Introduction

This manual contains complete documentation for Ultra Fractal 3 in printer-friendly format. All information in this manual is also accessible from the Help menu in Ultra Fractal. You can also get context-sensitive help in every dialog and tool window in Ultra Fractal. Click the **?** button in the title bar, and then click on a control to learn more about it.

The compiler reference is not included in this manual because it would make it unnecessary large. To access the compiler reference, click Contents on the Help menu in Ultra Fractal. In the Writing Formulas chapter, there's an additional Reference chapter that lists all functions, operators, keywords, and so on. Alternatively, click on a symbol in the formula editor and then click Topic Search on the Help menu.

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New features

These are the most important new features in Ultra Fractal 3:

- **Deep zooming**
  It's now possible to zoom to magnifications of about 10^{4000}. In practice, this means that there is no limit anymore to how far you can zoom in. Deep zooming is supported for all fractal types, including your own formulas. See Arbitrary precision.
- **Masks**
  With masks, you can make selected parts of a layer transparent, using transparency information from an invisible mask layer. See Masks.
- **Direct coloring algorithms**
  Direct coloring algorithms are a new kind of coloring algorithms that directly return a color, instead of using the gradient. This enables you to use various new coloring techniques. See Direct coloring algorithms.
- **Network calculations**
  You can now connect to other computers on a local network and even on the Internet to accelerate fractal calculations. This works for both fractal windows and disk render jobs. See Network calculations.
- **Browsers**
  The new browsers look and work like Windows Explorer. You can also open modeless browsers to organize your work. They can work with all Ultra Fractal file types, including fractal files, PAR parameter sets and MAP palettes. It's also possible to search for entries and files. See Browsers.
- **Gradient editor enhancements**
  Gradient editors are now resizeable, and they can edit transparency as well as colors. The alpha channel editor has been removed. See Gradients and Transparent gradients.
- **Fractal history**
  Undoing and redoing changes to a fractal no longer requires recalculations, because the image data is now saved as well. The new History tab on the Fractal Properties tool window shows a history list with previews that enables you to jump effortlessly to previous states. See Fractal history.
- **Render to disk enhancements**
  Render jobs are now put in a queue so they can be rendered more efficiently. There is a new Render to Disk tool window to monitor and manage the jobs in the queue. The quality of the rendered images is even higher, with smoother colors and better anti-aliasing. See Exporting and rendering.
- **Predefined layers and formulas**
  You can store predefined preset layers and masks to make it easy to use them in other fractals. You can also store predefined transformations, fractal formulas, and coloring algorithms. See Working with layers and Working with fractal formulas.
- **Formula database support**
  There is built-in support for downloading and installing new and updated formulas from the online formula database. See Public formulas.
- **Support for locating missing formulas**
  When opening a parameter set that uses a formula that cannot be found, a new dialog box will pop up that automatically searches for the formula on your computer. You can also choose to download the missing formula from the online formula database.
- **Stretching and skewing**
  Stretching and skewing of fractals is now natively supported, both in the Location tab on the Layer Properties tool window, and in Normal mode and Select mode.
- **Parameter set compression**
  Parameter sets are now optionally stored in a compressed format to make it easier to share them with other users via e-mail. See Parameter files.
- **Automatic credits list**
  The new credits list in the Comments tab on the Fractal Properties tool window automatically tracks all artists that have worked on the fractal, so everyone receives proper credit.
- **Formula folder enhancements**

The formula folder organization has been simplified. There is only one formula folder for all types of formulas now, with a subfolder for public formulas. You can specify additional folders that Ultra Fractal should search for formulas when opening a parameter set (for example with old Fractint formulas). There's a separate folder to store help on formulas. See the Folders tab in the Options dialog.

- **Standard formulas with help**
  There's a more comprehensive collection of standard formulas with help on each formula. See Standard fractal formulas, Standard coloring algorithms, and Standard transformations.
- **TIFF support**
  Exported and rendered images can now also be saved in TIFF format (used by many print shops). See File formats.

See Also

Tutorials

User interface enhancements

Compiler enhancements

User interface enhancements

This is a list of the other enhancements in Ultra Fractal 3:

- **Tool window enhancements**
  All tool windows are now resizeable. By default, they are docked to the new dock bar in the main window. If you prefer floating tool windows, simply drag them out of the dock bar. If you're running Windows 2000 or XP, the tool windows can also be made transparent. See Tool windows.
- **Formula parameters**
  All parameters of a formula are now visible at the same time so they are easier to work with. Parameters can be grouped in sections, and they can automatically be hidden or disabled when they are not used. You can copy and paste complex parameters in one step. See Formula parameters.
- **Layer management**
  The Layers tab on the Fractal Properties tool window now shows thumbnails for all layers and masks. Layers can be copied to other fractal windows simply by dragging and dropping them. See Layers.
- **Fractal Mode tool window**
  The new Fractal Mode tool window replaces the old Select and Switch tool windows. It shows options and previews depending on the current mouse mode. See Normal mode, Select mode, and Switch mode.
- **Transformation enhancements**
  The list of transformations in the Mapping tab on the Layer Properties tool window is now resizeable. Transformations each have their own solid color now, and they can be renamed. See Transformations.
- **Formula editor enhancements**
  The formula editor works better with large formula files. With the drop-down box on the toolbar, you can quickly jump to any formula within the file. New features include searching for formulas, searching for help on the word under the cursor, inserting commonly used templates, and easily commenting blocks of text. See Formula editors.
- **Window panel**
  The new window panel in the right-hand corner of the status bar shows all open document windows and makes it easy to switch between them. See Workspace.
- **Statistics**
  The new Statistics tool window replaces the old Information tool window. It contains a new iterations histogram that helps you to find a good maximum iterations value. See Maximum iterations.
- **Recently used files**
  At the bottom of the File menu, there is now a list of recently opened files. The number of items shown is adjustable in the Environment tab on the Options dialog.
- **Full screen mode**
  In full screen mode, you can now perform basic operations like zooming and panning, gradient adjustments, and color cycling. See Full screen mode.

See Also
New features
Compiler enhancements

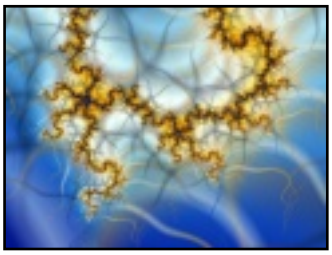
Compiler enhancements

This is a list of all compiler and formula language enhancements in Ultra Fractal 3:

- **Global sections**
  Formulas can now contain a global section that is executed only once per image. This is useful to calculate look-up tables, for example. See Global sections.
- **Arrays**
  You can now declare and use arrays of any variable type. Arrays can be multidimensional and of any desired size. See Arrays.
- **Color types and operations**
  A new color variable type is available, as well as new functions and operators that work on colors. This is intended for direct coloring algorithms. See Types and Writing direct coloring algorithms.
- **Parameter headings**
  Formula parameters can now be organized into logical groups by inserting parameter headings. See Headings.
- **Enabled and visible settings**
  Parameters can now be hidden and disabled dynamically when they are not used, making them easier to use. See visible setting and enabled setting.
- **Expressions for default values**
  The default value for parameters can now optionally be an expression. For example, you can set the default value to the current center coordinates. See default setting.
- **Print function and run-time messages**
  The new print function enables a formula to write messages to the Compiler Messages tool window while it is executing. This makes debugging much easier. See Debugging.
- **Comparing enumerated parameters**
  When testing enumerated parameters, you can now directly compare them to the string values they represent, instead of having to look up the corresponding numerical index values. See Enumerated parameters.
- **Parameter type declarations**
  Parameter blocks can now optionally include the type of the parameter, so the type no longer depends on the exact format of the default setting. See Parameter blocks.
- **Random values**
  Generating sequences of random values is much easier with the new random function. See Random values.
- **Variable declarations**
  For consistency with array declarations, you can now also declare variables without directly assigning a value to them. See Variables.
- **Support for HTML Help**
  Ultra Fractal now also supports help for formulas in HTML Help (*.chm) format. See Providing help and hints.

See Also
New features
User interface enhancements

Tutorials



To help you to get up to speed quickly with Ultra Fractal, this chapter contains a complete set of tutorials. Starting with the basics, you'll soon learn how to create your own fractals, change the colors, add layers and even use masks.

The tutorials are organized in such a way that beginners can follow the steps in the main text without stopping to learn more advanced features. Small boxes on the right contain Tips, Hints and links to Learn More... for more experienced users.

The following tutorials are available:

- Quick Start Tutorial
  Here, you'll learn how to create a new fractal from scratch. You'll experiment with formula parameters, add a coloring algorithm, and learn how to save and re-open fractals.
- Learning basic skills
  This tutorial explains the basics of working with fractals: using Switch Mode, zooming, and working with gradients to adjust colors.
- Working with layers
  Now that you know the basics, learn how to add new layers, work with opacity and merge modes, and create transparent gradients.
- Learning about transformations
  To make things even more interesting, this tutorial shows you how to add transformations to your fractals to create all kinds of different effects.
- Masking
  This final tutorial extends the skills you've learned so far and shows how to use the new masking feature. Along the way, you'll create a wonderful image to decorate your Windows desktop with!

All tutorials were written by Janet Parke (see Some final thoughts).

See Also
New features
What are fractals?
Workspace

Creating a fractal image

When you first open Ultra Fractal 3, the default Mandelbrot set is shown. Since we're going to create a new fractal from scratch, let's close this fractal.

Click **Close** on the **File** menu to close the fractal window.

Now, the workspace is empty except for a row of Tool Windows on the right side of the screen. These tool windows are where you'll enter and edit the information which creates the fractal image on your screen. The tool windows are the information center of the program and it is advisable to keep them open at all times.

Learn more about...
Tool windows

The first step in creating a new fractal is to select a Fractal Formula which determines the structure of the fractal with which we'll be working.

