

Working with Analytical Tools

It is commonly said that at age 3 a child will be half of his or her adult height. You may also have heard that teenagers grow “like weeds.” Both *Logger Pro* and LabQuest App have a set of tools you can use in your analysis of experimental data. This activity give you practice using these tools in *Logger Pro* and LabQuest App to answer these questions.

OBJECTIVES

In this activity, you will

- Add a calculated column to an existing data set.
- Re-size and group graphs in *Logger Pro*.
- Practice using the Examine, Tangent, Statistics, and Integral tools in *Logger Pro* or LabQuest App.
- Interpret the information obtained by the use of these tools.

MATERIALS

Logger *Pro* or LabQuest App
Sample data file: A3 Height v age.cmbl (computer)
or A3 Height v age.qmbl (LabQuest)

EVALUATION TOOLS IN *LOGGER PRO*

1. Open the *Logger Pro* file, A3 Height v age.cmbl, provided on the CD that accompanies this book. Note how Colin’s height increases as he grows older. To better describe how his growth depends on his age you can use *Logger Pro* to determine the rate of change of height with age.
2. Choose New Calculated Column from the Data menu. This brings up a dialogue box in which you can name the column (e.g., growth rate) and units (m/yr) as well as specify the equation used to calculate the values. Insert the cursor in the Equation field, then, choose calculus►derivative from the Function list. Choose height as the Variable, then click Done (see Figure 1). The newly created column should now appear in your data table.

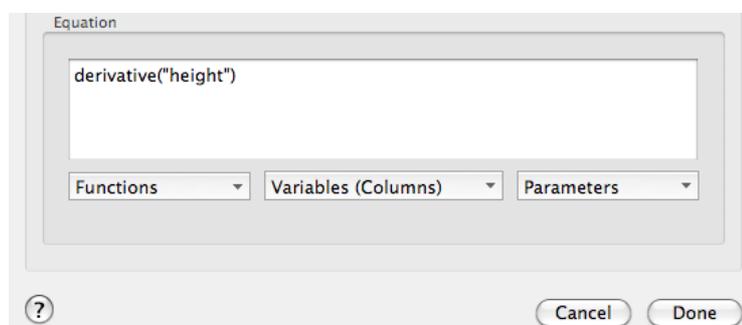


Figure 1

Activity 3

- By adding a graph you can view how both Colin's height and his growth rate vary with time. Choose Graph from the Insert menu; a small graph of growth rate *vs.* age appears superimposed on your data table and graph. Choose Auto Arrange from the Page menu; this re-sizes both graphs and arranges them nicely on the page.
- Select the height *vs.* age graph and activate the Tangent tool. You can do this either by choosing Tangent from the Analyze menu or by clicking the button in the toolbar shown on the right. Move the cursor across the graph to see how the software displays a portion of the tangent line drawn at a given point and gives the value of its slope. 
- Now select the growth rate *vs.* age graph and activate the Examine tool. You can do this either by choosing Examine from the Analyze menu or by clicking the button in the toolbar shown on the right. Move the cursor across the graph to see how the software displays a vertical line on the graph. In the information box the values of both variables for the nearest point are displayed. 
- To link both graphs so that these tools work simultaneously, select both graphs then choose Group Graphs (X-Axes) from the Page menu. As you move your mouse, note that the tangent and examine lines move in tandem. How does the value of the slope of the tangent in the top graph compare to the value of the growth rate in the bottom graph?
- Deactivate these tools on each graph either by selecting a graph and clicking the tool you chose (it behaves like a toggle switch), or by clicking the little 'x' in the upper left corner of the information box.
- Now select an age interval (e.g., from age 5 to 10) on the top graph by drag-selecting your mouse across a portion of the graph. Note that this action highlights a portion of the graph and the relevant entries in the data table as well. Choose Statistics from the Analyze menu or click the button in the toolbar shown to the right. From the maximum and minimum values determine Colin's change in height during this interval. 
- Now select this same age interval on the bottom graph. Choose Integral from the Analyze menu or click the button in the toolbar shown on the right. Note how Logger Pro shades in the area under the curve for this interval. Examine the units of the variables on the axes of this graph; what would you expect this area to represent? How does the value of the selected area compare to the value you obtained in Step 8? 
- Close the Logger Pro file, but do not save changes. Assuming Colin reached his maximum height at age 20, does the generalization made in the introduction apply? Was he growing most rapidly as a teenager? If not, at what age was he growing most rapidly?

