Iterations Overview

"Iterations" is a program that generates fractal images which can be used in backgrounds and textures for other images, artwork or photos. It can generate images of any size as long as you have the disk space to support the images. Currently the largest image I have generated has been 7000 by 5440 which created a bitmap file of 37.189 MBytes. The minimum requirements to run "Iterations" is a system with the Windows 95 operating system (I have not tried it with Windows NT), 8 Mbytes of Ram, and a 256 color display. The program is optimized for a pentium processor, however, it will run with a 486 processor, but you will be waiting a long, long time for some of the images to complete.

This program uses double precision floating point operations for all of the calculations and also makes extensive use of C++ operator overloading. These methods are not the most efficient but are extremely well suited for this application.

Features and capabilities:

- Approximately 80 equations for creating fractal images.
- About 40 filters which can be applied to the equations. The filters change the parameters within the iteration such as counting the number of change in the direction of the slope of the real and imaginary axis.
- Audio Video Interleave (AVI) file creation capability for generating fractal videos by zooming and panning in and around a fractal image.
- 8-bit (256 color) Bitmap file import and export.
- The image parameters can be saved and loaded to / from a file parameters file.
- Multiple windows for creating and viewing multiple images simultaneously.
- Image processing using pre-defined convolution kernels such as edge detection, sharpening, averaging, and emboss. A custom kernel can also be applied and the image can continuously convolute to create an animated image.
- The points of the real and imaginary data can be graphed. This program produces three graphs, the real & imaginary plane graphed against the iteration count, the sum of the squares of the real and imaginary values, and the real data plotted against the imaginary data.
- All fractal images can be zoomed in or out of by use of a zoom rectangle drawn with the mouse. The rectangle has a 'X' cross in the middle. This is used for selecting points (pixels) which are used for creating the Julia set and the 'Orbits' graphs.
- Two utility programs are available, one can be used to compress the AVI files and the other is to play the AVI files. The AVI files created by "Iterations" can be played with any AVI file media player software such as "fmedia.exe" which comes with the Windows 95 operating system.
- The color palette can be changed by use of the color dialog box.
- Five color palettes are supported. Each color palette can be altered by use of the color dialog box.

Overview of Iterative Equations

The most common iterative equation is F(z) = z*z + c. In this equation, z, and c are complex numbers. "c" represents the x and y screen coordinate and "z" (which is usually initialized to complex(0,0)), is dynamically incremented until z either escapes a pre-determined escape (bailout) value, converges towards a point, or oscillates within a range. As an example, in equation F(z) = z*z + c, let z start at complex(0,0), and c start at complex(1,1). The first iterative calculation will be z = complex(0,0) * complex(0,0) + complex(1,1). The result will be a new value of "z" which will then be used in the next calculation. The same calculation will be performed, with a new value of "z", until the sum of the squares of "z" are either greater than the bailout parameter (4) or the number of iterations exceed

the allowed maximum iterations. Once the iteration sequence is complete, then the number of iterations is used to color that pixel. Iterative equations in this program have complex boundaries which usually are coordinates of complex(-2,2) (left, top) and complex(2,-2) (right, bottom). Iterations are counted until a point escapes the complex boundaries or it converges or oscillates within the complex boundaries.
Three types of fractal images can be created from iterative equations which have become commonly known as the "Mandelbrot set", "Julia set" and the "Newton Raphson Method for Finding Zeros".
1.) In the Mandelbrot Set, "z" is usually initialized to zero and the constant 'c' is mapped to the current x,y pixel coordinate.

2.) In the Julia Set, "z" is mapped to the x,y coordinate of the pixel and the constant "c" is mapped to the center point within the region.

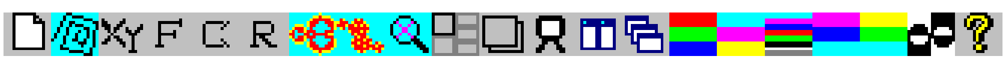
3.) In the Newton Method for Finding Zeros, "z" is mapped to the pixel and a search for a small number, such as 1e-5, is performed within the iteration sequence.

Many iterative equations can be used to generate fractal images, such as F(z) = c * (sin(z) + cos(z)).
The Mandelbrot set is named after Benoit Mandelbrot (pronounced Benwa Mandelbro).
The Julia set is named after the French mathematician 'Julia Gaston' (1893-1978). The Julia set fractal images can be generated for most of the equations found in this program.

Iterations Quick Start

Toolbar Buttons

All of the toolbar buttons have an equivalent menu item. The toolbar buttons are the most frequently used operations and are used for quick access to the menu items.