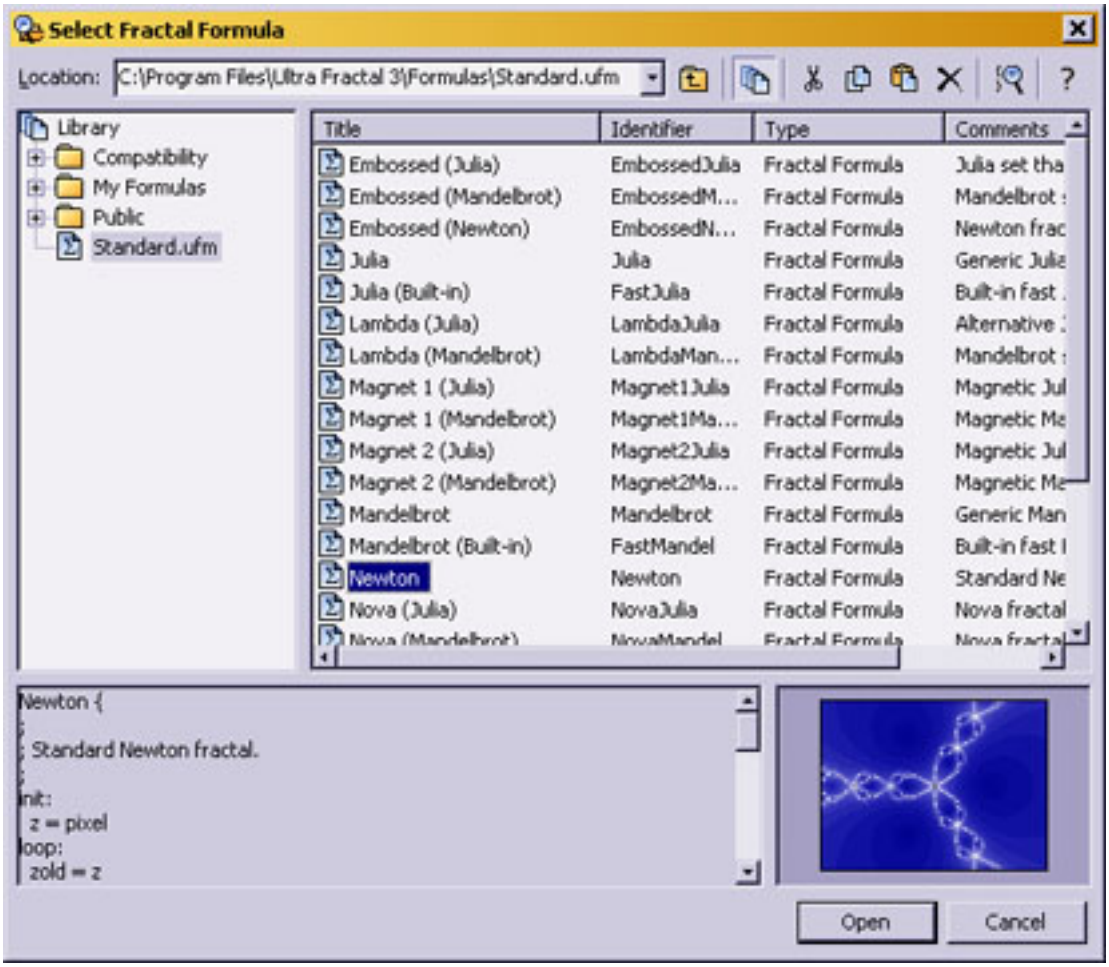
To open a new fractal window, click **New** on the **File** menu and select **Fractal**.

This opens the "Select Fractal Formula" browser. The left pane shows three folders (Compatibility, My Formulas, and Public) and a file named "Standard.ufm".

When you click on **Standard.ufm**, its contents — a list of the formulas it contains, appears in the right pane of the browser window. Clicking on any of these formula names will show a preview of the image that the formula will produce in the thumbnail pane.

Learn more about...
Fractal formulas

Tip!
There are three additional ways to access most features and tools: Toolbar buttons, Right-click (mouse) menus, and Keyboard shortcuts.



Click on the ***Newton*** formula and then on the **Open** button. *(Note: Make sure it's the **Newton** not the "Embossed Newton" formula!)*

This opens a new fractal window, loaded with the *Newton* formula, which looks like the preview in the browser window above.

Learn more about...

The *Newton* formula

Next: Changing formula parameters

Changing formula parameters

Look at the Tool Windows on the right side of your screen and click on the **Formula** tab of the topmost (**Layer Properties**) window.

Under the formula name at the top (in this case, *Newton*) you'll see settings (Drawing Method, Periodicity Checking, Additional Precision, and Maximum Iterations) which appear for every fractal formula. The parameters specific to this particular formula are listed below the dividing line (in this case: Exponent (Re), Exponent (Im), Root (Re), and Root (Im)).

The Exponent parameter determines the number of "arms" of the *Newton* fractal structure. The default value is "3" so the fractal has three arms. Try entering different values in the Exponent (Re) parameter.

When you're finished experimenting, enter **4** in the Exponent (Re) parameter. Your fractal will look like this:

At this stage, you may want to change the size of the fractal window. To do this, click on the **Image** tab of the second (**Fractal Properties**) tool window. Make sure the "Maintain Aspect Ratio" box is checked and then enter a new value in the width field.

Tip!

While Guessing, the default drawing method, is the fastest method of rendering fractals, it often introduces artifacts into the image. You may wish to choose either the Multi-Pass or One-Pass Linear options for accurate rendering.

For fun...

Try entering negative numbers and other values (e.g. .5, 1.2, and .0385) in the various parameters and see how they twist and fracture the structure.

Tip!

You can customize the default fractal window size by clicking **Options** on the **Options** menu and selecting the **Defaults** tab.

Next: Applying a coloring algorithm

Applying a coloring algorithm

The next step in creating a fractal is to apply a **Coloring Algorithm** to the fractal structure. Here's where the real fun begins!

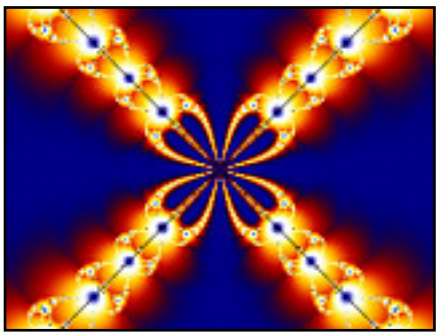
Learn more about...
Coloring Algorithms

Click on the **Outside** tab of the **Layer Properties** tool window.

The default coloring algorithm is called "None" and it simply assigns a color to each pixel. Let's load an algorithm which will give us some more creative control over the image.

Click the **Browse** button on the **Outside** tab which brings up the "Select Outside Coloring Algorithm" browser.

Click on the **Standard.ucl** file in the left pane and then on the ***Orbit Traps*** algorithm in the right pane. Click **Open** to apply this algorithm to your fractal.



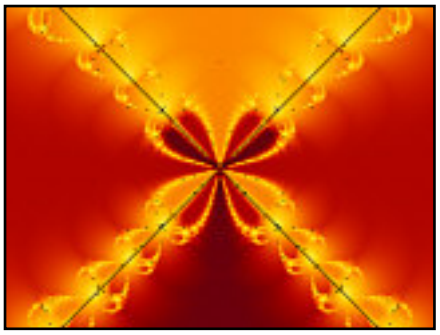
Learn more about...
The *Orbit Traps* Coloring Algorithm

Just as on the Formula tab, there are several settings on the Outside coloring tab (Color Density, Transfer Function, Solid Color, Gradient Offset, and Repeat Gradient) which appear regardless of the algorithm chosen. The parameters below the dividing line are specific to the *Orbit Traps* algorithm.

Click on the arrow at the right of the **Transfer Function** setting and select **Log** from the drop-down list.

Click on the arrow at the right of the **Trap Shape** parameter and select **Egg** from the drop-down list. Your fractal will now look like this:

Tip!
To learn more about a particular parameter, click **?** in the title bar of the tool window, and then click the parameter.



Tip!

There are so many options available with the *Orbit Trap* coloring algorithm. It would be well worth your time to work through them, observing what effect each change, and each combination of parameters, has on your image.

You may notice, now that we've selected this combination of parameters, the black lines that bisect each of the arms of the fractal. This is due to the precision of Ultra Fractal's calculations. We can circumvent this effect by making a small adjustment on the Location tab.

Click on the **Location** tab of the **Layer Properties** tool window, and enter **.01** in the **Rotation Angle** setting. This rotates the fractal imperceptibly and eliminates the black lines.

Next: Saving your fractal

Saving your fractal

This is not a very exciting fractal yet, but before we go further, let's save our work. There are various ways to save a fractal, and we will cover them one by one in these tutorials.

This time, we will save the image within Ultra Fractal in a text-only form called a **Parameter File**. This file takes up very little space on your hard drive and can be easily shared with other users via email and mailing lists.

Learn more about...
Sharing parameter files with other users

 Choose **Save Parameters** on the **File** menu.

With the "Save Parameter Set" browser open, you can create a parameter file which will hold all the images we create in these tutorials. At the bottom of the browser, in the **File Name** field, append the entry with **tutorials.upr** so that the end of the path reads:

... My Documents\Ultra Fractal 3\Parameters\tutorials.upr

(This assumes that you've installed Ultra Fractal using the default document folders.)

Next, in the **Title** field, enter **Newton 1** (the title can be any length and may contain spaces) and then click the **Save** button. We will use this image again later in the tutorials so you can close the fractal window or even Ultra Fractal itself at this time.

Next: Opening your saved fractal

Opening your saved fractal

You can re-open the saved fractal at any time by clicking **Browse** on the **File** menu. Check to make sure that **Parameter Files** is selected on the toolbar.

