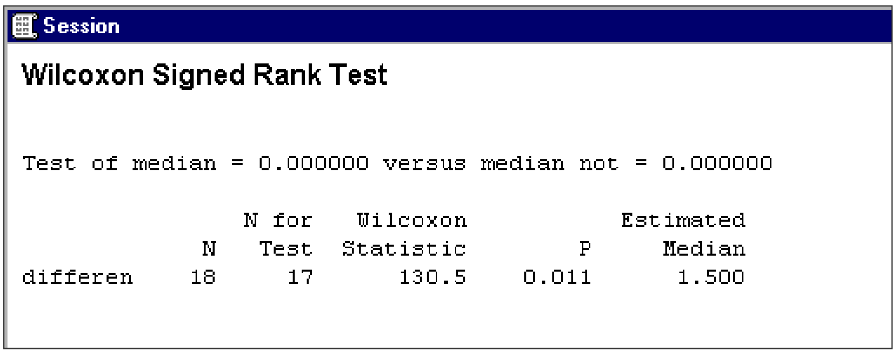


Figure 5

3. Click **OK**. The results are outputted to the **Session** window, which is shown below.



Session

Wilcoxon Signed Rank Test

```
Test of median = 0.000000 versus median not = 0.000000

                 N for   Wilcoxon            Estimated
             N   Test   Statistic       P       Median
differen    18     17       130.5   0.011        1.500
```

Figure 6

4. The *P*-value is 0.011.

One-Way ANOVA Ñ *F*-Test

Example:
Perform an *F*-test on the Reading Methods Data. (Refer to Example 10.3.1 in your textbook.)

1. Enter the data into MINITAB. Shown in Figure 1 are the first few rows.

Worksheet 3 ***

↓	C1 both	C2 maponly	C3 scanonly	C4 neither
1	0.1	1.0	1.0	-0.3
2	3.2	-0.5	3.3	-1.3
3	4.3	1.0	1.4	1.6
4	-0.5	0.6	-0.9	-0.4
5	1.9	0.6	1.0	-0.7
6	3.3	1.0	0.0	0.6
7	2.5	1.0	0.6	-1.8

Figure 1

2. On the menu bar click on **Stat** Ł **ANOVA** Ł **One-way (Unstacked)**. The **One-way Analysis of Variance** dialog box pops up. The option **One-way (Unstacked)** was chosen because the responses are in separate columns. Click in the **Responses (in separate columns)** box, then select in the big box, **C1 both**. Then click the **Select** button. Repeat this for the other three variables. The dialog box should then look like Figure 2 below.

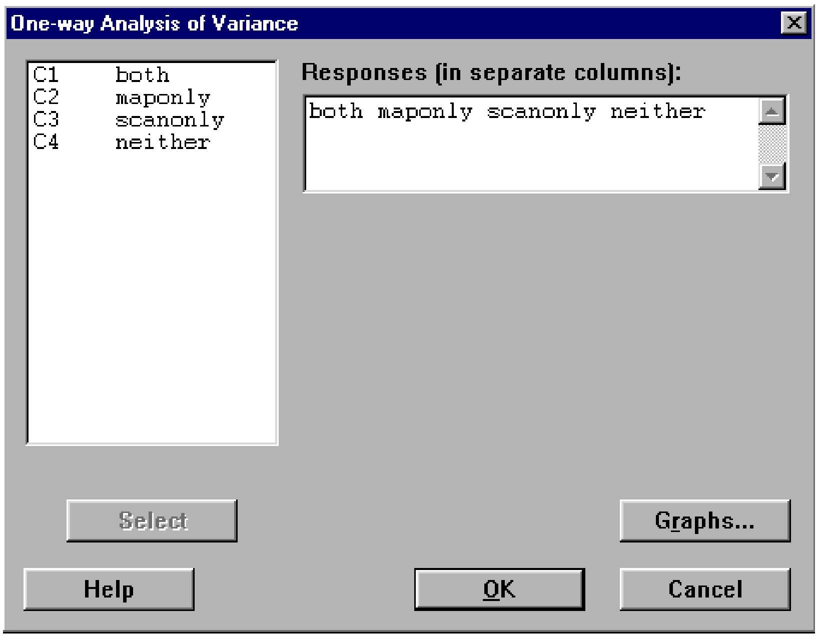


Figure 2

3. Click **OK**. In the **Session** window the answer will appear. See Figure 3.

Session

One-way Analysis of Variance

```
Analysis of Variance
Source     DF        SS        MS        F        P
Factor      3     27.06      9.02     4.45    0.008
Error      46     93.35      2.03
Total      49    120.41
                                   Individual 95% CIs For Mean
                                   Based on Pooled StDev
Level       N      Mean     StDev  ------+---------+---------+---------+
both       22     1.459     1.544                        (------*-----)
maponly    12     1.233     1.441                    (-------*--------)
scanonly    7     0.914     1.302              (----------*----------)
neither     9    -0.556     1.135   (--------*---------)
                                   ------+---------+---------+---------+
Pooled StDev =    1.425               -1.0       0.0       1.0       2.0
```

Figure 3

4. The P-value is 0.008.

Nonparametric One-Way ANOVA Ñ Kruskal-Wallis Test

Example:
Perform a Kruskal-Wallis test on the Reading Methods Data. (Refer to Example 10.3.1 in your textbook.)

1. Enter the information into MINITAB, as shown in Figure 1. Only a few of the rows are shown here.

reading.MTW ***

	C1	C2-T
↓	values	factor
33	3.1	maponly
34	2.6	maponly
35	1.0	scanonly
36	3.3	scanonly
37	1.4	scanonly
38	-0.9	scanonly
39	1.0	scanonly
40	0.0	scanonly
41	0.6	scanonly
42	-0.3	neither
43	-1.3	neither

Figure 1

2. From the menu bar choose **Stat** Ł **Nonparametric** Ł **Kruskal-Wallis**. A dialog box appears. Click in the **Response** box, and the select **C1 values** in the big box. Click the **Select** button. Do the same for the **Factor** box, but select **C2 factor** instead.