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

From left to right, the following tool bar buttons are shown on in the application main window:

1.) New - Creates a new window.
2.) Orbit - Used for graphing the orbit of a single pixel location selected by the X point within the zoom rectangle.
3.) XY Size Dimensions - Used for changing the size of the image.
4.) Fractal Parameters - Used for changing the fractal parameters, such as the screen coordinates, maximum iterations, and the bailout value.
5.) Color Parameters - Used for changing the palette color parameters.
6.) Reset Fractal Parameters - Used for resetting most of the fractal parameters back to the default.
7.) Draw Fractal - Used to re-draw the current fractal image.
8.) Draw Julia Fractal - Used for drawing Julia Fractal types. This toolbar button is highlighted only when a zoom rectangle is drawn on an image. The X cross point within the rectangle is the point selected for the Julia Set.
9.) Zoom Into Rectangle - Used for zooming into a rectangle. This toolbar button is highlighted only when a zoom rectangle is drawn on an image with the mouse pointer.
10.) New View on Zoom Mode - This toolbar button can be used to enable or disable a new window opening when zooming or generating Julia sets. The default is to enable new windows when zooming into fractals or creating Julia fractals.

11.) Stretch to Fit - This button can be used to stretch the image to fit in the entire window. By default this mode is disabled. Currently, this application cannot operate on a zoom rectangle when in the stretch to fit mode.
12.) Movie Dialog - This toolbar button brings up the movie dialog box.
13.) Tile Windows - This will tile the windows. There is an "**Auto Tile**" option under the "**Windows** " menu to enable auto tiling.
14.) Cascade Windows
15.) Red Green Blue - Enables the "Red Green Blue" palette.
16.) Cyan Magenta Yellow - Enables the "Cyan Magenta Yellow" palette.
17.) RGB Mix - Enables the "RGB Mix" palette. This is the default pallete.
18.) Magenta Blue Cyan - Enables the "Magenta Blue Cyan" palette.
19.) Yellow Green Cyan - Enables the "Yellow Green Cyan" palette.
20.) Invert Color - This toolbar button will invert the colors regardless of which palette is selected.
21.) About

Selecting an equation

The first thing to do is select an equation. The equations are numbered starting with 0 and go through 115. The equations are grouped in pop-up menu items under **"Menu" | "Polonomials 1", Polonomials 2", Polonomials 3", "Newton", "Geometric", and "Genesis".** There is also a group called **"Custom"** however these are special cases and have no specific equation.

Once an equation number is selected, then the image will be automatically generated with the default fractal parameters. After the equation has been selected and generated, then several other options can be selected to change the appearance of the image such as changing the palette color, selecting a filter, zooming into the image or drawing a Julia fractal by selecting a point within the image.

Zooming in and out

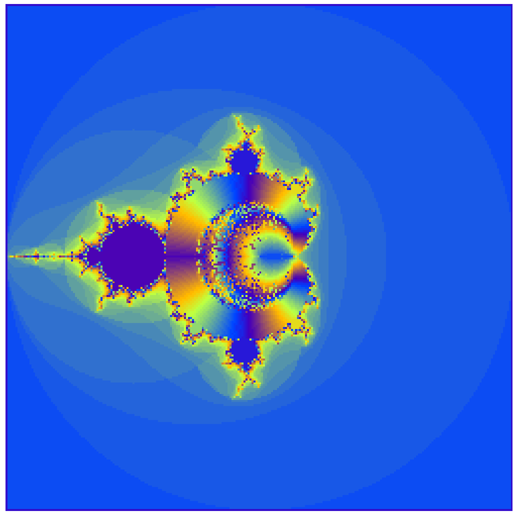
For example, after the application has been started, select equation 0.) F(z) = z*z+c. This is found under the **Menu | Polynomials 1 | 0.) F(z) = z*z + 1;** menu item. Once this equation is selected, the image will automatically draw with the default parameters. You will see the fractal image appear in the window. To zoom into the window, draw a rectangle with the mouse by pointing to a location, pressing the left mouse button and dragging the pointer, then releasing the mouse button. You will see a rectangle drawn on the image with an X cross in the middle of it. This rectangle can be moved around in the image by pointing inside the rectangle, pressing the left mouse button, and dragging the rectangle to a new location. The right mouse button can be used to clear the rectangle. Once a region is within the rectangle, two toolbar buttons are highlighted. These are the "**Draw Julia Fractal**" and the "**Zoom into Rectangle**" toolbar buttons. To zoom into the region of the rectangle, click on the "**Zoom into Rectangle**" toolbar button. The program will create a new window and generate a new image which was the region within the rectangle. To zoom out of an image, the rectangle can be drawn outside of the image boundaries. Also the fractal parameter coordinates can be adjusted using the fractal parameters dialog box.

