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Overview

This program draws the Mandelbrot Set and Julia sets. It consists of two windows, one for Mandelbrot and one for Julia sets. The Draw command will cause the appropriate set to be calculated. Sets are drawn to fill the frame. To get a larger depiction, stretch the frame to the desired size, first, and then draw the figure.

Drawings are sensitive to the number of iterations. More iterations will eliminate points that generate sequences that diverge slowly. However, the more iterations, the longer the image takes to draw. I recomend that initial images be drawn with a small frame. Then, if you find an interesting image, increase the size of the frame and redraw it with the same parameters.

Using the right mouse button will set the parameters to draw around the point at the cursor. Double clicking the left mouse button will cause a window to redraw itself at five times the magnification, zooming in on the point that was clicked. Iterations (if less than 100) are doubled.

If iterations > 30 then you can abort a drawing by pressing the *ESCAPE* key.

See also Draw Command

Mandelbrot Set

The Mandelbrot Set is the set of all complex numbers "c" such that the iterated transform $Z_{n+1} = Z_n^2 + c$ gives connected Julia Sets. This program checks each pixel in the display to see if the point (0,0) generates a sequence that remains within distance two of the origin. The number of iterations is the maximum times the transform is performed before the program decides that the point is in set.

Points on the edge of the Mandelbrot set usually give the most interesting Julia sets. When a small number of iterations is used, points that appear on the edge of the Mandelbrot set actually give disconnected Julia sets, and will disappear from the Mandelbrot drawing if a larger number is used for iterations. These points give Julia sets that are "almost" connected and usually with quite intricate detail.

Julia Sets

A Julia set is related to a complex number "c". For every complex number "c", there is a set of points "z" (maybe empty) that remains within a finite distance of the origin under the transform $Z_{n+1} = Z_n^2 + c$. In other words, pick a point $Z_0 = X_0 + Y_0 i$. Find Z_1, Z_2, Z_3 ... The sequence of $Z_n 2$ either lies in a finite area about the origin (0,0) or it approaches infinity (gets arbitrarily large). If it remains bounded, then point Z_0 that generated the sequence (and all the other points in the sequence) is in the Julia set for "c".

Julia sets may be either connected or disconnected. If all the points interior to a boundary are in the Julia set for "c", then the Julia set is connected. For some Julia sets, there are points "Z" not in the Julia set between every two points that are in the Julia set. These are disconnected Julia sets, also known as Cantor sets or "dust". The Mandelbrot set is the set of all complex numbers "c" which have connected Julia sets associated with them.

Draw Command

The draw command causes a dialog box to appear. If OK is selected, then the appropriate set is drawn in the window, using the parameters from the dialog box.

C Real - Real portion of the constant in the transform equation.

C Imaginary - Imaginary portion of the constant.

Center Point - The value of the point at the center of the drawing. This is a complex number X + Y*i*.

Image Width - The range of the real parts of the points to be displayed.

Image Height - The range of the imaginary parts of the points to be displayed.

If the width is two, the height is three and the center poisition is (0,0), then the left bottom of the drawing will display the point (-1,-1.5).

Iterations - The number of times the transform $Z_{n+1} = Z_n^2 + c$ will be executed to test if a series stays bounded. The drawing can be very sensitive to the number of iterations. When image width and height are small, iterations may need to be increased.

Pressing the right mouse button in the Mandelbrot window will set the center point in the Draw dialog box for the Mandelbrot window and set the constant "C" in the Julia Draw dialog box.

Pressing the right mouse button in the Julia window sets the center point for the Julia window, only.

Resizing the window causes the drawing in the window to be stretched or shrunk to the fit the new window size. Subsequent drawings will be made to fit the window. It is a good idea to have the image width and height be in the same ratio as the window you are drawing in. Otherwise, the drawing will appear distorted.

If you have already drawn an image in the window, then double clicking on a point in the window will cause that window to be redrawn with five times the resolution. This effectively zooms in on the selected point. If iterations are less than 100, then iterations will be doubled. You can see the parameters used by clicking on the Draw menu item.

File New Command

New clears the window and prepares it for a new drawing.

File Open Command

This command will allow you to load bitmap files into the window. These files may not be saved. Only files that are drawn by the window can be saved. However, the file can be copied from *Fractal* to another application (ie Paint), where they can be saved. When a file is loaded, the window resizes itself to the size of the stored bitmap.

See also Save SaveAs Copy Draw

File Save Command

See SaveAs Command.

File SaveAs Command

SaveAs is only available when a drawing has been made in the window. Drawings in the windows are saved as monochrome bitmaps to save space. Most programs display monochrome bitmaps in black and white. The color information is saved with the bitmap but is not used by many programs. If the program uses the color data, the drawings will be displayed in the appropriate color (red for Julia sets, blue for Mandelbrot). If you want to save a drawing as a color bitmap, then use the Copy Command to copy the drawing to some other program (ie. Microsoft Paint) first and save it from there. This will result in a larger file.

File Copy Command

Copy places a copy of the drawing onto the clip-board. From here it can be pasted into any program that can handle bitmaps. This is the easiest way to transfer a bitmap (image) and maintain the color. Usually, copying a bitmap will convert it to the appropriate kind of bitmap for the display being used. Therefor, the monochrome bitmap from this program will probably change to a 16-color (VGA) bitmap. If you save a copied bitmap in another program, the file will probably be larger than if you had saved the bitmap from the *Fractal* program.

File Exit Command

Exit will cause the program to terminate. If you have drawn either a Mandelbrot or Julia set and not saved it, the *Fractal* program will offer you the chance to save the drawings before closing. Be sure to look at the caption of the dialog box to see if it is for the Mandelbrot window or the Julia window.

Abort a Drawing

You can abort a drawing if the number of iterations is more than thirty. To abort, press the ESCAPE key. This will stop the drawing, and clear the window. The parameters will remain set and can be changed by using the Draw Command.