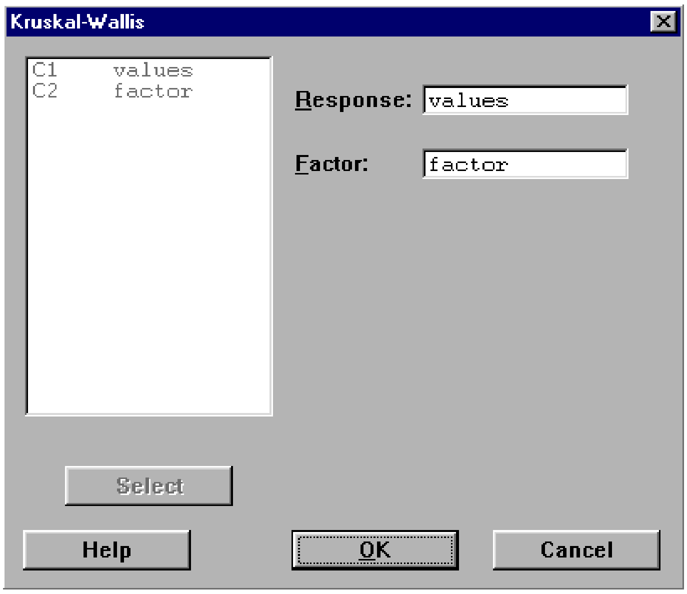


Figure 2

3. Click **OK**. In the Session window, shown in Figure 3, will be displayed the results

Session

Kruskal-Wallis Test

```
Kruskal-Wallis Test on values

factor      N    Median    Ave Rank        Z
both       22    1.6000        29.8     1.84
maponly    12    1.0000        28.2     0.75
neither     9   -0.7000        11.6    -3.16
scanonly    7    1.0000        25.2    -0.06
Overall    50                  25.5

H = 10.49  DF = 3  P = 0.015
H = 10.52  DF = 3  P = 0.015 (adjusted for ties)
```

Figure 3

4. The P-value is 0.015.

Test of One Proportion

Example:

Test to see if the proportion is 0.2 for the ESP example. (Refer to Example 9.3.1 in your textbook.)

1. From the menu bar choose **Stat** Ł **Basic Statistics** Ł **1 Proportion**. The **1 Proportion** dialog box appears. Mark the circle next to **Summarized data**. The **Number of trials** is **60000**, and the **Number of successes** is **12489**.The window should then look like Figure 1.

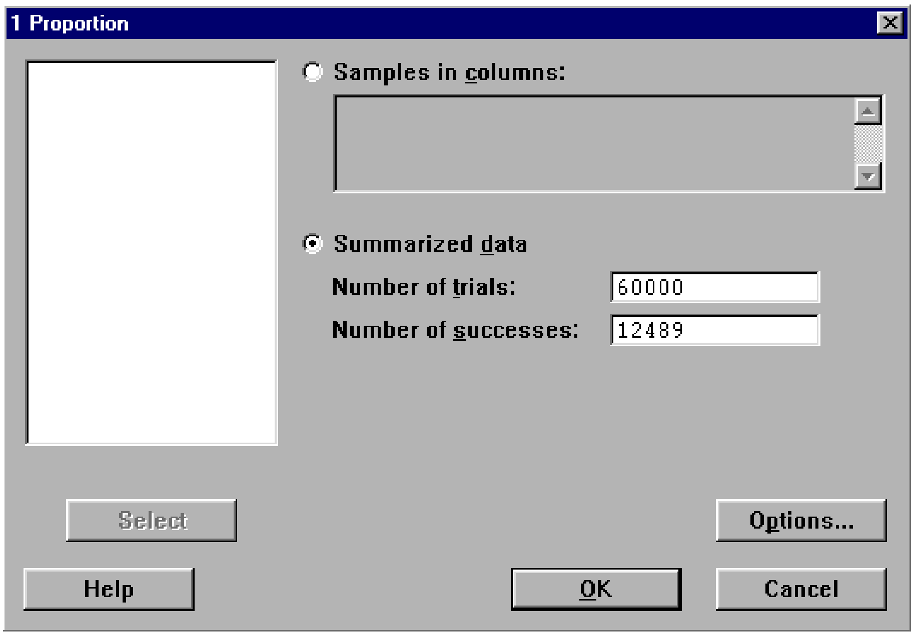


Figure 1

2. Click the **Options** button. Another window appears. The **Test proportion** is **0.2** and the **Alternative** is **greater than**. Mark the box next to **Use test and interval based on normal distribution**. Click **OK**. Refer to Figure 2.

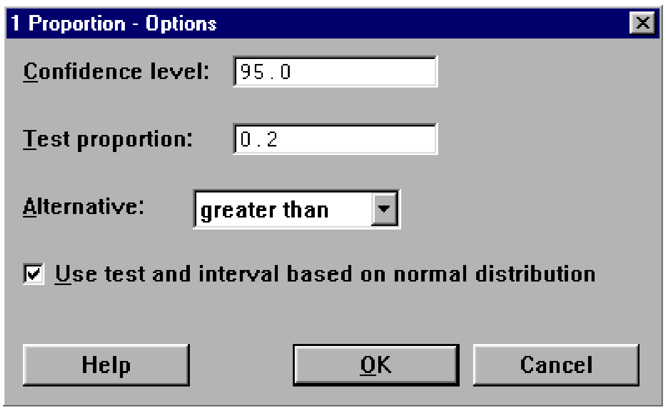


Figure 2

3. Click **OK** again. The results are outputted in the **Session** window. See Figure 3.

```
Session
Test and Confidence Interval for One Proportion

Test of p = 0.2 vs p > 0.2

Sample       X      N  Sample p        95.0 % CI          Z-Value  P-Value
1        12489  60000  0.208150  (0.204902, 0.211398)       4.99    0.000
```

Figure 3

4. The *P*-value is 0.000.

Test of Difference of Proportions from Two Independent Samples.

Example:
Carry out a test to determine if there is a difference in the proportions for the Playback Speed Data. (Refer to Example 9.3.4 in your textbook.)

1. Choose from the menu bar **Stat** → **Basic Statistics** → **2 Proportions**. Mark the circle next to **Summarized Data**. For the **First sample** the **Trials** are **74** and the **Successes** are **32**. For the **Second sample** the **Trials** are **57** and the **Successes** are **15**.