Drawing Julia Set Fractals

For example, select equation 0.) F(z) = z*z + c; by selecting **the Menu | Polynomials 1 | 0.) F(z) = z*z + 1;** menu item. Draw a zoom rectangle over the image. Position the center of the rectangle over an area near the fractal curve. The center point is the center of the X within the rectangle. Once a point is selected, the "**Draw Julia Fractal**" toolbar button will be highlighted. Click on the "**Draw Julia Fractal**" toolbar button and the Julia fractal will automatically be drawn in a new window.

Filters

Filters are found under the "**Filters**" main menu item. Currently there are about 30 different filters. A filter is used to operate within the fractal equation to enhance the basic fractal image. Each filter can operate on most of the equations. Generally, only one filter can be used at a time. For example, select equation **0.) F(z) = z*z + c** by selecting the **Menu | Polynomials 1 | 0.) F(z) = z*z + 1;** menu item. Then select **Filter | 23.) Sum of 2nd Derivative.** The image will be automatically re-drawn with this filter applied.



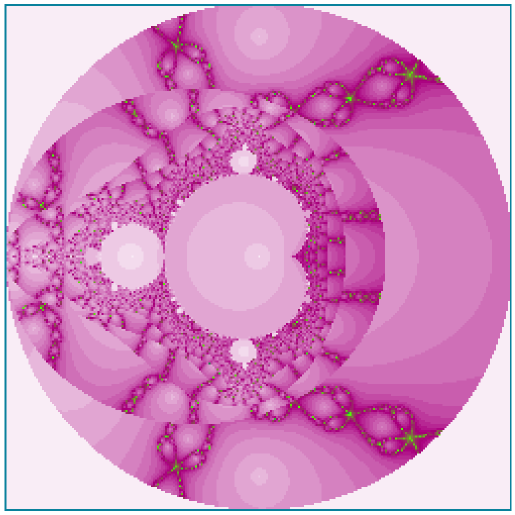
Equation 0 with Filter 23

To remove the filter, select **Filter | 0.) No Filter.** The image will be re-drawn without the filter applied to it. Whenever a new filter is selected, it will turn off the previously selected filter.

Combo-Fract

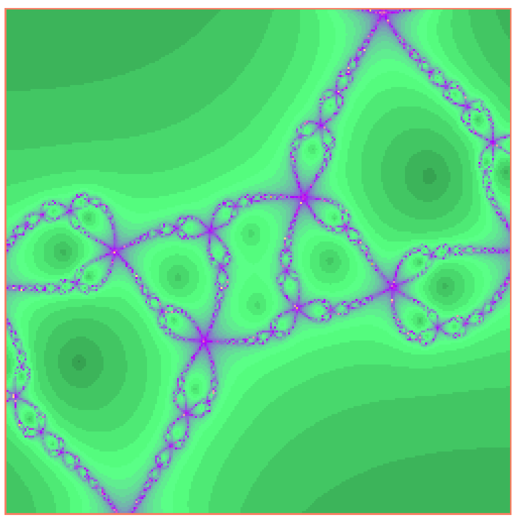
This pop-up menu item is found under the "**Menu**" menu item. "Combo-Fract" is a method for selecting two different equations. The result of the first equation is fed back into the 2nd equation to produce an image which is the combination of two fractal equations. The final coordinate value of the first equation is used as the pixel coordinate of the 2nd equation. Using this method a combination of different fractal types can be achieved such as combining Newton fractals with the Mandelbrot or Julia fractal types.

As an example, create a new window by selecting **File | New.** Select the **Combo-Fract** | **13.) z = c/z;** menu option. A dialog box will appear asking you to enter an equation number. Enter equation "0' and click on OK. An image will be re-drawn in the window. Now select **Menu | Newton | 61.) F(z) = … [Newton].** An image will be re-drawn in the window which may look like the following image after adjusting the palette colors.



Combo Fract, Equation 0 and Equation 63.

The image is a combination of a Mandelbrot and a Newton fractal. Now draw a rectangle in a region to select a Julia point. Click on the "**Draw Julia Fractal**" toolbar button to draw the Julia Fractal. Now zoom into an interesting region within the image and adjust the palette color. If you were successful you should see something like the following image:



Combo Fract 13. Z = c/z; , Julia Set from Equation 0 and Equation 63.

End…
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Hope you enjoy this program and find it interesting. If you have questions, comments or suggestions, please contact me at:
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