EVALUATION TOOLS IN LABQUEST APP

- To evaluate the data in LabQuest App, you will need to transfer the file, A3 Height v age.qmbl, provided on the CD that accompanies this book to a USB flash drive, connect that to the LabQuest, then open the file from the flash drive. Tap the graph tab. Note how Colin's height increases as he grows older. To better describe how his growth depends on his age you can use LabQuest App to determine the *rate* of change of height with age.
- Tap the Table tab. Choose New Calculated Column from the Table menu. This brings up a window in which you can name the column (growth rate) and units (m/yr) and choose the precision you wish to display. This window also provides the place where you can specify the equation used to calculate the values. Select 1st Derivative (Y,X) as the Equation Type from

the options in the drop down menu. Accept the default choices of variables for X and Y by tapping the OK button (see Figure 2 below).

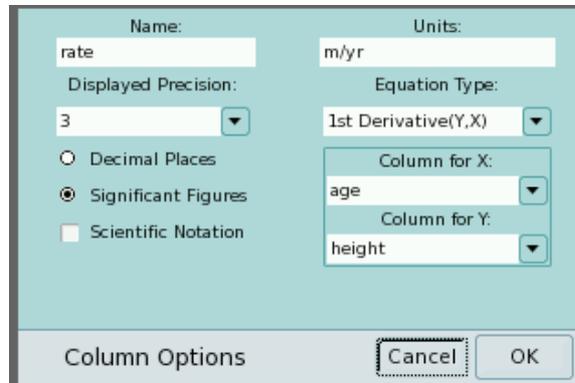


Figure 2

- When you tap OK, LabQuest App returns you to the graph window. From the Graph menu choose Show Graph ► All Graphs; you should now see two graphs. Activate the Tangent tool by choosing Tangent from the Analyze menu. As you tap the stylus on different parts of the screen, see how the software displays a portion of the tangent line drawn at a given point on both graphs. To the right of the graphs are boxes displaying the x and y values of that location on each graph and the values of the slopes of the tangents. How does the value of the slope of the tangent in the top graph compare to the value of the growth rate in the bottom graph?
- Deactivate the Tangent tool by choosing Tangent from the Analyze menu (tapping a selected tool deactivates it like a toggle switch). Now select an age interval (e.g., from age 5 to 10) on the top graph by dragging your stylus across a portion of the graph. From the Analyze menu choose Statistics and then check the **height** box. LabQuest App provides various statistics for the selected interval. Use the up and down arrows to view all the information in the window (see Figure 3).

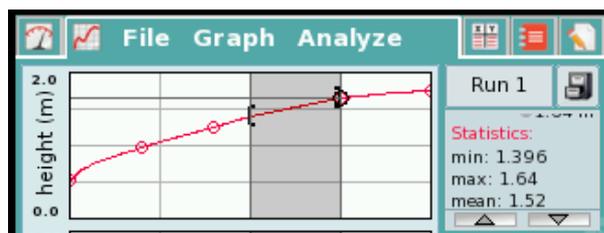


Figure 3

From the maximum and minimum values determine Colin's change in height during this interval.

- Now select the same age interval on the bottom graph. Choose Integral from the Analyze menu and check the box next to **rate**. Note how LabQuest App shades in the area under the curve for this interval. Examine the units of the variables on the axes of this graph; what would you expect this area to represent? How does the value of the selected area compare to the value you obtained in Step 4?

Activity 3

6. Assuming Colin reached his maximum height at age 20, does the generalization made in the introduction apply? Was he growing most rapidly as a teenager? If not, at what age was he growing most rapidly?