Now select **tutorials.upr** in the left pane of the browser window and **Newton 1** in the right pane. Double-clicking on the name will open the fractal.

***Note**: If you are brand new to fractals or Ultra Fractal, you might want to become more comfortable with these beginning steps before moving along to the next tutorial. Feel free to experiment with other fractal formulas and coloring algorithms in different combinations as you practice.*

Next tutorial: Learning basic skills

Learning basic skills

In this tutorial, we are going to learn some basic skills for working with fractals — using Switch Mode, zooming, and working with gradients.

Let's create a new image using a different fractal formula.

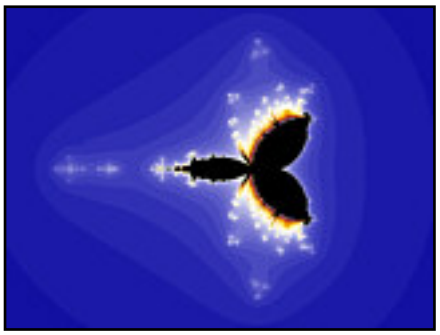
Click **New** on the **File** menu, and then click **Fractal**.

Select the ***Phoenix (Mandelbrot)*** formula from the list in the right pane of the "Select Fractal Formula" browser window. Double-click on the name, or click **Open**.

If you cannot find the formula, make sure that the file *Standard.ufm* is selected in the left pane first.

The *Phoenix* formulas

You should now see this image on your screen:



Next: Learning to use Switch Mode

Learning to use Switch Mode

Although we could work with this image as is, let's learn about using the Switch feature to open a corresponding *Julia* version of this *Phoenix (Mandelbrot)* fractal.

Using the Switch feature is often a good way to find interesting fractal structure.

Learn more about...
Switch Mode

Click **Switch Mode** on the **Fractal** menu.

Place your mouse cursor anywhere in the active fractal window and look at the **Fractal Mode** tool window on the right-hand side of your screen. Each point in the *Phoenix (Mandelbrot)* set corresponds to a separate *Julia*-type fractal. As you move your mouse around the fractal window, notice that a preview of that corresponding *Phoenix (Julia)* image is displayed in the Fractal Mode preview window.

When you find an image in the preview window that appeals to you, click once and a new fractal window containing that image will open. This window (named *Fractal2*) is the one with which we'll be working, so you can close the original window (*Fractal1*) without saving it.

Click on the **Formula** tab of the **Layer Properties** tool window and notice that this fractal uses the *Phoenix (Julia)* calculation formula.

Just below the horizontal line in this same tool window are the Julia Seed parameters that you brought to this fractal when you switched from the *Phoenix (Mandelbrot)* to the *Phoenix (Julia)* formula. You can experiment with changing these parameters to see how the structure of the fractal changes.

At any time, you can undo your changes by clicking **Undo** or **Redo** on the **Edit** menu.

Next: Synchronizing the Julia Seed

Synchronizing the Julia Seed

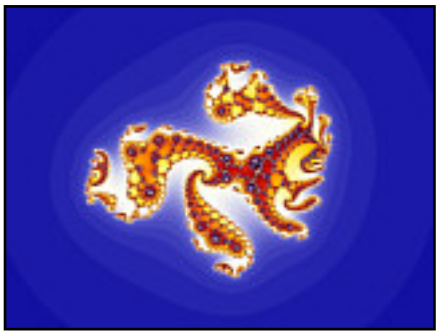
Because it is highly unlikely that you have chosen the exact Julia Seed values that we'll be using in this tutorial, we'll need to synchronize those values before we can proceed.

The Julia Seed parameters for this tutorial image are long, complicated numbers, but you won't need to type them in by hand. Just click on them below to copy them to the Clipboard.

-0.2589852008
-0.1395348837

Switch to Ultra Fractal and right-click in either of the **Julia Seed** parameter fields on the **Formula** tab of the **Layer Properties** tool window. In the menu that appears, click **Paste Complex Value**.

Your image should now look like this:



Next: Zooming into the image

Zooming into the image

The most interesting fractal structure of this *Phoenix (Julia)* fractal exists in the red-orange-yellow areas so let's zoom in and explore what's there.

Click **Select Mode** on the **Fractal** menu and notice that a rectangular box appears in your fractal window.

Press **Enter**. The fractal now re-draws onscreen filling your image with the previously selected area.

Another way to invoke the selection box is to place your mouse cursor on an interesting part of your image. Click and hold the left button and drag the cursor until you've selected the area in which you wish to zoom.

Learn more about...

Select mode

Notice that by placing your mouse cursor over different parts of the selection box, you can also move, resize and rotate the box. The status bar at the bottom of the main Ultra Fractal window displays helpful hints while you move the mouse cursor around.

Try these options until you've framed an interesting section and then press **Enter** to zoom into this new area. To zoom out, press **Ctrl+Enter** instead.

You may want to spend some time zooming in and out to explore your fractal before we move on to the next part of the tutorial. Don't worry about where you travel, for we'll synchronize locations in the next section.

Tip!

Instead of pressing **Enter** or **Ctrl+Enter**, you can also right-click in the fractal window and click **Zoom In** or **Zoom Out** on the menu that appears.

Next: Synchronizing the location

Synchronizing the location

Now that you've explored a bit, let's synchronize your fractal's location with that of the tutorial image so we can proceed together.

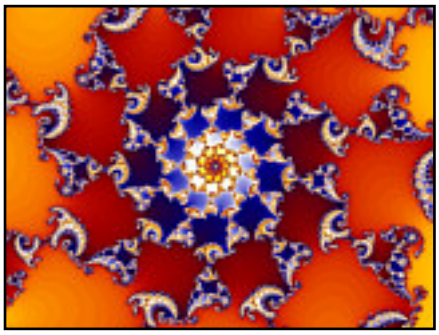
Click on the **Location** tab of the **Layer Properties** tool window. This time you're going to copy and paste all the necessary parameters in one operation.

Click on the text below to copy it to the Clipboard.

BackgroundLocation {
location:
** center=-0.3979/0.28282 magn=1102.9412**
}

Now switch to Ultra Fractal and click the **Paste Location** button on the **Location** tab of the **Layer Properties** tool window.

Your image should now look like this:



Next: Adding outside coloring

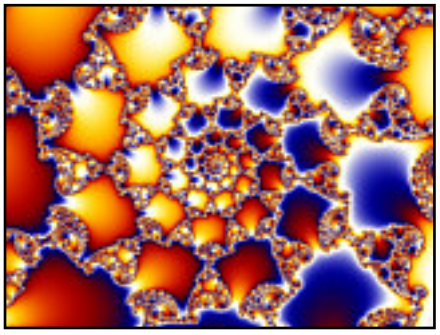
Adding outside coloring

Next, let's apply a coloring algorithm to this image.

Click on the **Outside** tab of the **Layer Properties** tool window and then click the **Browse** button.

Select the ***Smooth (Mandelbrot)*** entry in the right pane of the "Select Outside Coloring Algorithm" browser and then click **Open**.

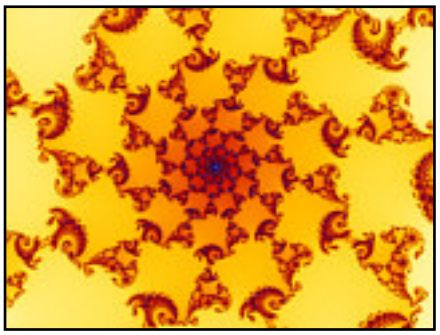
If you can't find it, make sure *Standard.ucl* is selected in the left pane first.



Learn more about...

The *Smooth (Mandelbrot)* coloring algorithm

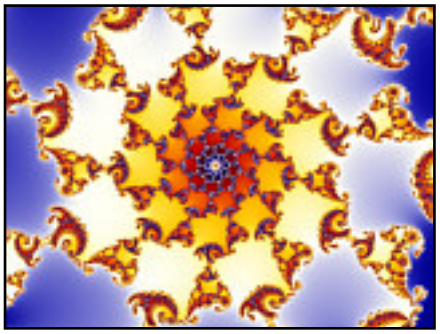
This isn't very pretty but we can make some improvements by changing two of the coloring settings. Change the **Transfer Function** to **Sqrt**, which makes the image less busy...



Learn more about...

Coloring settings

... and change the **Color Density** to **5** to add in a few more colors.



Next: Working with the gradient

Working with the gradient

So far, the only adjustments we've made to the colors in our fractal have been through changes we've made to the coloring algorithm and its parameters. Since the coloring algorithm references colors found in the palette of the gradient, let's open and explore the **Gradient Editor**.

Learn more about...
How gradients work

Select **Gradient** from the **Fractal** menu to bring up the gradient editor for our fractal.

You'll notice that the colors in the gradient correspond to the colors in your image. Both the gradient editor and your fractal contain blue, white, yellow, red, and black areas.

