

"Zooming In" on a Graphing Calculator

Alan Stickney
Department of Mathematics, Wittenberg University

Introduction

Whether one is using a computer or a calculator to display graphs, the ability to choose a new, smaller viewing rectangle is a very useful pedagogical tool, since it allows the instructor or student to "zoom in" on points of particular interest (roots, extrema, intersections, etc.). While there are several schemes for doing this, probably the most convenient method is for the user to indicate the corners of a new viewing rectangle in an interactive mode while the graph is displayed.

The purpose of this paper is to show how this "zoom-in" feature can be implemented on the Casio fx-7000/8000G series of calculators. Related programming topics on the Casio, and an implementation of the "zoom-in" feature for the HP-28S are also considered.

A Program for the Casio

To implement a "zoom-in" feature on the Casio, enter the following program as "Prog 9" in the program memory:

```

Cls
Lbl 1: Prog 0
Plot ▴
X → A
Y → D
Plot ▴
X → B
Y → E
( B - A ) ÷ 12 → C
( E - D ) ÷ 8 → F
Range A, B, C, D, E, F
Goto 1

```

"Prog 0" should contain one or more "Graph" commands which will generate the desired graph. For example:

```

Graph Y = X x5 - 3 X x3 + 2
Graph Y = 2 X - 1

```

The program is used as follows:

1. Enter the range information for the first graph as usual.

2. Begin execution of "Prog 9".
3. Following the appearance of the graph on the screen, the calculator enters "plot" mode. A small blinking dot will appear at the center of the screen, and its x-coordinate is displayed at the bottom of the screen.
4. Use the arrow keys to move the blinking dot to the lower-left corner of the desired viewing rectangle.
5. Press the "EXE" button. The lower-left corner will now be marked by a non-blinking dot, and the calculator will again enter "plot" mode.
6. Use the arrow keys to move the new blinking dot to the upper-right corner of the desired viewing rectangle.
7. Press the "EXE" button, and the graph will be redrawn in the new viewing rectangle.
8. Repeat steps 3-7 until done. Pressing the "AC" button at any time will terminate execution of the program.

Once the program has been terminated, it can be restarted with the last viewing rectangle that was displayed unless the range information has been changed.

Possible Enhancements

There are several options which can enhance the usefulness of the above program, although they all require additional space in program memory, a resource which is rather limited on the fx-7000G. A partial list includes:

1. Last Graph Recall. To do this, use additional variables to store the range information contained in A-F before it's changed. If an unsatisfactory graph is obtained, the user can stop the program with "AC", restore the range data for the previous graph (using a "Range" command in a separate program), and restart the zoom-in program.
2. Improved Marking of Lower-Left Corner. The program above leaves only a small "dot" to mark the lower-left corner of the new viewing rectangle. It is possible, but complicated, to plot several points at that corner in any shape, perhaps an "+", using the "Plot" function. This would improve the visibility of the lower-left corner of the rectangle.

3. Improved Scale Markings. The program as given has a nice number of scale markings on each screen, but they occur at "strange" numerical values. If scale marks at "even" values (e.g. 2.343, 2.344, 2.345, etc.) are desired, the scale value can be calculated from the values of A, B, D, and E. For example, the following does a reasonably good job of choosing the x-scale if the x-range is less than one:

$$10 \times \text{Int} (\log (B-A) - 1.3) \rightarrow C$$

4. Zoom-In with Other Graphing Routines. The program can be used with a wide variety of graphing routines. Any routine that generates a graph without changing the range values can be stored as "Prog 0" and used with the zoom-in program. For example, a polar graphing procedure can be stored as "Prog 0". In this case, the user should be allowed to re-specify the range of theta values before each new view is obtained. If this is not done, the calculator might waste a great deal of time attempting to plot points which are not in the viewing rectangle.

Modularity and Subroutines on the Casio

The Casio is designed to allow programming with subroutines (one program calling another), and that is a distinct advantage when using the calculator in a classroom setting. The "zoom-in" program given above can be entered as "Prog 9" just once at the beginning of a course, and it never needs to be changed. For different graphing applications, students only need to enter new graphing commands in "Prog 0". This reduces programming errors and student frustration with procedures that are used repeatedly in different applications.

Polar and parametric plotters, as well as other procedures for student use, can all be written in a similar fashion. The idea is to isolate those parts of the program which will change from one application to another (functions, equations, etc.) by putting them in a separate subroutine in the program memory. The general procedure is then entered just once, and students only change the isolated subroutine as they move from one application to another.

On the other hand, it should be noted that a maximum of 10 programs can be stored in the program memory at one time. This tends to limit the number of separate subroutines that should be used in programming.

How to Zoom-In on an HP-28S

It is also easy to mark a new viewing rectangle for a graph on the HP-28S. In fact, it can be done using only the built-in functions of the calculator and doesn't require any programming. Here's how:

1. Press "PLOT" so that the Plot Menu shows in the display and enter the function/equation using "STEQ".
2. Set the initial range values using "PMIN" and "PMAX".
3. Press "DRAW" to draw the graph.
4. Use the arrow keys to move the cursor to the lower-left corner of the desired viewing rectangle.
5. Press "INS" to store the coordinates of that point on the stack. Note that this does not place a "mark" at the point.
6. Use the arrow keys to move the cursor to the upper-right corner of the desired viewing rectangle.
7. Press "INS" again to store the coordinates.
8. Press "ON" to return to the text screen.
9. Press "PMAX" followed by "PMIN" to store the new range information.
10. Repeat steps 3-9 until done.

Summary

A "zoom-in" feature is now readily accessible on at least two different graphing calculators. The implementations are easy, and students should find them convenient to use. The only drawback is that the outline of the new viewing rectangle does not appear on the screen while the cursor is being moved to the second corner, as it does in some microcomputer software. This is unfortunate, but not a significant problem.