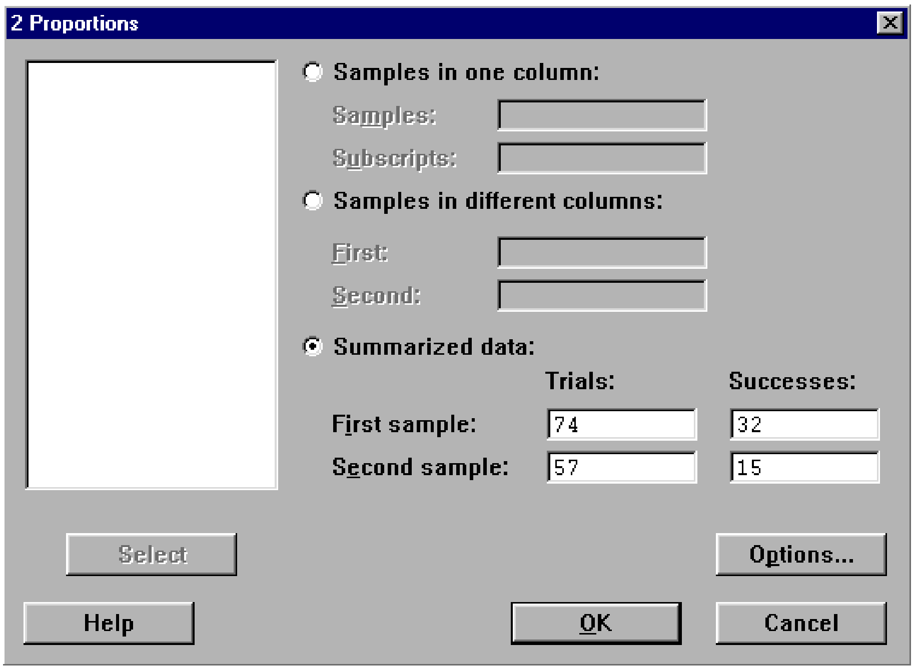


Figure 1

2. Click the **Options** button. The **Test difference** is **0** and the **Alternative** is **not equal**. The **Options** window should now look like Figure 2. Click **OK**.

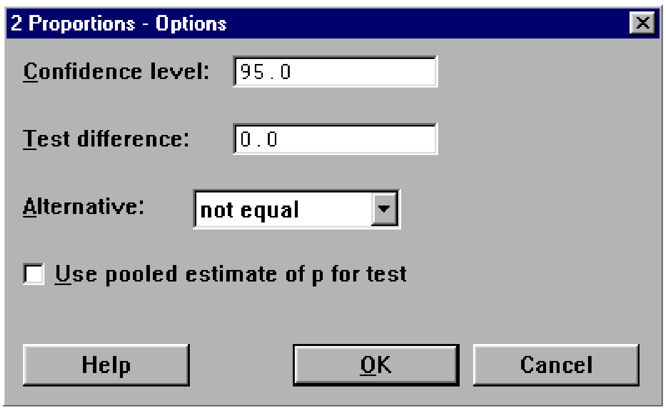


Figure 2

3. Click **OK** again. The answer is displayed in the **Session** window. See Figure 3.

```
Session

Test and Confidence Interval for Two Proportions

Sample       X      N  Sample p
1           32     74  0.432432
2           15     57  0.263158

Estimate for p(1) - p(2):  0.169275
95% CI for p(1) - p(2):  (0.00862275, 0.329926)
Test for p(1) - p(2) = 0 (vs not = 0):  Z = 2.07  P-Value = 0.039
```

Figure 3

4. The *P*-value is 0.039.

Chi-Square Test

One-Dimensional Tables

Example:

Determine if a certain die is symmetrical. (Refer to Example 11.1.1 in your textbook.)

1. Enter the information into MINITAB in the manner shown in Figure 1.

Worksheet 4 ***

	C1	C2	C3	C4	C5	C6
↓	outcome	observed	expected	chi-square	cumprob	p-value
1	1	26	35			
2	2	40	35			
3	3	37	35			
4	4	26	35			
5	5	43	35			
6	6	38	35			

Figure 1

2. On the menu bar choose **Calc Ł Calculator**. The **Calculator** window pops up. Click in **the Store result in variable** box. In the big box select **C4 chi-square**, then click the **Select** button. In the **Expression** box type **SUM((observed-expected)**2/expected)**. The window should look like Figure 2. Click **OK**.

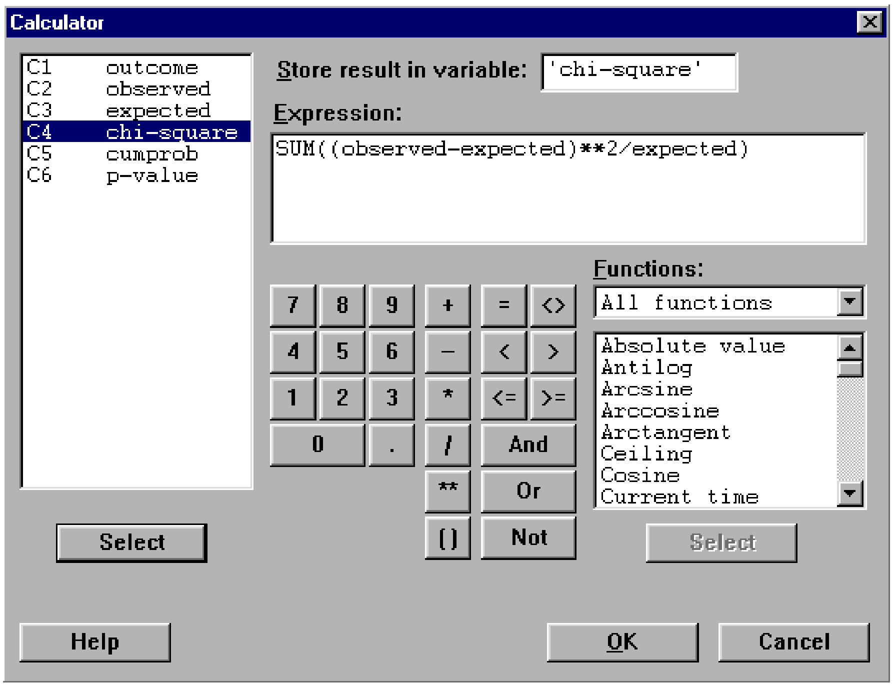


Figure 2

3. From the menu bar choose **Calc Ł Probability Distributions Ł Chi-Square**. The **Chi-Square Distribution** window appears. Mark the circle next to **Cumulative probability**. **The Degrees of freedom** is **5**. Ensure that the circle next to **Input column** is marked. The **Input column** is **Ôchi-squareÕ**(include the single quote marks) and the **Optional storage** is **cumprob**. See Figure 3. Click **OK**.

