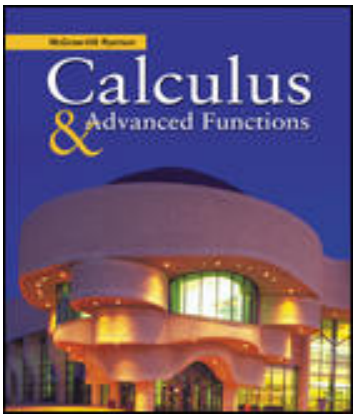
Fathom™ Tutorial

Dynamic Statistical Software

designed for teachers using

McGraw-Hill Ryerson
Calculus & Advanced Functions



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Thank you!

Foreword

This tutorial is designed for the teacher who wants to use the power of Fathom™ to teach the Grade 12 Calculus & Advanced Functions MCA4U course. Although Fathom™ was designed as a statistical program, it contains powerful function plotting capabilities. This tutorial is keyed to the *McGraw-Hill Ryerson Calculus & Advanced Functions* text, © 2002, McGraw-Hill Ryerson Limited. Several applications of Fathom™ are included in this tutorial. Step-by-step keystroke instructions and liberal use of screen shots will ease the novice along the learning curve for this powerful new technology. The user will find it helpful to follow through the text as he or she works through this tutorial. By working through the tutorial, the user will gain a solid knowledge of Fathom™ as applied to the MCA4U course.

About Fathom™

Fathom™ is a powerful dynamic statistical software package published by

An excellent web site, with Fathom™ resources and links to other web sites, is at **www.keypress.com**.

Introduction:

Fathom™ is a statistics software package that offers a variety of powerful data analysis tools in an easy-to-use format. This section introduces basic features of Fathom. A complete guide is available on the Fathom™ CD. The real power of this software will be demonstrated in later chapters with examples that apply its sophisticated tools to statistical analysis and simulations.

When you enter data into Fathom™, it creates a **collection**, an object that contains the data. Fathom™ can then use the data from the collection to produce other objects, such as a **graph**, **table**, or **statistical test**. These secondary objects display and analyse the data from the collection, but they do not actually contain the data themselves. If you delete a graph, table, or statistical test, the data still remains in the collection.

Fathom™ considers a collection as a set of **cases**. Each case in a collection can have a number of **attributes**. For example, the **cases** in a **collection** of medical records could have **attributes** such as the patient's name, age, sex, height, weight, blood pressure, and so on. There are two basic types of attributes, **categorical** (such as male/female) and **continuous** (such as height or weight). The **case table** feature displays the cases in a collection in a format similar to a spreadsheet, with a row for each case and a column for each attribute. You can add, modify, and delete cases using a case table.

Technology Extension **Page 23 MHR CAF**

Functions on a Computer Algebra System

If you don't have a class set of TI-92 calculators, you can use Fathom™ to duplicate or closely approximate many of the functions.

Example 1 Polynomial Functions

a) Evaluate the function $f(x) = x^3 - 2x^2 - 5x + 5$ for $x = 3, -5$, and $\sqrt{6}$.
b) Plot these values on a graph.
c) Plot the function on the same graph.

Solution

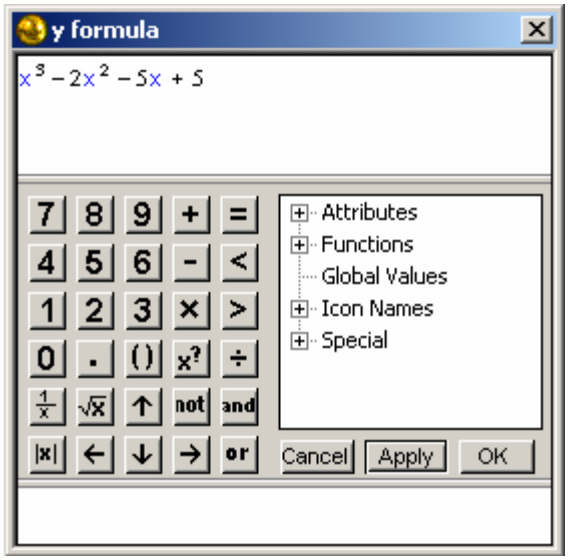
Launch Fathom™ and drag the **case table**  icon from the shelf to the workspace. Click on the attribute **<new>**, type the heading **x**, and press **Enter**. Repeat the process to create an attribute column for **y**. Note that your collection has been given the generic name **Collection 1**. You can double-click on the collection box and change the name to something more descriptive, such as **Graphing Functions**.