Learn more about...
Gradients

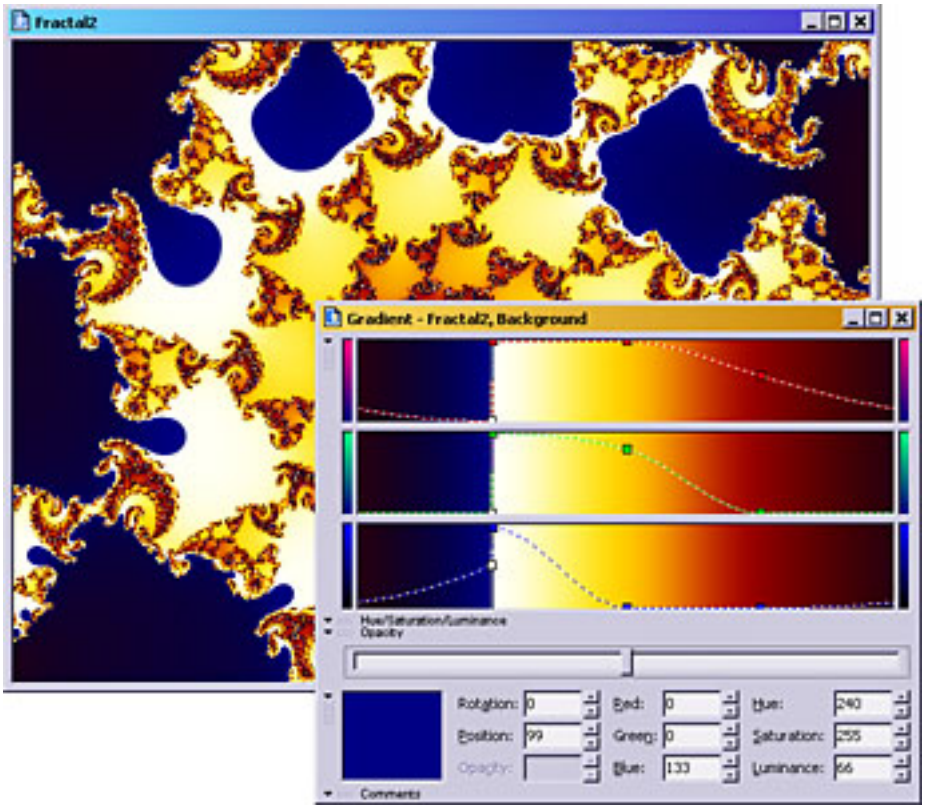
By clicking and dragging the horizontal slider on the Gradient editor to the right and left, you can rotate the gradient, and thus the colors in your image.

You can also move individual control points in the top 3 panels. Click on the top- and left-most control point and drag it to the right.

Learn more about...
Editing gradients

Notice that you can drag it horizontally past other control points and that doing so affects the shading between colors. Any changes made in the gradient editor are immediately reflected in your fractal onscreen.

If you drag a control point to a position immediately adjacent to another control point, this creates a sharp line between those two colors in the image rather than the smoother gradation that occurs when the control points are farther apart.



You can also drag each control point vertically within its panel of color to change the color of that point. Try moving the various control points up and down to see this.

Note: Unless you have experience with similar gradient editors in other graphics programs, you will want to spend time working with the gradient editor to learn how to manipulate the control points to make the colors you want.

While you can add, delete, move, and adjust the control points yourself — and you will eventually want to become very comfortable with these skills — an easy way to change colors is to use the **Randomize** feature.

Learn more about...

Adjusting colors and Random gradients

To generate a random gradient, click **Randomize Bright** (or **Randomize Misty**) on the **Gradient** menu. You can repeatedly press their respective keyboard shortcuts (**F6** and **F7**) until you find a set of colors you'd like to use.

For fun...

You can create some really interesting gradients with the **Randomize Custom** editor.

Next: Synchronizing colors and Saving the image

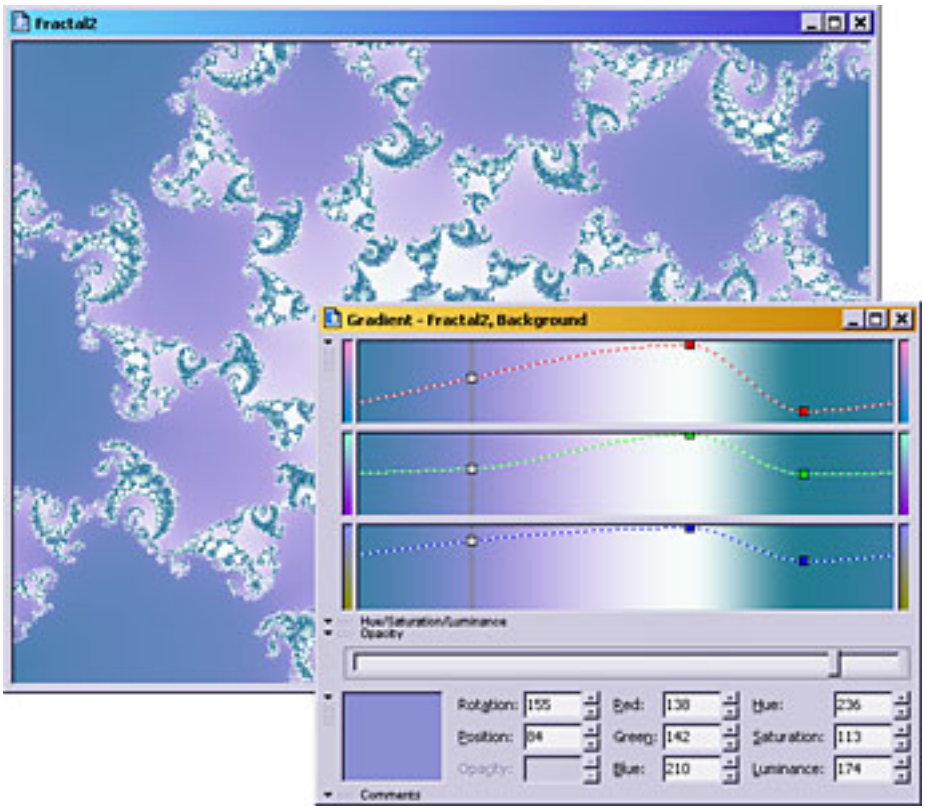
Synchronizing colors and Saving the image

Now that you've become more familiar with gradients, let's synchronize the gradient of your image with the tutorial fractal. Click on the text below to copy it to the Clipboard.

```
Gradient-Fractal2,Background {
gradient:
  title="Gradient - Fractal2, Background" smooth=yes rotation=155 index=84
  color=13799050 index=247 color=16448758 index=332 color=9665827
opacity:
  smooth=yes
}
```

Now switch to Ultra Fractal. Right-click on the gradient editor and select **Paste**.

Your image and gradient editor should look like this:



Before we go on, let's save the parameters for this image. Click on the fractal image and then select **Save Parameters** on the **File** menu. Click on ***tutorials.upr*** in the left pane of the Save Parameter Set browser and then enter **Phoenix Julia 1** in the **Title** field at the bottom. Click **Save**.

Saving the parameters only saves the "recipe" for the image in text form. Ultra Fractal can also save the image in graphic form so that it can be re-opened and edited at a later time. Let's also save this image in this way as a **.ufr** file.

Click **Save** on the **File** menu. By default, Ultra Fractal puts all .ufr files in its "Fractals" folder. Since we've already named the image, its title appears in the **File Name** field and we can accept these defaults by clicking on the **Save** button.

Next tutorial: Working with layers

Tip!

The **.ufr** format saves the rendered image so re-opening it does not require recalculation as parameter files do. This is very handy and time-saving for many-layered or slow-to-render images.

See also File types.

Working with layers

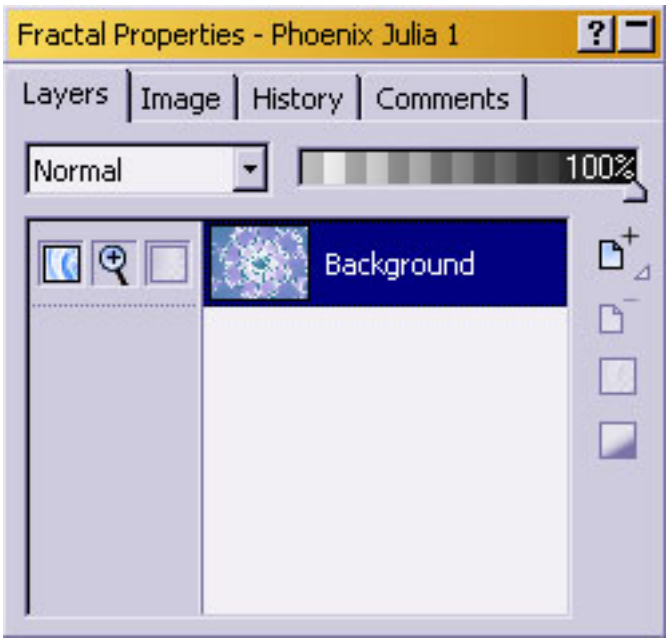
Note: This tutorial assumes that you have worked through the Quick Start and Basic Skills tutorials and have saved the "Phoenix Julia 1" image from the Basic Skills tutorial.

Now that we've learned some basic skills, it's time to explore one of Ultra Fractal's key features — layering.

Learn more about...
Layers

Let's open the image we created in the last tutorial. This time we'll use the .ufr file which will open the fully-rendered image onscreen. Click **Open** on the **File** menu. Locate the .ufr file — remember that we saved it in the "Fractals" folder — click on the file name (***Phoenix Julia 1.ufr***) and click **Open**.

Now look at the **Fractal Properties** tool window. Click on the **Layers** tab and notice that there is a tiny copy of the image in a layer named Background.



To add a new layer, simply click the **Add Layer** button on the **Layers** tab.

Now you'll see two layers — your original, still labeled "Background", and a new, identical layer labeled "Layer 1".

Next: Coloring the new layer

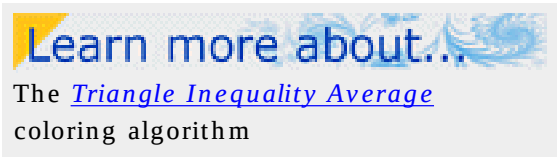
Tip!
If you click and hold down the **Add Layer** button, a menu with predefined layers appears. Click a predefined layer to add it, or click **Define** to customize the menu.

Coloring the new layer

Let's apply a different coloring algorithm to this new layer.

Click on the **Outside** tab of the **Layer Properties** tool window and then click the **Browse** button.

Select the ***Triangle Inequality Average*** coloring from the browser's right pane and click **Open**. You can immediately see the new coloring applied to the fractal.