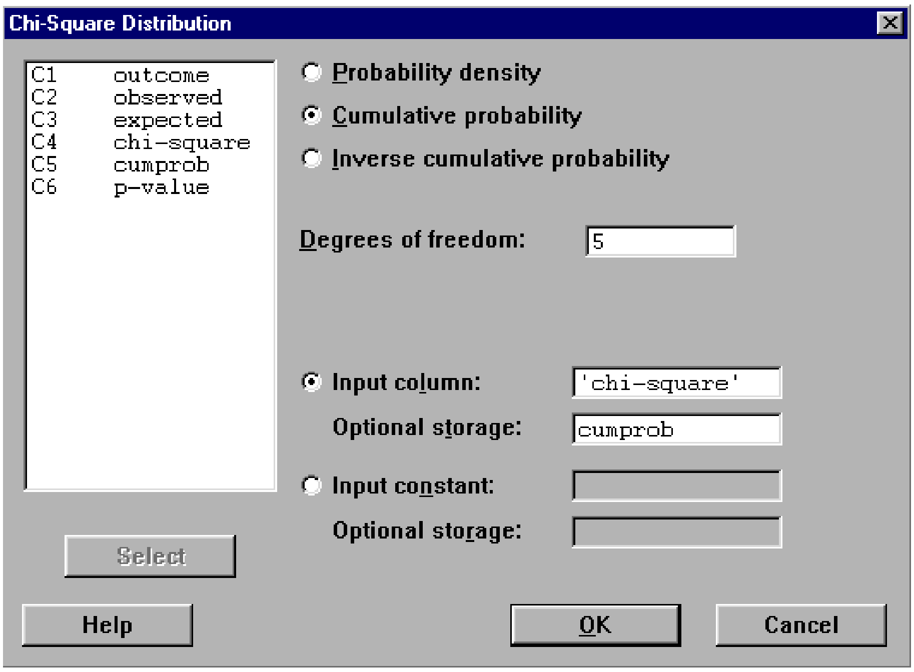


Figure 3

4. On the menu bar click **Calc Ł Calculator**. The **Calculator** window appears. Enter **Ôp-valueÕ** (with single quotes) into the **Store result in variable** box, and in the **Expression** box type **1-cumprob**.

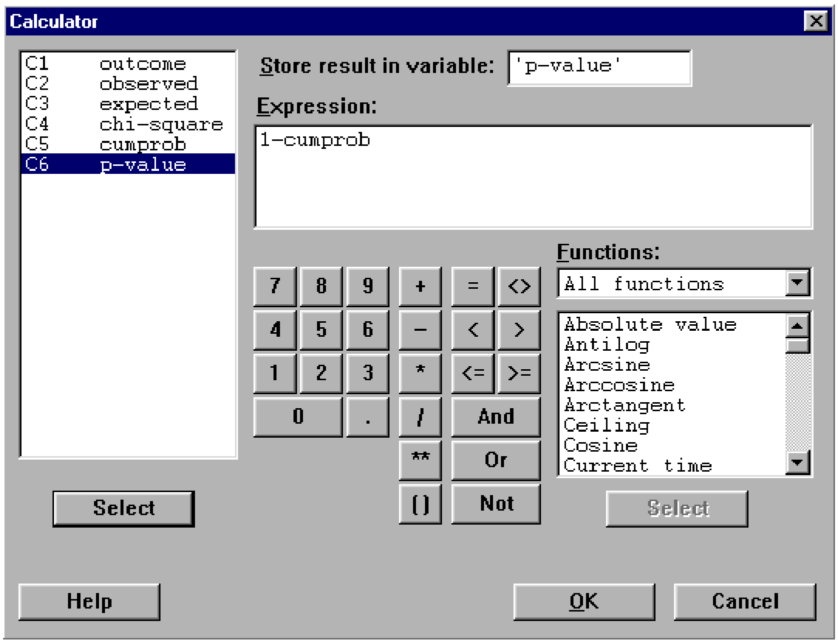


Figure 4

5. Click **OK**. The answer is displayed how it is displayed in Figure 5.

C4	C5	C6
chi-square	cumprob	p-value
7.54286	0.816705	0.183295

Figure 5

Two-Dimensional Tables

Example:

Perform a Chi-square test of homogeneity on the Blood Type Data. (Refer to Example 11.2.2 in your textbook.)

1. Enter the information in the same way as that shown in Figure 6.

bloodtype.MTW ***

	C1	C2	C3	C4
↓	A	B	O	AB
1	98	35	115	5
2	38	9	79	6
3	36	9	47	7

Figure 6

2. From the menu bar choose **Stat** Ł **Tables** Ł **Chi-Square Test**. The **Chi-Square Test** dialog box appears. Click in the **Columns containing the table** box. Enter **A-AB**. The dialog box should now look like Figure 7.