Enter the values 3, –5, and 2.449 ($\sqrt{6}$) in the **x** column. Right-click the heading in the **y** attribute column to bring up the expression editor. Enter the polynomial $x^3 - 2x^2 - 5x + 5$, as shown in the following screen shot. Click **Apply**, and then **OK**.

When you are finished, your **case table** will look like the screen shot shown below.

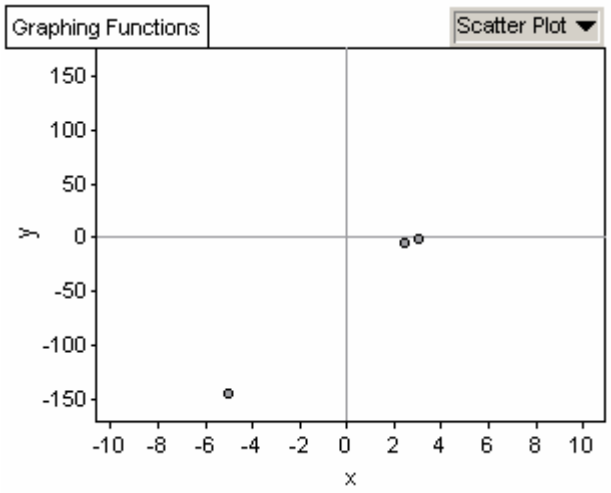
Graphing Functions

	x	y
1	3	-1
2	-5	-145
3	2.449	-4.55208

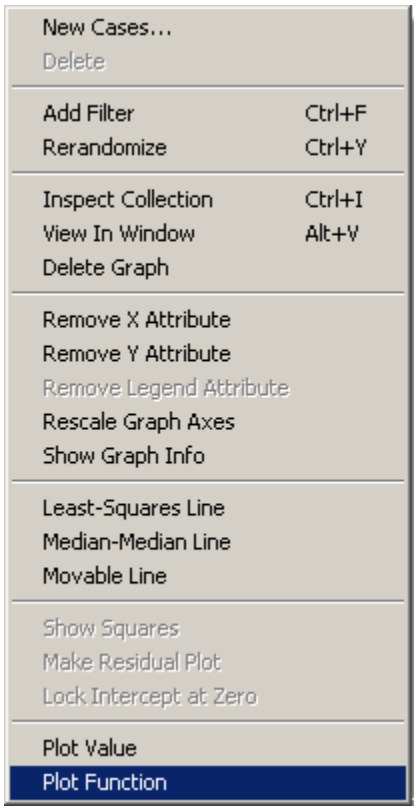


Drag the graph icon  to the workspace.

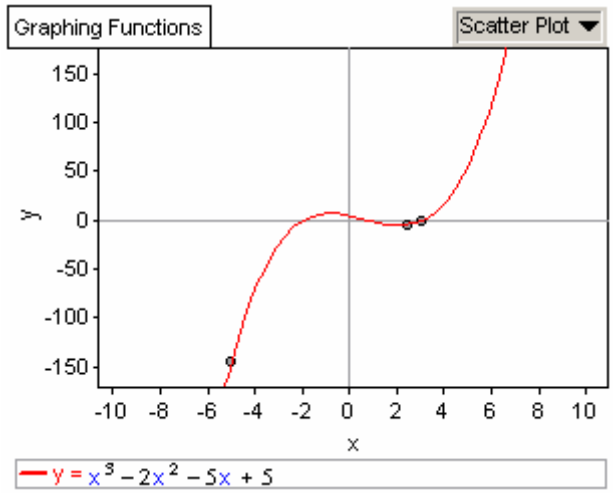
Drag the **x** attribute from the **case table** to the horizontal axis of the graph. Drag the **y** attribute to the vertical axis of the graph. Drag the numbers on the axes until the origin appears in the middle of the graph, and the graph appears as shown in the screen shot at the right.