The *Triangle Inequality Average* coloring algorithm

These colors are OK, but let's take this opportunity to learn more about gradients. First, open the gradient editor by selecting **Gradient** from the **Fractal** menu.

We could adjust the control points on this gradient, or generate a random gradient as we learned in the Basic Skills tutorial, but we can also load a pre-saved gradient. To do this, select **Replace** from the **File** menu.

The "Select Gradient" browser shows the pre-saved gradient files which come with Ultra Fractal and any gradients you have saved or imported. Click on the ***Standard.ugr*** gradient file in the left pane of the browser window and ***Grayscale*** in the right pane. Click **Open**.

Opening and saving gradients

The pre-saved *Grayscale* gradient has now been loaded into the gradient editor and the active layer of your fractal.

Next: Editing the gradient

Editing the gradient

Before we edit the gradient, go to the **Outside Tab** of the **Layer Properties** tool window and change the Color Density setting to **1** and the Transfer Function setting to **Linear**.

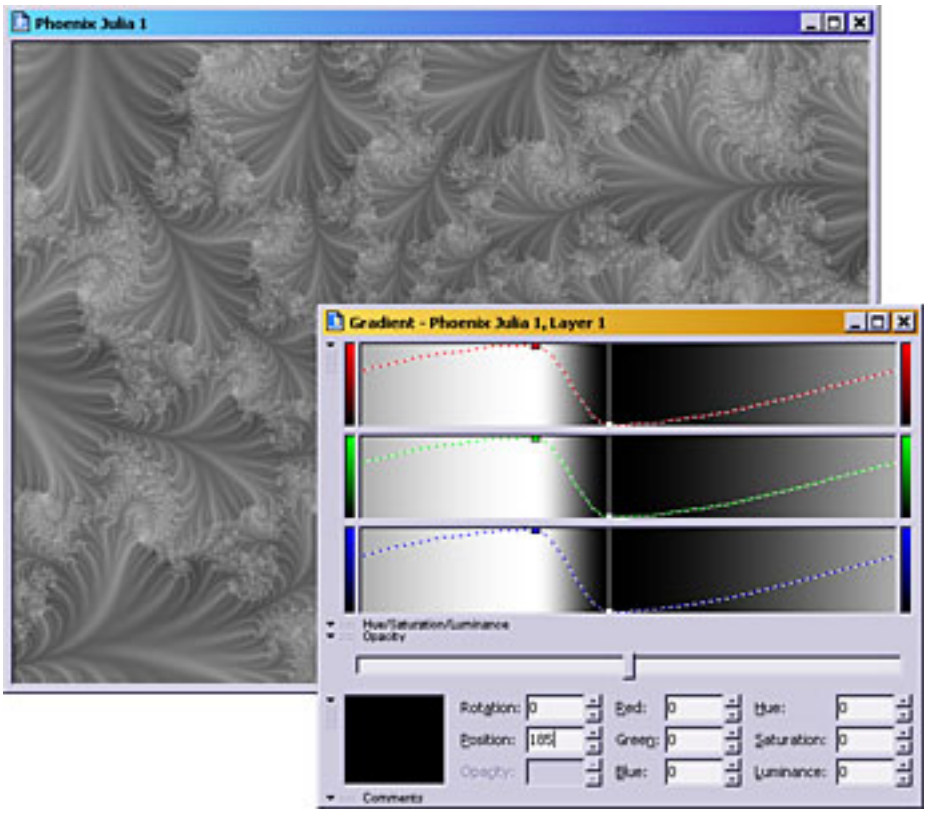
Learn more about...
Editing gradients

Now, looking again at the gradient editor, you'll notice that there are only two sets of control points. Those in the left-most set are all at the bottom of their respective color panels — creating black, while those in the middle of the gradient editor are at the top of their panels — creating white.

Let's move the control points around until we increase the contrast between the white and black areas. As you drag the control points, be sure to keep them pulled all the way down (for black) or all the way up (for white) in their color panels to prevent introducing color into the gradient.

After you've experimented with moving the control points, let's synchronize their positions. A nice contrast can be found with the set of white control points at Position setting **130** and the black control points at Position setting **185**. You may either drag the points to these locations, or click on the respective points and type their positions into the **Position** setting.

Your image and gradient should now look like this:



Next: Learning about layer opacity

Learning about layer opacity

If you'll look again at the **Layers** tab of the **Fractal Properties** tool window, you'll see both your layers and their tiny thumbnails listed.

Learn more about...
Working with layers

But when you look at your image, you only see the top, grayscale layer. This is because the top layer is 100% visible in "Normal" merge mode, which means that you won't see any layers underneath it.

 To check that the other layer is still really there, click the **Visible** icon on the **Layer 1** layer.

This toggles this layer's visibility off and on. When the visibility is off, you will see the layer(s) underneath. When it is on, you will see the active layer.

Having multiple layers in our image is useless, though, unless we can see more than one at a time. There are many ways to do this, so let's work through them one at a time.

At the top of the **Layers** tab there are two controls. The one on the left is the Merge Mode setting (which currently says "Normal") and to its right is a horizontal slider (currently all the way to the right at 100%).

Make sure the top layer of your fractal (*Layer 1*) is visible again. With the top layer highlighted in the layer list, click and drag the Opacity slider slowly to the left and watch what happens to your fractal.

As the top layer becomes more transparent, the bottom (*Background*) layer begins to show through. When the Opacity slider is all the way to the left, at 0%, the top layer is no longer visible at all.

Next: Learning about merge modes

Learning about merge modes

Another way to view more than one layer at a time is to change the way the layers interact with the **Merge mode** setting. This setting determines how each pixel combines with the pixel(s) directly underneath it in other layers.

How layers are merged

Make sure the opacity of the top layer is back at 100% and then click on **Normal** in the Merge mode drop-down box. Select the next option — **Multiply**. Notice that the colors from the *Background* layer are now visible (although they appear darker) along with the textures of *Layer 1*.

Merge modes

Use the down arrow key on your keyboard to cycle through the list of merge modes. Remember that you can also change the opacity setting with any of the merge modes.

You can also reverse the order of the layers by clicking on the title of one and dragging it up or down in the list. After reversing their order, try changing the merge modes of the *Background* (top) layer.

When you are finished exploring all the options, make sure the *Background* layer is on the bottom. *Layer 1* should be on top with the **Hard Light** merge mode selected. Also make sure that both layers are set at **100%** opacity.

Before we go on to the next step, save this image — either by saving the parameter file, or the fractal (as a .ufr). Keep the image name (*Phoenix Julia 1*) the same.

Next: Adding a third layer

Adding a third layer

Let's explore another way to work with layers.

Click on the *Layer 1* layer and then on the **Add Layer** button.

Note that a new layer appears at the top of the list and that it is identical to *Layer 1* in every respect except for its name, which is *Layer 2*.

These layer names start to get confusing, so let's give them more descriptive names.

Right-click on the ***Background*** layer and choose **Rename** from the right-click menu. Type **Coloring** as its new name and press **Enter**. Rename the middle (*Layer 1*) layer **Texture**. Rename the top layer **Web**. The *Texture* and *Web* layers still look the same, they just have different names.

With the *Web* layer highlighted, go to the **Outside** tab of the **Layer Properties** tool window and click on the **Browse** button.

Select the ***Orbit Traps*** coloring algorithm from the right pane and click **Open**.

One method of naming layers is to use the coloring algorithm applied to that layer, except that can get confusing if you use the same algorithm on more than one layer. Another idea is to give them functional names that relate to what effects they contribute to the overall image.

Note: There is no right or wrong way to name layers and indeed you may never want to rename them at all. You will eventually develop a system that is meaningful to you.

This creates a soft, gentle effect that you might be interested in pursuing at another time, so let's make a duplicate of the whole fractal and save it for later. Select **Duplicate** from the **File** menu.

Notice that the name of the duplicate is *Copy of Phoenix Julia 1*. Save the duplicate image either as a parameter or fractal file. You can choose to keep this name, or give it another, as you wish.

Next: Transparency in the gradient

Transparency in the gradient

Let's go back to the *Orbit Trap* coloring on the top (*Web*) layer and change some settings. Enter **5** in the **Color Density** setting, and select **rectangle** as the **Trap Shape** parameter.

We need to work with the gradient for this layer to better see the trap shapes so open the gradient editor by selecting **Gradient** from the **Fractal** menu. Click and drag the set of **white** control points to the left to position **85**. Click and drag the set of **black** control points to position **86**. This creates a sharp line between the white and black areas of your fractal.

Now let's open up a new part of the gradient editor — the Opacity bar — by clicking on the little down arrow next to the word **Opacity**, just above the rotation slider. This opens a fourth horizontal band of color that looks right now very much like the other three.

Just as the opacity setting on the **Layers** tab controls the transparency of the entire layer, the opacity bar in the gradient editor allows us to assign different transparencies to the individual colors in our gradient.

