

Instructions for Bifurcation Fractal Plotter form v6.0

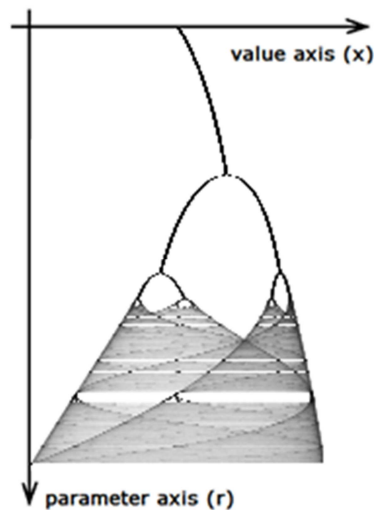
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Bifurcation Fractal Plotter program is written to generate and render several type of bifurcation fractals. It has no GUI, but use of it is clear and simple as program writes all necessary information for you.

Bifurcation fractals

Bifurcation fractals is made by stepped a parameter along parameter-axis and plot results of the iterated equation along value-axis. If you simulate a physical system, then plot value of one system variable when the rendering criterium is fulfilled. So fractal is generated pixel column to pixel column instead of pixel to pixel (as usual at escapetime fractals). Regarding above, program uses 10 times oversampling along value-axis because it does not require extra calculation time.

Because of the structure of bitmap (.bmp) file format program saves pictures the followed orientation:



Moreover image resolution, iteration number also determines image quality. Set it on experimental way in low resolution calculations. After each calculation program print the averaged point/pixel ratio which specifies the image quality. If you not zoomed into fractal it is equal with setted "Iterations per pixel per parameter step" number.

Program files

Program uses and generates several files:

- *BifFraPI_Input_File.txt*: Input file. Contains operating mode (normal/zoom), parameters of image to generate, coloring features of it and fractal features: type, parameter- and value range. In addition you can set multicore calculation here, and adding comments is also possible if you want to save this file for later use.

Tip: if you use Windows Notepad for edit this file you don't have to close it before running program, just press Ctrl+S to save changes.

Please do not rename it and do not delete/insert any lines except of comments on top of the file! Save a backup copy of this file is recommended in case of something do wrong with it.

- *Psuruseg.txt*: Fractal file. This file contains the fractal itself: the point density from pixel to pixel, ie. how many times plotted value dropped under the current pixel. File has two line header: first line is about fractal features and second line contains the resolution (width, height).

For fun try to open this file with IrfanView picture viewer software (it's freeware)!

- *Psur_partX-Y.txt*: Fractal part file. Contains calculated part of the fractal when you use multicore calculation mode (see later). X: actual part, Y: total parts. This file has the same structure as *Psuruseg.txt* has.

- *bifurcatio_Zoom.txt*: Information file of last generated fractal. Does not contains rendering- or coloring features, only parameter- and value ranges and extra data if that exist.

Save this with your image is recommended if you would like to recalculate the image in higher resolution in the future, or want to zoom into it. You can do these in Zoom mode (see later).

If you calculate image in higher Image height resolution and after that resize the image (this is the way of oversampling), remember update height information in the info file! Otherwise mistake takes place when select zoom area. (In the Image width direction oversampling takes place anyway, it does not require any action from you.)

- *bifurcatio_Zoom-prev.txt*: information file of previously generated fractal area for the case if you want to undo last zooming step. For undo last step, copy the content of this file into *bifurcatio_Zoom.txt*! If you generate the same fractal in different resolution this file will not be generated or changed.

- *Bifurcation.bmp*: Rendered image of fractal from *Psuruseg.txt*. If you like it, rename and save as .png format for save memory (it uses lossless compression).

Normal mode

For Normal mode set 0 in the first parameter line of the input file. In normal mode program gets all input parameters from the input file. **It is important** that if you select a new fractal choose min. and max. value of r and x from the given ranges, otherwise program maybe try to divide by zero and halt without any error messages!

In Normal mode program can continue interrupted calculation. If you don't want to continue, just delete the fractal (part) file.

Zoom mode

For Zoom mode set 1 in the first parameter line of the input file. Because of program has no any graphical interface, I didn't write selection algorithm for zooming. For this you can use a little freeware picture viewer called **IrfanView**. Just select the area you interests for and type four coordinates from the window header (in the second brackets) into the program. Do not rotate picture! Zoom in/out picture is allowed.

In Zoom mode program gets only image-, axis scaleing- and coloring parameters from input file, and gets parameters of last fractal from information file and zoom area parameters from you. If you type -1 for A, program calculates last fractal area with the new other parameters given in the input file.