Ensure that the graph is selected. Right-click on the graph, and select **Plot Function**.



The expression editor will appear. Enter the polynomial $x^3 - 2x^2 - 5x + 5$ as before. Click on Apply, and then OK. The function will be plotted, as shown in the screen shot below.



Example 2 Other Functions

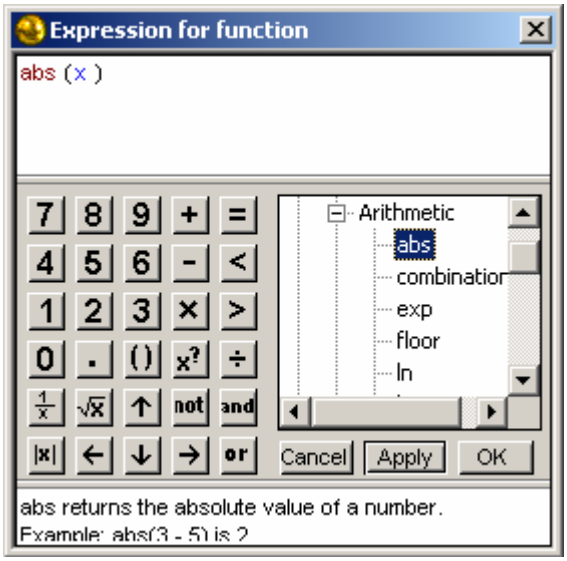
Fathom™ has many built-in functions. As an example, plot *f(x)* = |x|.

Solution

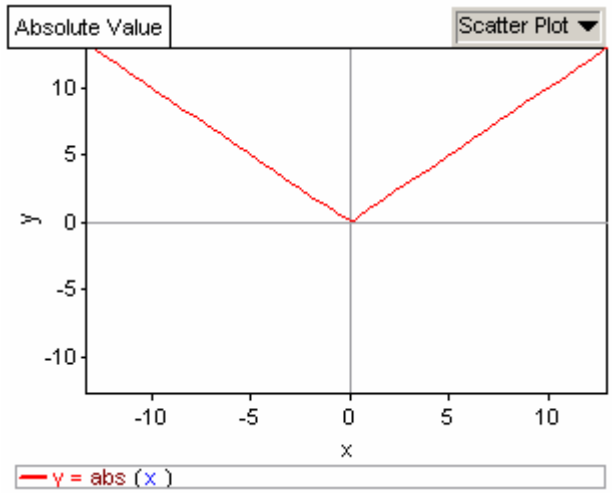
Launch Fathom™ and drag the **case table** icon from the shelf to the workspace. Click on the attribute **<new>**, type the heading **x**, and press **Enter**. Repeat the process to create an attribute column for **y**. Rename the collection **Absolute Value**.

Drag the graph icon to the workspace. Drag the **x** attribute from the **case table** to the horizontal axis of the graph. Drag the **y** attribute to the vertical axis of the graph. Drag the numbers on the axes until the origin appears in the middle of the graph, and the graph appears as shown in the screen shot at the right.

Ensure that the graph is selected. Right-click on the graph, and select **Plot Function**. The expression editor will appear. Select **Functions-Arithmetic-abs**. Type an **x** between the brackets of the abs function, as shown in the screen shot at the right.



Click on Apply, and then OK. The function will be plotted, as shown in the screen shot below. Drag the numbers on the axes to position the origin in the centre and the axis ranges as shown.



Note: It is not necessary to enter values in the case table before plotting a function.

Example 3 Piecewise Functions

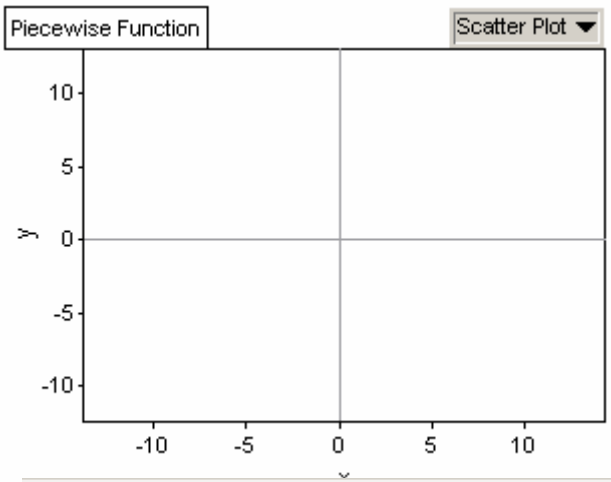
Fathom™ can plot piecewise functions by using the **if** function. Suppose that you define a function:

$$f(x) = \begin{cases} x^2 & x < 0 \\ x & 0 \le x \le 1 \\ \sqrt{x} & x > 1 \end{cases}$$