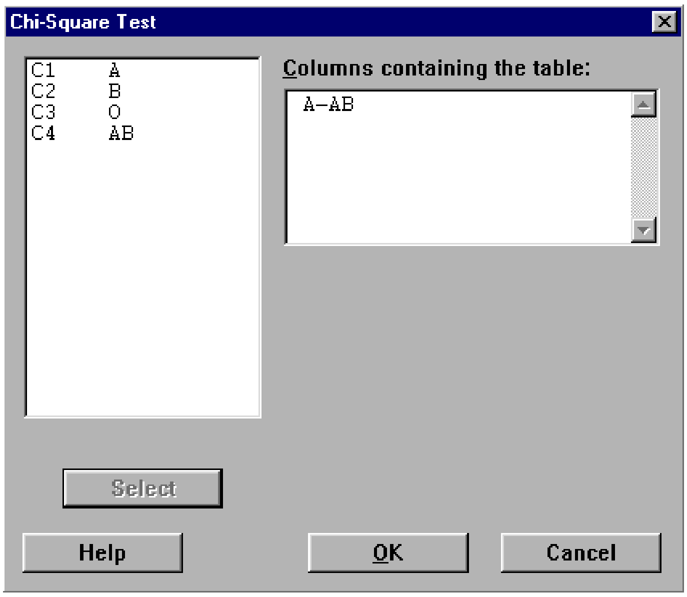


Figure 7

3. Click **OK**. The **Session** window now contains the results of the Chi-Square test. See Figure 8.

Session

Chi-Square Test

```
Expected counts are printed below observed counts

             A        B        O       AB    Total
    1       98       35      115        5      253
         89.91    27.70   125.98     9.41

    2       38        9       79        6      132
         46.91    14.45    65.73     4.91

    3       36        9       47        7       99
         35.18    10.84    49.30     3.68

Total      172       53      241       18      484

Chi-Sq =  0.728 +  1.921 +  0.957 +  2.066 +
          1.692 +  2.058 +  2.680 +  0.242 +
          0.019 +  0.313 +  0.107 +  2.990 = 15.774
DF = 6, P-Value = 0.015
2 cells with expected counts less than 5.0
```

Figure 8

4. The *P*-value is 0.015.

Normality Test

Example:

Check the Nitrate Ion Concentration Data for normality using the Normality test. (Refer to Example 10.1.1 in your textbook.)

1. Enter the data, shown below in Figure 1, into MINITAB.

concentration.MTW ***

↓	C1 concentration
1	0.513
2	0.524
3	0.529
4	0.481
5	0.492
6	0.499
7	0.518
8	0.490
9	0.494
10	0.501

Figure 1

2. From the menu bar select **Stat** Ł **Basic Statistics** Ł **Normality Test**. Click in the **Variable** box, then select **C1 concentration** in the big box, and then click the **Select** button. Ensure that the circle next to **Ryan-Joiner** is marked. Enter the **Title**: **Normal Plot and Normality Test for Concentration Data**.