Learn more about...
Transparent gradients

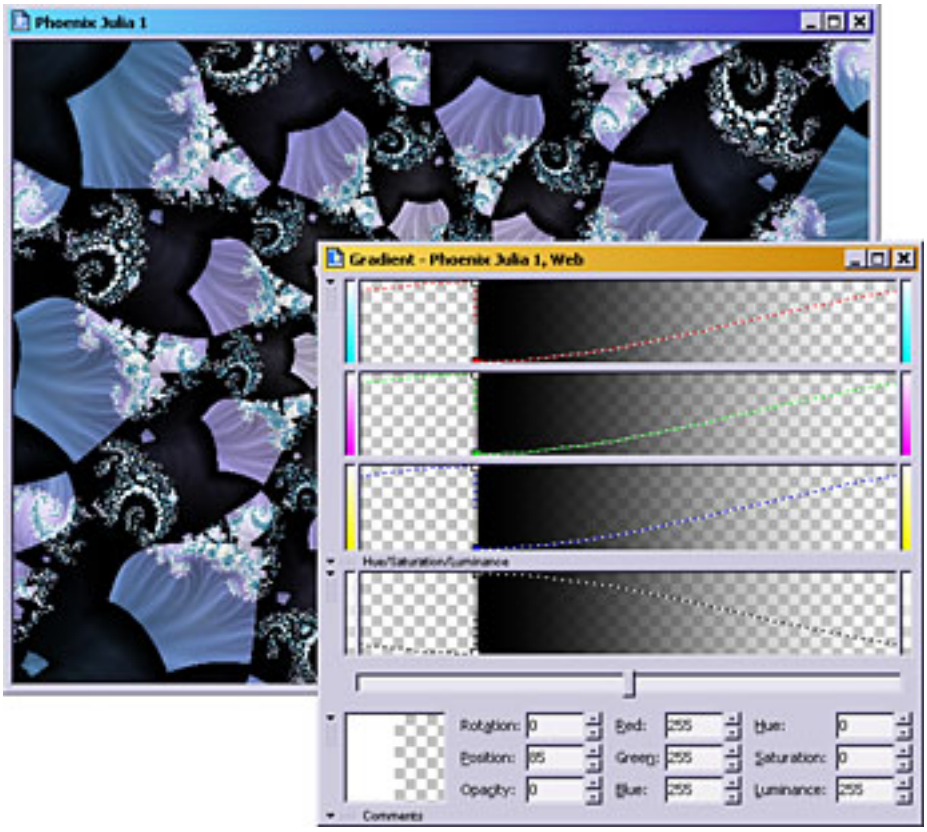
By default, the opacity bar is empty. Let's link it to the color bars so they both contain the same control points.

Click **Link Color and Opacity** on the **Gradient** menu.

Click on the set of white control points — they're the ones at the tops of their respective color bands. Now click and hold that same highlighted control point in the Opacity channel and drag it all the way to the bottom.

*Note: This can be a tricky maneuver with all the control points so close together. Remember you can always **Undo** an unwanted change.*

Your fractal and gradient should now look like this:



Note that the areas which were previously white are now completely transparent, allowing the *Coloring* and *Texture* layers to show through.

Next: Adding control points

Adding control points

Let's add a couple of more control points to our gradient to refine our web-like structure.

Right-click anywhere in the gradient editor and select **Insert** from the right-click menu.

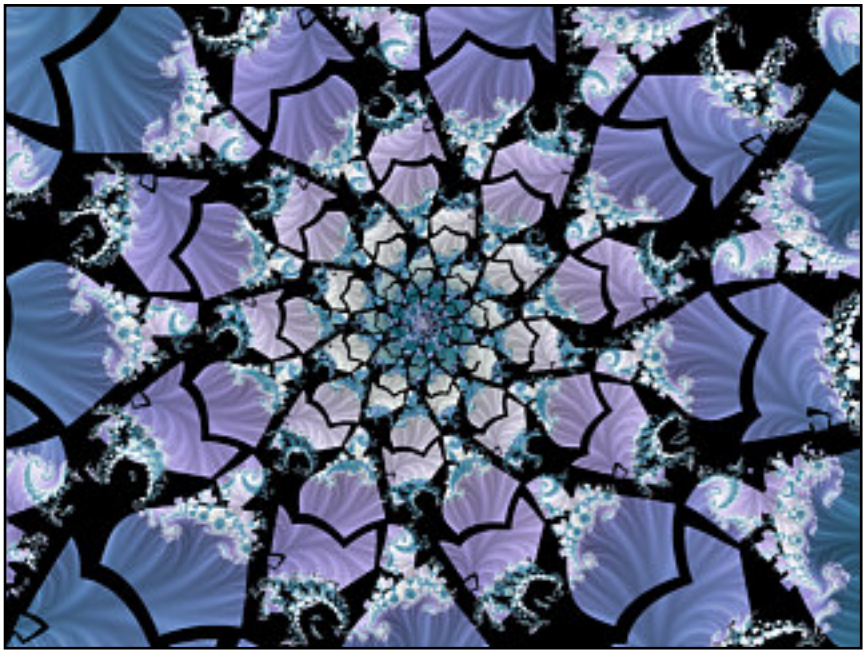
With the insert mouse pointer, click to the right of the set of black control points in any one of the horizontal color bands. Change the **Red**, **Green**, and **Blue** settings each to **0**. Change the **Position** setting to **115** and the **Opacity** setting to **255**. This creates a set of black control points with 100% opacity.

Add another control point with these settings:

- **Red**, **Green**, and **Blue** set to **255**
- **Position** set to **116**
- **Opacity** set to **0**

This creates a 4th set of control points — this time white, with 100% transparency.

Save this image (either as a parameter or fractal file) as ***Phoenix Julia 2***.



Tip!

While you're working with the gradient, try to show and hide the various layers once in a while to see what's going on.

If you hide the *Texture* and *Coloring* layers to make only the *Web* layer visible, you can easily see and edit the transparent areas that the gradient creates.

For fun...

Try playing with the control points of the *Web* layer gradient and watch what happens in your image. Change their transparencies, move them around, give one or more of them color. And periodically, while you're playing around, try different merge modes and opacity settings on the **Layers** tab of the **Fractal Properties** tool window.

You can also experiment with changing the order of layers in the list to see how this affects the overall image.

Next tutorial: Learning about transformations

Learning about transformations

Note: This tutorial assumes that you've completed the Quick Start, Basic Skills, and Layers tutorials. This includes: opening a new fractal, selecting fractal formulas and coloring algorithms, opening and working with the gradient editor, adding layers and changing merge modes.

In this tutorial we're going to use the ***Newton 1*** image we created in the Quick Start tutorial so locate and open its parameter file. *(Hint: You'll want to **Browse** the **tutorials.upr** file.)*

We're going to make a square image this time, so click on the **Image** tab of the **Fractal Properties** tool window. **Uncheck** the **Maintain aspect ratio** box and change the **Width** setting to match the Height setting.

In Ultra Fractal, **transformations** are formulas which apply special effects to the fractal. They are selected and applied to a layer on the **Mapping** tab of the **Layer Properties** tool window.

Learn more about...
Transformations

To add a transformation, switch to the Mapping tab and click the **Add** button.

Select the ***Lake*** transformation in the **Standard.uxf** file of the "Select Transformation" browser. This applies a rippled water effect to this layer of your fractal.

Learn more about...
The *Lake* transformation

You'll notice that the first two parameters for this transformation are *Water level (Re):* and *Water level (Im):*. This means that the coordinates that provide the location of the water level are a complex number. The default setting is **0, 0** and on our fractal, this places the water level at the middle of the fractal.

To change this, right click in one of the ***Water level*** parameter fields and select **Eyedropper** from the menu that appears.

Now move your mouse cursor over the fractal image. You'll notice that the cursor has become an eyedropper with crosshairs at the tip. Choose a new placement for the water level with the crosshairs and **left-click**. The fractal immediately redraws, placing the water level at these new coordinates. Try different locations.

When you're finished playing with this nifty tool, **Check** the **Use screen center** box on the Mapping tab which will override any *Water level* settings and return the level to the center of your fractal so that your image looks like this:

Next: Using the Kaleidoscope transformation

Using the Kaleidoscope transformation

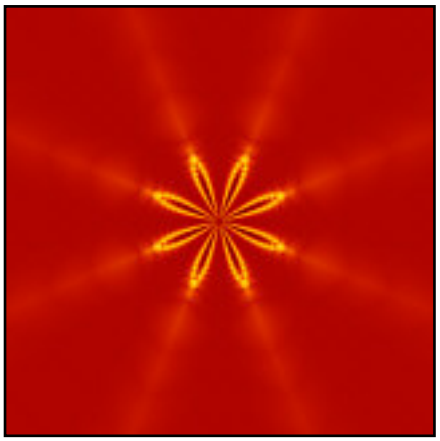
Before we add another layer, rename this layer **Lake** in the **Layers** tab of the **Fractal Properties** tool window.

Now add another layer and rename it **Sky**. Go ahead and leave the **Normal** merge mode and **100%** opacity settings as they are. This means we won't be seeing the bottom layer for a bit.

On the **Mapping** tab of the **Layer Properties** tool window, delete the *Lake* transform by clicking the **Delete** button.

The layer again looks like our *Newton 1* image from the Quick Start tutorial.

Now add a new transformation — the ***Kaleidoscope*** transformation in **Standard.uxf**. We are going to keep the default settings for this layer, but this transformation has a lot of interesting effects you may want to pursue at a later time.



Learn more about...
The *Kaleidoscope* Transformation

Next: Using 3D Mapping

Using 3D Mapping

It's possible to add more than one transform to the same fractal layer, so let's **add** the ***3D Mapping*** transform on top of *Kaleidoscope*.

Learn more about...
Multiple transformations

The idea of the 3D Mapping transform is to map the fractal layer onto a three-dimensional surface. Let's first use the default, *Plane* shape.

Learn more about...
The *3D Mapping* Transformation

As you can see, our kaleidoscopic flower shape has been mapped onto the lower half of the fractal and the top half of the image is now black. This gives the effect of a floor extending toward the horizon.

We can make this mapping shift to the top half of the image, to become more of a sky-effect, by changing one of the transformation parameters. It's not immediately clear which of the parameters effects this change, so now is a good time to learn how to get **Help**.