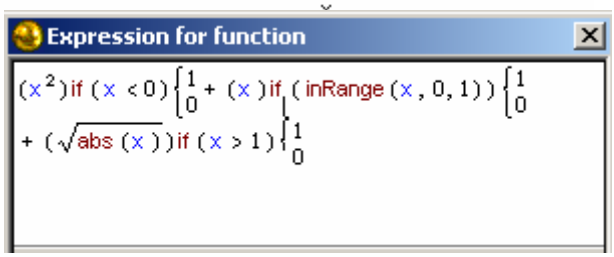
Graph this function using Fathom™.

Solution

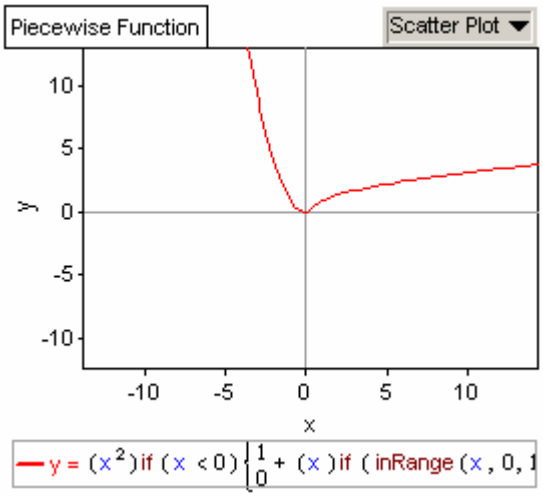
Launch Fathom™ and drag the **case table** icon from the shelf to the workspace. Click on the attribute **<new>**, type the heading **x**, and press **Enter**. Repeat the process to create an attribute column for **y**. Rename the collection **Piecewise Function.**



Drag the graph icon to the workspace. Drag the **x** attribute from the **case table** to the horizontal axis of the graph. Drag the **y** attribute to the vertical axis of the graph. Drag the numbers on the axes until the origin appears in the middle of the graph, and the graph appears as shown in the screen shot at the right.



Ensure that the graph is selected. Right-click on the graph, and select **Plot Function**. The expression editor will appear. Select brackets, and type x^2 in the brackets. Outside the brackets, type a multiplication *. Select **Functions-Condition-if**. Type **x<0** between the brackets of the **if** function, set the **True** condition as **1** and the **False** condition as **0**, as shown in the screen shot. Continue with the other two conditions for this function. To handle the 0 to 1 range, select the **inRange** function from the **Functions-Logical** menu. Be sure to use the absolute value function under the root sign, or Fathom™ will restrict the graph to positive values of **x**. Note: Fathom uses only < and > signs.



Click on **Apply**, and then **OK**. The function will be plotted, as shown in the screen shot.

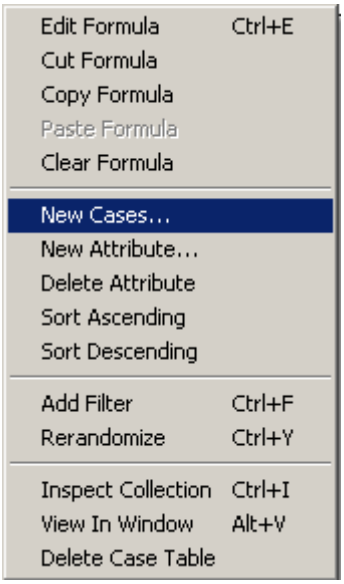
Example 4 Derivative of $f(x) = x^2$ — Page 187 MHR CAF