Before calculating a high quality zoom recommended to do a lower quality precalculation not just for checking selected zoom area and evaluate calculation time, but for the information file of the farctal section. **In Zoom mode program can continue interrupted calculation only if you have the information file!**

Oversampling

Please read above at section of *bifurcatio_Zoom.txt*!

Multicore calculations

Program can handle up to 20 processor core even in several machines for faster calculation, in Normal- and also in Zoom modes. For this set Actual- and Total parts number in the input file. After that start program several times.

When you are in Zoom mode use info file for running multicore calculation in any case, otherwise program cannot continue calculation in case of interraptuion, and in addition is hard to set the same zoom area in all the started programs. Use the same info file for all started program! Use own input file for all programs, and make shure that the only difference between them is the Actual parts number!

Let's see an example for a two-core calculation:

- run a low resolution precalculation with low Iteration number for the info file
- set Actual part number to 1, Total parts number to 2
- start the program
- set Actual part number to 2

- start the program again
- when both runs are finished, restart the program, select merge parts
- if fractal is correct, delete fractal part files and keep fractal file if you want to recolor it in the future

Coloring

You can choose two color palettes: gray and blue, and three color distribution: hyperbolic, linear and logarithmic with point density of pixels. With hyperbolic and logarithmic coloring patterns of fractal are observable in every magnitude of point density, but sometimes linear coloring is also useful. When you use hyperbolic or linear coloring set a saturation/reveal value in order that patterns will be observable also in low point density regions. Make experiments to find the proper saturation/reveal value for your picture! If fractal file exists program can recolor it without further calculations (in Normal mode only).

About extra features

Fractals -1..-11 except -5 has multiple attractors, which means that the image depends on the initial values of the iterated variables. In order to find all the attractors, program can perform the calculation with several initial values. To do that, set "Trials to change attractor" parameter more than 1, preferably between 20..500: then program generates random initial values for all variables 20..500 times during the calculation.

Fractal -10 and 15 are coupled systems: the result of every iteration is the linear combination of variables of two identical systems. Set the "Coupling factor" between 0..0.5.

You can apply parameter perturbation on fractal 0 and -1..-10 except -5. To do this, set "Amplitude of parameter perturbation" between more than $1E-7$, preferably 0..0.1, and "Frequency of parameter perturbation" to any value, preferably 0..1. If the "Amplitude of..." = 0 (or $<1E-7$), perturbation will be not applied. At fractal -10, only the plotted system's parameter can be perturbed, because this resulted more interesting images.

By setting "Swap actual parameter (r) and..." to 1, the coupling factor will be the stepped property between Min. r and Max. r, and parameter of fractal will be fixed to the value of coupling factor. Similarly, you can swap the parameter with Amplitude or Frequency of the perturbation by set Swap to 2 or 3, respectively. Perturbation will be applied always on the stepped property. For no perturbation, set Amplitude to 0 and Swap to 0, 1 or 3 (but not to 2)!

Compile the code

I wrote the source code of this program in Pascal language and compiled it with FreePascal compiler for Windows operation systems. If you use other OS, you can download FreePascal for free and compile BifFraPl_vXX.pas source code for your OS (under your OS only). Comments and some of the variables are in Hungarian language.

Before compile, select *Option – Compiler – Allow LABEL and GOTO and Turbo Pascal compatible mode* on *Syntax* tab, and unselect *Range checking, Stack checking and I/O checking* on *Code generation* tab. Choose also *Generate faster code* and *Level 1 optimisation* here. After compile it with *Compile – Build* command.

For further info and pictures please see the following topics on Fractal Forums

Bifurcation fractals discovery:

<http://www.fractalforums.com/new-theories-and-research/bifurcations-fractals-discovery/>

Bifurcation Diagram Bouncing Ball:

<http://www.fractalforums.com/new-theories-and-research/re-bifurcation-fractals-discovery/>

Bifurcation fractal of Standard Map:

<http://www.fractalforums.com/new-theories-and-research/bifurcation-fractal-of-standard-map/>

Parametric color mapping techniques:

<http://www.fractalforums.com/programming/parametric-color-mapping-techniques/>

Bifurcation Fractal Plotter – BifFraPl:

<http://www.fractalforums.com/windows-fractal-software/bifurcation-fractal-plotter-bifrapl/>

Multiple attractor bifurcation fractals:

<http://www.fractalforums.com/new-theories-and-research/multiple-attractor-bifurcation-fractals/>

Bifurcations of Coupled systems:

<http://www.fractalforums.com/new-theories-and-research/bifurcations-of-coupled-system/>

Parameter perturbation and exotic "bifurcation" fractals:

<http://www.fractalforums.com/new-theories-and-research/parameter-perturbation-and-exotic-'bifurcation'-fractals/>