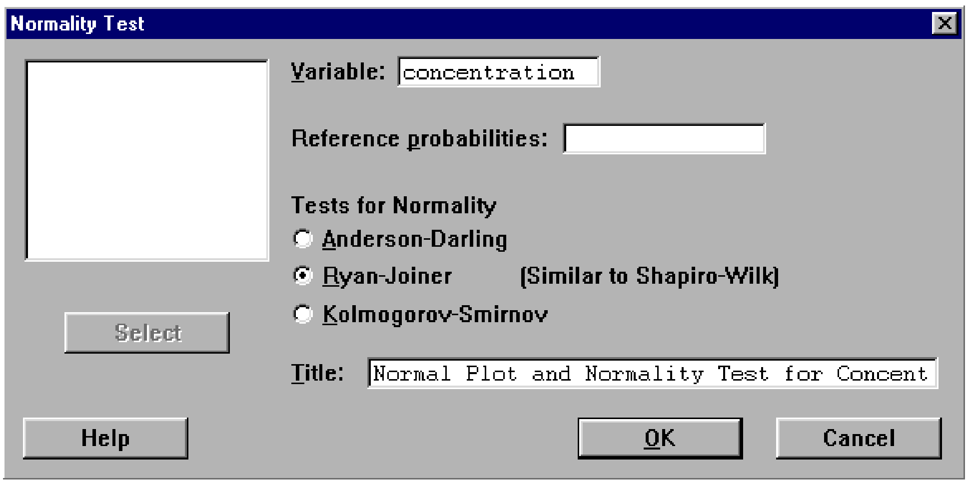


Figure 2

3. Click **OK**. A window containing the Normal Plot and the Normality Test pops up.

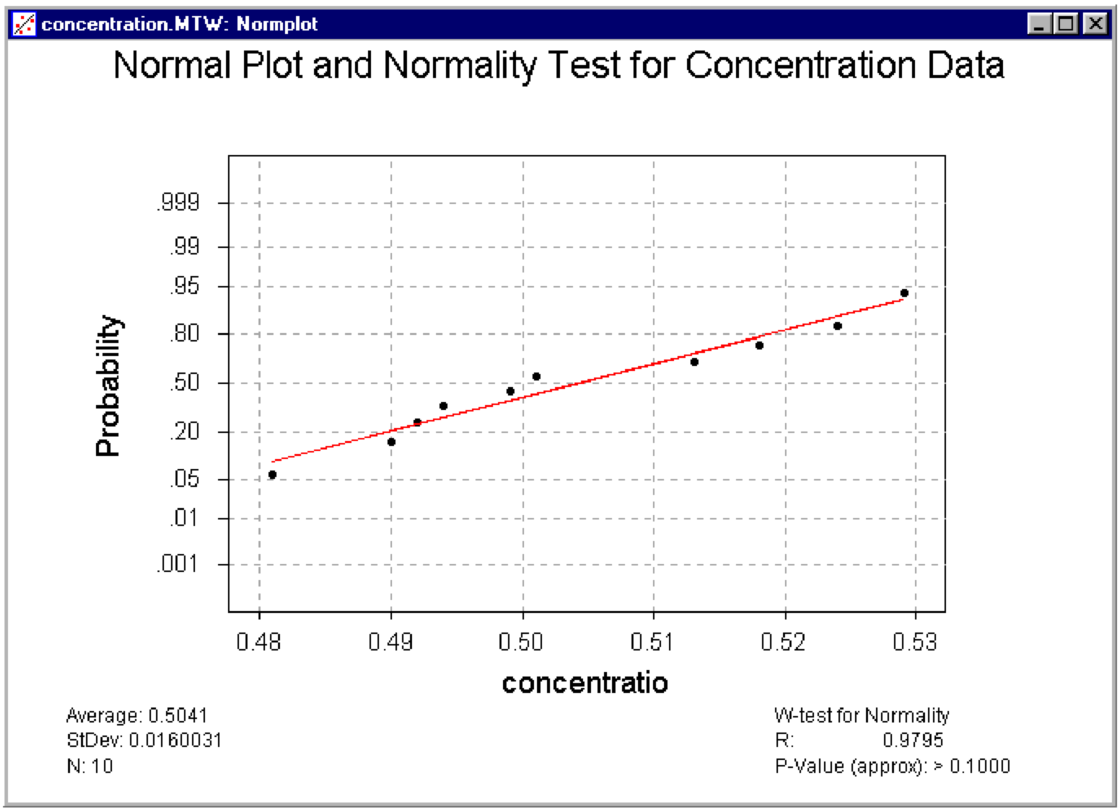


Figure 3

4. The *P*-value is greater than 0.1.

Simple Linear Regression

Example:
Using the Chernobyl Data carry out simple linear regression. (Refer to Example 3.1.1 in your textbook.)

1. Enter the information, shown in Figure 1, into MINITAB.

chernobyl.MTW ***

	C1	C2
↓	radioactivity	death increase
1	23	2.2
2	20	2.4
3	22	1.9
4	29	3.9
5	32	3.6
6	21	2.6
7	16	0.0
8	37	4.2
9	44	5.0

Figure 1