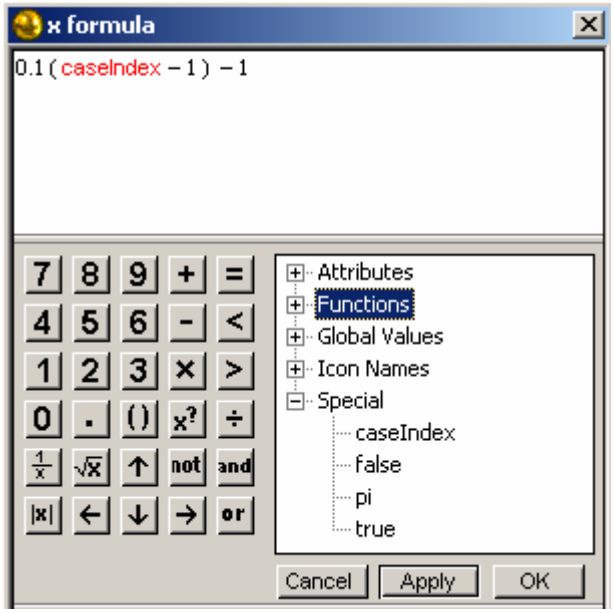
Fathom™ can be used to illustrate the limiting process of obtaining derivatives. Use it to illustrate how this works for $f(x) = x^2$.

Solution

Launch Fathom™ and drag the **case table** icon from the shelf to the workspace. Click on the attribute **<new>**, type the heading **x**, and press **Enter**. Repeat the process to create an attribute column for **y,** and a third column called **Derivative**. Rename the collection **Derivatives.**

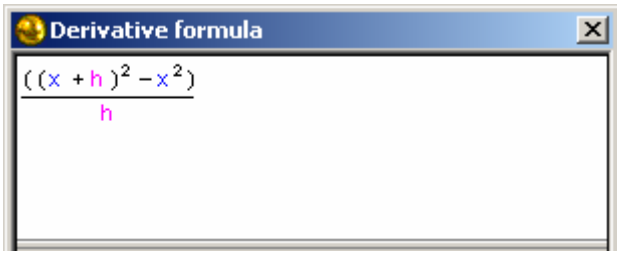
Set up the x values from -1 to 1 in increments of 0.1. To do this, right-click on the x attribute column, select **New Cases...** and change the number of cases to **21**. Click **OK**. Right-click on the **x** attribute again, and select **Edit Formula**. Enter the formula as shown in the screen shot. Note: **caseIndex** is located under **Special**. A set of values from -1 to 1 increasing by 0.1 increments appears in the column under the **x** Attribute.