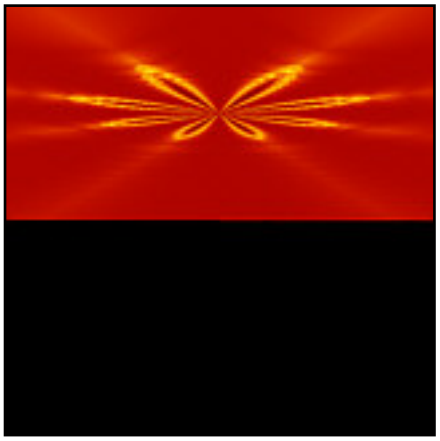
Click on the **?** button in the title bar (in the upper right corner) of the **Layer Properties** tool window and place your cursor over any parameter field or transformation setting. When you left-click, a helpful hint for that particular parameter or setting will pop up on the screen.

In this case, a little investigation tells us that the parameter we need to change in order to make our fractal appear in the "sky" is the **Y Translation** parameter. It is currently set at -0.5. If we change that to **0.5**, the fractal moves into the upper half of the image.

Tip!

There is a **?** button in the title bar of each of the tool windows. Any time you don't know what a parameter or setting is for, use this handy context-sensitive help to find out.

Conscientious formula writers will also provide helpful hints for their formulas' parameters.



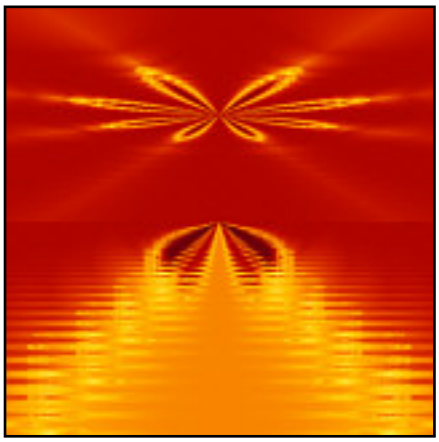
Now... what is this big black area doing in our image? Some transformations, like *Lake* and *Kaleidoscope* warp the fractal but still fill the entire image.

Learn more about...
Solid color in transformations

Others, like the *3D Mapping* transform, map the fractal onto an object or create a mask which doesn't fill the entire image. The leftover area that isn't fractal is filled with a solid color which is designated on the Mapping tab.

To see this, click on the black area next to the **Solid Color** setting. To change the solid color from the default Black to another color, adjust the sliders. You'll see the changes immediately on your image.

But what we really want to do in this image is to make the black area transparent by clicking and dragging the **Opacity** slider all the way to the left. Now we can see both the *Lake* effect from the bottom layer and the *Kaleidoscopic* flower in the sky plane of our top layer. Click **OK** to close the "Select Color" dialog.



Next: Twist transformation

Twist transformation

Now add a third layer and rename it **Sphere**. Clear the *Kaleidoscope* and *3D Mapping* transformations from the Mapping tab.

Add a new transformation — ***Twist***.

This is a fun transform, because you can use the eyedropper to select the center of the twist. Remember to right-click in one of the **Center of twist** parameters to select and activate the **Eyedropper**.

Learn more about...
The *Twist* Transformation

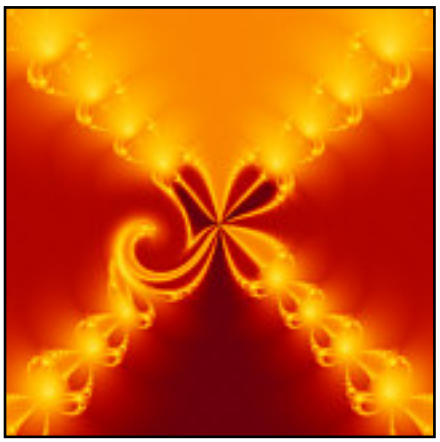
The **Strength** and **Decay Factor** parameters affect the tightness and shape of the spiral. Try making them smaller and larger. Try using a negative number in the **Strength** parameter.

When you're done playing with these parameters, click on the complex number below to copy it to the Clipboard.

-0.65 / -0.18125

Paste it into the **Center of twist** parameter by selecting **Paste Complex Value** on the right-click menu.

Enter **4** in the **Strength** setting and **10** as the **Decay Factor**.



Next: Mapping a sphere

Mapping a sphere

Let's add another mapping transformation to this layer. Load ***3D Mapping*** again and this time select the **Sphere** shape.

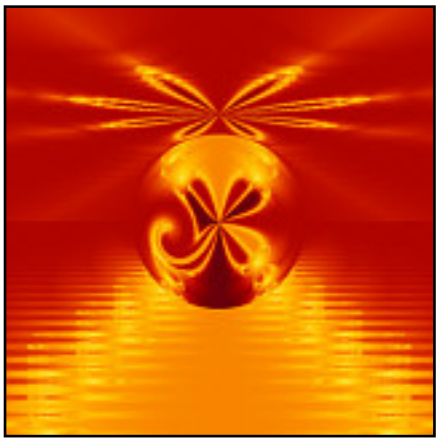
First, let's change the solid color opacity to **0**.

Next, to center the sphere in the image, change the **Y Translation** setting to **0**.

Tip!

You can resize the list of transformations by clicking on the dividing line above the parameters and dragging downwards.

The help hint for the **Z Translation** setting says that increasing the value will move the sphere farther away (thus making it smaller) so let's change that setting to **2.5**. Now the sphere is positioned just below the Kaleidoscopic flower.



For fun...

Transformations are applied in a particular order, starting with the bottom one on the list and working upward. So it matters, sometimes, in which order they are placed in the list.

For fun, reverse the order of the *Twist* and *3D Mapping (Sphere)* transforms by dragging one above or below the other.

As you can see, the sphere is now mapped before *Twist* is applied resulting in an unusual effect.

Next: Adding a frame

Adding a frame

In this last part of this tutorial, we're going to add a simple frame to our image. One way to do this is to create a solid color layer (which will become the frame) and then clip out a transparent area in the middle of the image through which the other layers below may be seen.

Add a new, fourth layer, name it **Frame**, and remove the transformations on the Mapping tab.

Click on the **Formula** tab of the **Layer Properties** tool window and replace the current (*Newton*) formula with the ***Mandelbrot*** formula in *Standard.ufm*.

Before we go on, notice the black area on the inside of the Mandelbrot figure. Up until now, in the images with which we've worked, we've only dealt with "Outside" points and "Outside coloring." In this layer, we're going to work with the **Inside** points.

Learn more about...

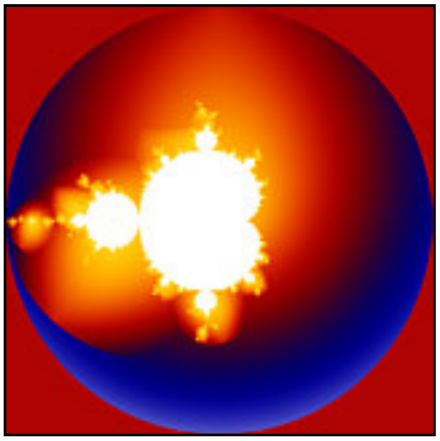
Inside and Outside areas

The coloring of inside points is controlled on the **Inside** tab of the **Layer Properties** tool window. Switch to the Inside tab and notice the **Transfer Function** setting. When the Transfer Function is set to *None*, the coloring algorithm is ignored and the **Solid Color** setting takes effect.

Learn more about...

Solid Color

To see how this works, let's change the solid color to something other than black. Click on the **Solid Color** swatch on the **Inside** tab. Click and drag the **Luminance** slider to **255**, and note that the inside of the Mandelbrot figure becomes solid white.



Next: Zooming with multiple layers

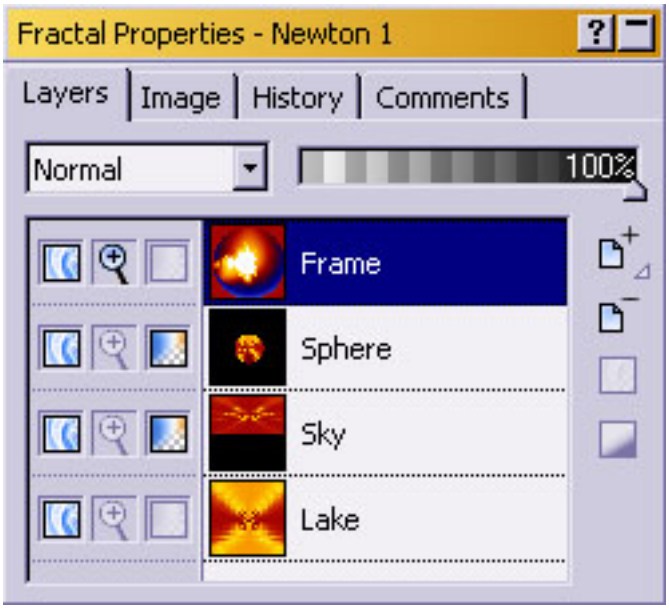
Zooming with multiple layers

We will use the solid white area in the center of the *Frame* layer as the basis of our frame so we are going to zoom into it without changing the location of any of the layers below.

To do this, click on the **Layers** tab of the **Fractal Properties** tool window.

Locate the **Editable** icon on the top (*Frame*) layer. While holding down the **Shift** key, **click** on this icon.

This disables the editability of all the other layers.

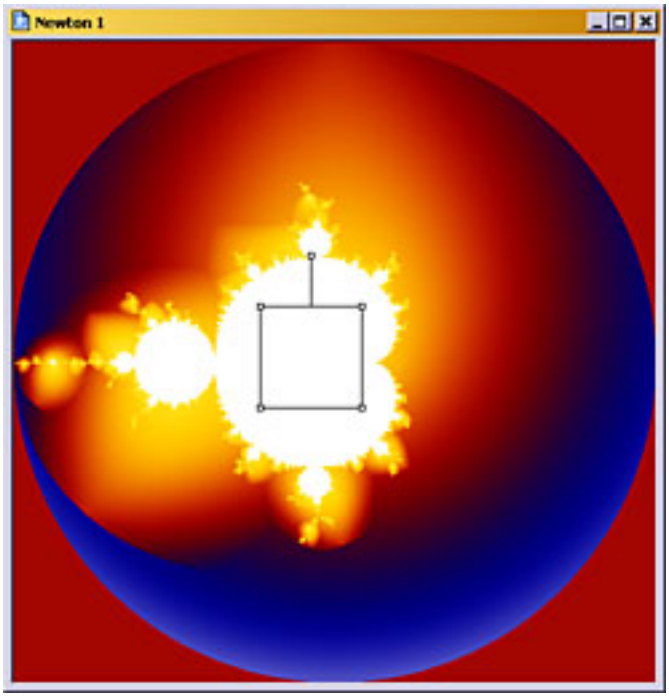


Having the Editable icon enabled for just this layer means that any location changes we make will only affect this layer. The layers for which the Editable icon is grayed out will remain unchanged.