2. On the menu bar choose **Stat** Ł **Regression** Ł **Regression**. The **Regression** dialog box appears. In the **Response** box enter **'death increase'** (include the single quotes). Type **radioactivity** into the **Predictors** box.

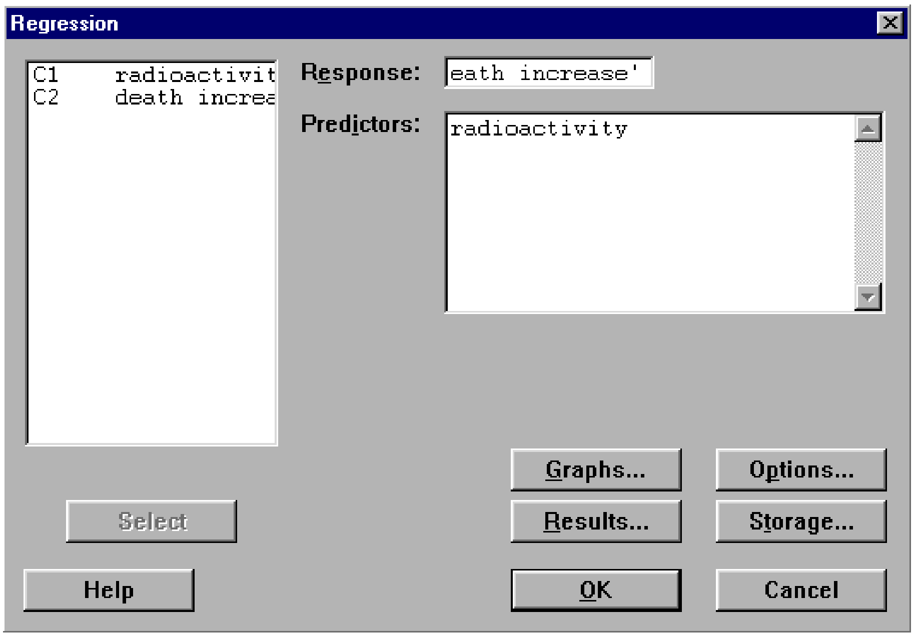


Figure 2

3. Click the **Graph** button. Another window will pop up. Ensure that the circle next to **Regular** is marked, as well as the squares next to **Normal plots of residuals** and **Residuals versus fits** are marked. Click **OK**.

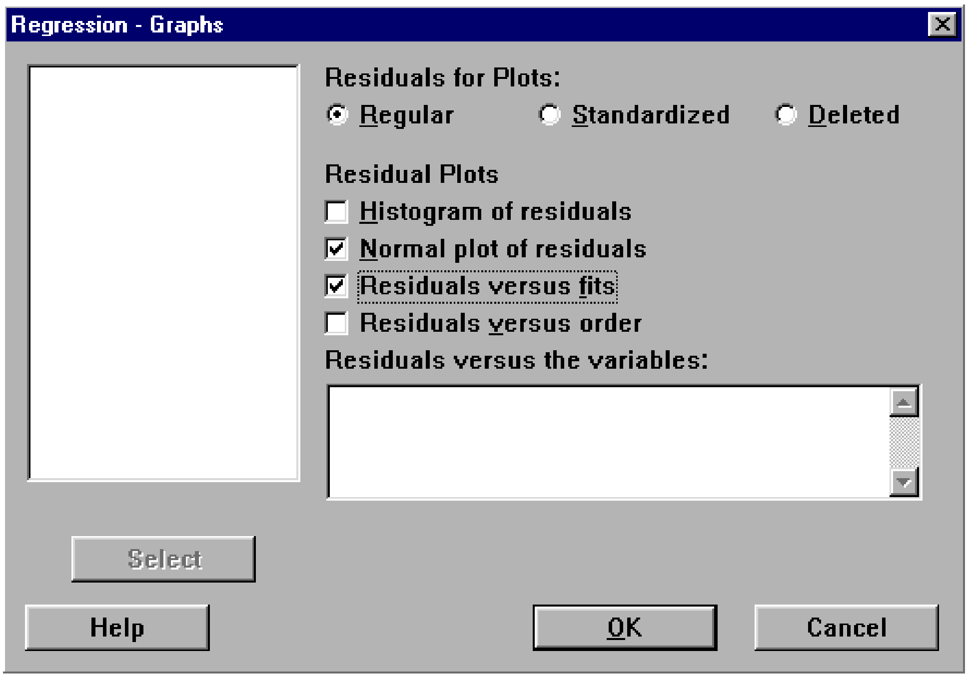
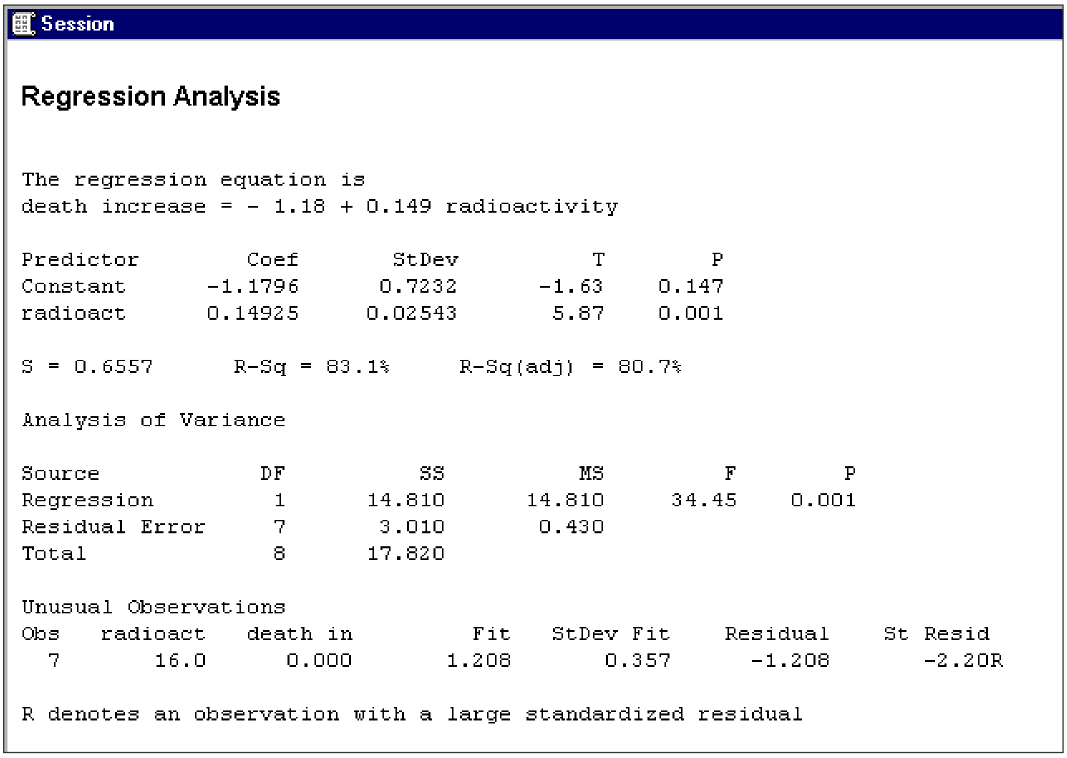