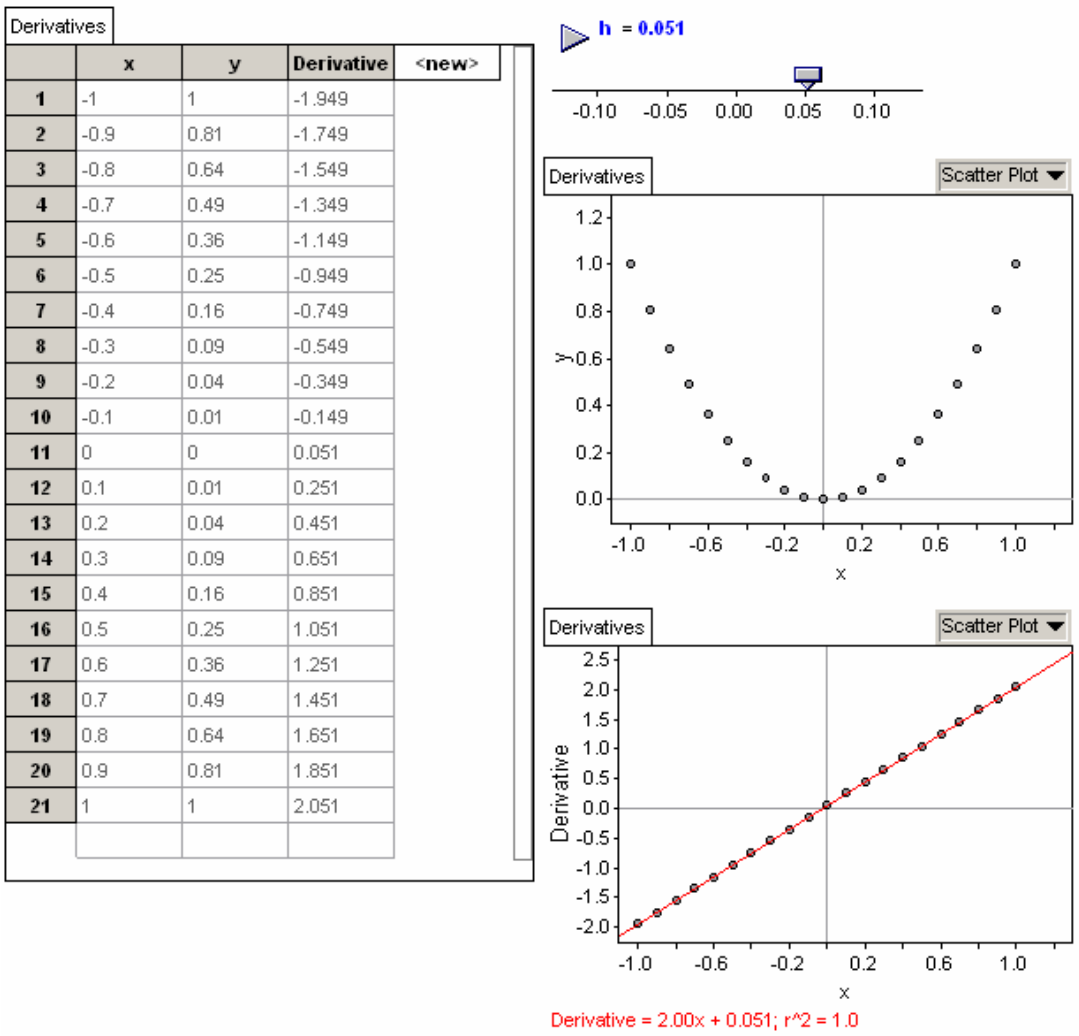
Right-click on the **y** attribute, select **Edit Formula**, and enter $\mathbf{x^2}$**.**

Drag a slider from the shelf to the workspace, and rename it h. Right-click the **Derivative** attribute, select **Edit Formula**, and enter the Leibnitz formula as shown in the screen shot.



Adjust the scale on the slider so that h can be varied over a range from about -0.1 to 0.1.

Drag the graph icon to the workspace. Drag the **x** attribute from the **case table** to the horizontal axis of the graph. Drag the **y** attribute to the vertical axis of the graph. Drag another graph icon to the workspace. Drag the **x** attribute from the **case table** to the horizontal axis of the graph. Drag the **Derivative** attribute to the vertical axis of the graph. Select the second graph. Select **Least Squares Line** from the **Graph menu**. When you are finished, your screen will appear much like the following screen shot.



	x	y	Derivative	<new>
1	-1	1	-1.949	
2	-0.9	0.81	-1.749	
3	-0.8	0.64	-1.549	
4	-0.7	0.49	-1.349	
5	-0.6	0.36	-1.149	
6	-0.5	0.25	-0.949	
7	-0.4	0.16	-0.749	
8	-0.3	0.09	-0.549	
9	-0.2	0.04	-0.349	
10	-0.1	0.01	-0.149	
11	0	0	0.051	
12	0.1	0.01	0.251	
13	0.2	0.04	0.451	
14	0.3	0.09	0.651	
15	0.4	0.16	0.851	
16	0.5	0.25	1.051	
17	0.6	0.36	1.251	
18	0.7	0.49	1.451	
19	0.8	0.64	1.651	
20	0.9	0.81	1.851	
21	1	1	2.051	

Adjust the value of h, and watch how the graph of the derivative changes as $h \to 0$, both from the right and from the left. Use the equation of the least squares line to demonstrate the effect of a non-zero value of h. You can also refine the scale of the slider to approach 0 with more precision.

This file can be saved as a template, and used to investigate the derivatives of other functions as they occur. Change the formulas under the **y** and **Derivative** attributes to any desired formula.

This concludes this Fathom™ Tutorial.

For additional Fathom™ resources, visit the Key Curriculum Press web site at www.keypress.com.