Figure 3

4. Click **OK**. The output is displayed in the **Session** window (See Figure 4). The two plots requested, the Normal plot and the Residual plot, are shown in Figures 5 and 6.


Session

Regression Analysis

```
The regression equation is
death increase = - 1.18 + 0.149 radioactivity

Predictor        Coef       StDev          T        P
Constant      -1.1796      0.7232      -1.63    0.147
radioact      0.14925     0.02543       5.87    0.001

S = 0.6557      R-Sq = 83.1%     R-Sq(adj) = 80.7%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1      14.810      14.810     34.45    0.001
Residual Error     7       3.010       0.430
Total              8      17.820

Unusual Observations
Obs    radioact   death in         Fit   StDev Fit    Residual    St Resid
  7        16.0      0.000       1.208       0.357      -1.208      -2.20R

R denotes an observation with a large standardized residual
```

Figure 4

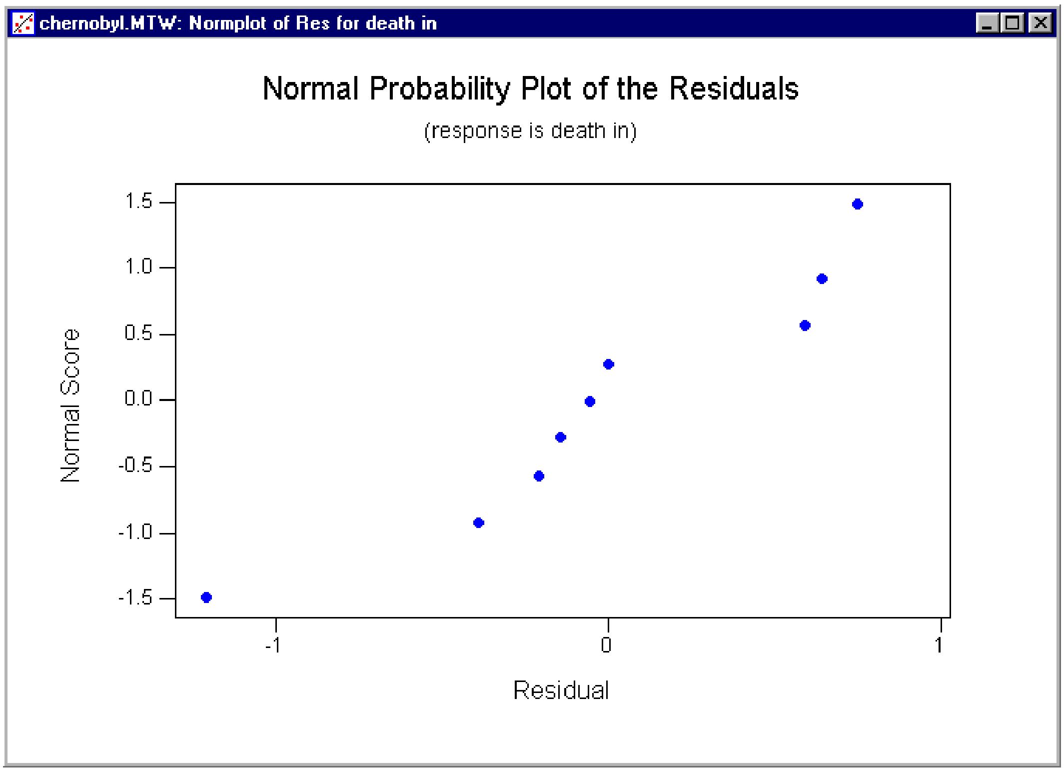


Figure 5

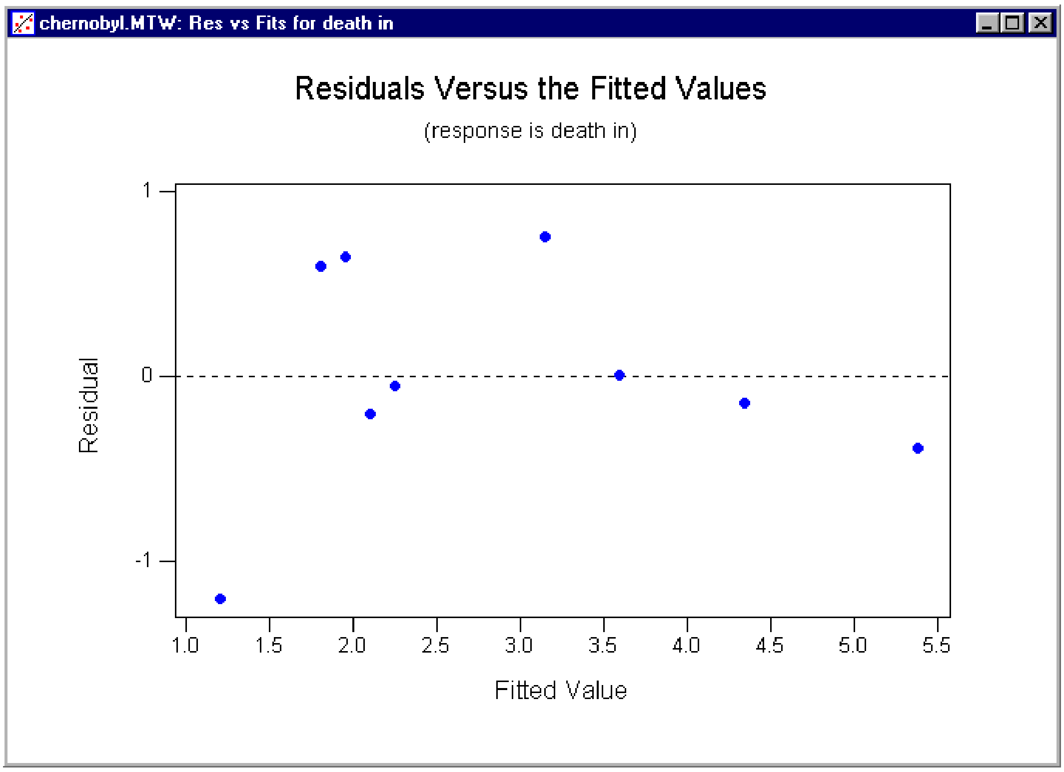


Figure 6

Correlation

Example:

Determine the sample correlation coefficient of the Chernobyl Data. (Refer to Example 3.1.1 in your textbook.)

1. Enter the data, seen in Figure 1, into MINITAB.

chernobyl.MTW ***

	C1	C2
↓	radioactivity	death increase
1	23	2.2
2	20	2.4
3	22	1.9
4	29	3.9
5	32	3.6
6	21	2.6
7	16	0.0
8	37	4.2
9	44	5.0

Figure 1

2. On the menu bar choose **Stat Ł Basic Statistics Ł Correlation**. The **Correlation** window pops up. Click in the **Variables** box. Then select **C1 radioactivity** in the big box, and click the **Select** button. Do the same for **C2 death increase,** so that the dialog box looks like Figure 2.

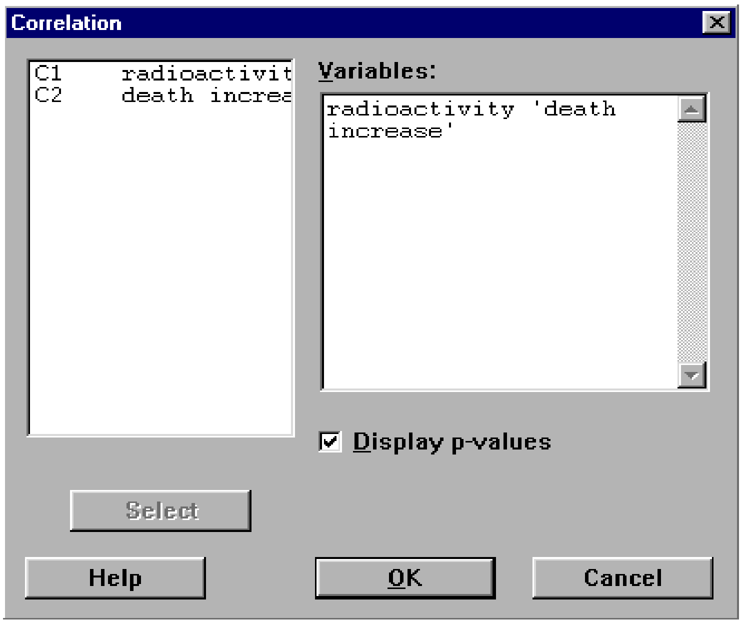


Figure 2

3. Click **OK**. The answer is outputted to the **Session** window, which can be seen in Figure 3.

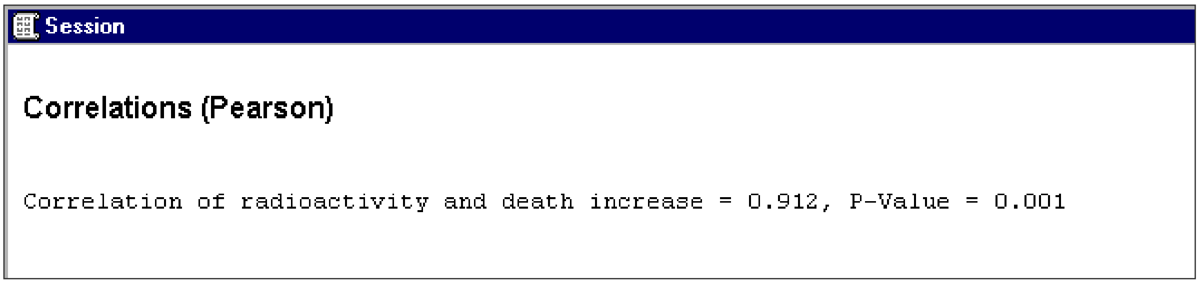


Figure 3

4. The sample correlation coefficient is 0.912