Now choose **Select Mode** from the **Fractal** menu to activate the selection box. Click and drag on one of the sides to make the selection box small enough to fit entirely into the solid white area, something like this:

Tip!

By holding down Shift while clicking on the Visible, Editable, or Transparent icons, you toggle all other layers instead. This also works with the Enable icon on the list of transformations on the Mapping tab.



Select **Zoom In** from the **Fractal** menu. Your top layer should now be solid white. You can verify this by looking at your **Layers** list.

And, by **Shift-clicking** the **Visible** icon on each layer in the list, you can see that none of the other layers has changed location.

*Note: If something went awry, you can always use the **Undo** option on the **Edit** menu to recover.*

Next: Using the Clipping transform

Using the Clipping transformation

The last transformation we'll explore in this tutorial is ***Clipping***. This handy transform has many uses, but we'll use it in this image to clip out the inside of our frame.

Add the ***Clipping*** transformation to the *Frame* layer.

The *Clipping* transformation

First, we'll center the frame on the screen. Switch to the **Location** tab, right click on one of the **Center** settings and select **Copy Complex Value**. Then switch to the **Mapping** tab and right-click on either of the **Clipping Center** parameters and select **Paste Complex Value** from the right-click menu. This ensures that the clipping center is set to the center of the screen.

On the **Mapping** tab, find the **Clipping Region** parameter and change it to **Inside** — because we will be clipping out the inside area. The image will become black — the designated solid color for this transformation.

To select our frame width, right-click in one of the ***Clipping Right Edge*** parameter fields and select **Eyedropper** from the menu. Place the eyedropper (your mouse cursor) near the right edge of the image and **left-click**. You can repeat this until your frame is the desired width.

You should now have a white frame with a black square inside. Click on the **Solid Color** swatch on the **Mapping** tab and change the **Opacity** to **0**. You should now be able to see the underneath layers surrounded by a white frame.

As one last finishing touch, let's change the color of the frame to coordinate with the fractal by using the eyedropper tool.

Switch to the **Inside** tab and right-click on the white-colored **Solid Color** swatch. Select **Eyedropper**. As you move the eyedropper over the image, the color underneath the center of the crosshairs is shown in the **Solid Color** swatch.

When you've found a color you like, **left-click**. This changes the white frame to a color that coordinates with your image. With the exception that your frame may be a different color and/or width, your image should now look like this:

Next: Exporting the image

Exporting the image

Let's save this image in both parameter and fractal file form. Save it with the name **Newton World**.

We can also export images to graphic file formats that can be used outside of Ultra Fractal. This is useful when you want to print an image or post it on the web.

To export the image, select **Export Image** from the **File** menu. By default, the image will be saved in Ultra Fractals' **Export** folder with the name we've given it (*Newton World*).

Ultra Fractal supports several file formats so let's select **JPEG** from the **Save as type:** drop down list.

Exporting

File Formats

When you click **Save**, Ultra Fractal will ask you to select the export quality for the JPEG image. Move the slider to 95%. This will allow for some compression (which makes the file smaller) without too much loss of quality. Click **OK**.

Now you may open the image up in another graphics program, email it to a friend, or post it on a web page.

***Note**: All exported and rendered images made with an evaluation copy of Ultra Fractal 3 will be marked with* Evaluation Copy *text. Please purchase your copy of the software!*

Next tutorial: Masking

Introduction to Masking

One of the most exciting features of Ultra Fractal 3 is the ability to create layers which serve as masks for other layers. These layers contain areas of both transparency and opacity which allow only designated areas of the linked layer to be visible. This ability opens up a whole range of artistic possibilities that have never before been available in fractal software.

Before we get to the actual masking concept, though, let's create a new image using some of the skills we've learned thus far.

Create a **New Fractal** using the ***Julia*** formula. Click on the complex number below to copy it to the Clipboard.

-0.815 / 0.235

Right-click on the **Julia Seed** parameter on the **Formula** tab and click **Paste Complex Value.**

Apply the ***Triangle Inequality Average*** coloring algorithm on the **Outside** tab.

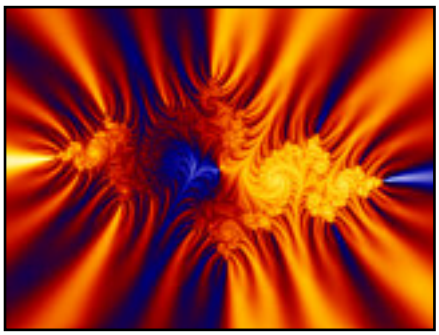
Note that the *Julia* calculation formula and the *Triangle Inequality Average* coloring algorithm each have a **Bailout** parameter. This tells Ultra Fractal how many times to iterate the formula before designating a point "inside" or "outside."

Learn more about...
Inside and outside points

In this case, the bailout setting for the *Julia* formula is **4** and the bailout for the *Triangle Inequality Average* coloring is **1e20** — a much higher number (100 sextillion) which, for our purposes, approximates infinity.

This coloring algorithm is intended to work best when the formula and coloring have matching bailout values, so let's change the **Bailout value** on the **Formula** tab to **1e20** to match the higher value on the Outside tab.

Next, open the Gradient Editor and rotate the rotation slider to the left until the **Rotation** setting is **-137**. Our first layer should look like this:



In this image, we're going to name our layers by the coloring algorithm used, so **Rename** this layer to **TIA**.

Next: Layer 2 - Waves Trap

Layer 2 - Waves Trap

Add a new layer and **Rename** it **Waves Trap**.

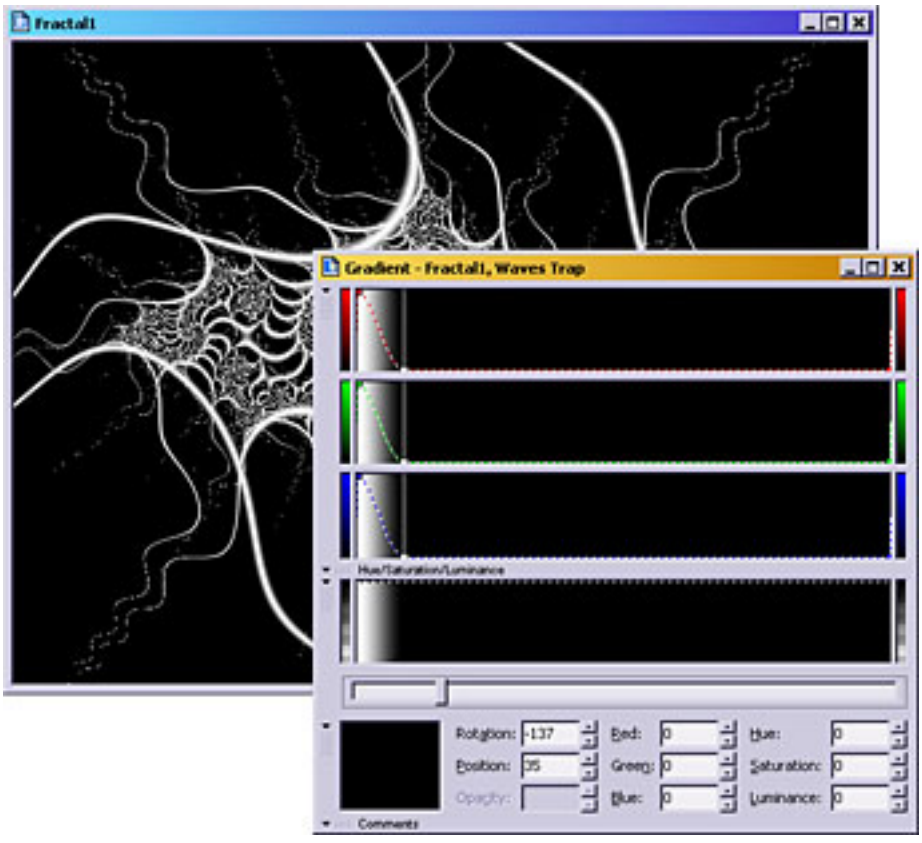
Replace the current **Outside** coloring with ***Orbit Traps*** and make the following setting and parameter changes:

- Change the **Transfer Function** to **Log**
- **Uncheck** the **Repeat Gradient** box
- Change the **Trap Shape** to **Waves**

Now, open the gradient editor to edit the gradient for this layer to meet the following conditions:

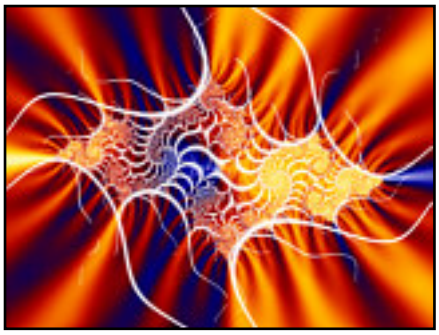
- Three control points — *You can delete unneeded control points with the right-click menu*
- **Position** the first (left-most) control point at **0** and color it **White**
- **Position** the second control point at **35** and color it **Black**
- **Position** the third control point at **399**, also colored **Black**

Your image and gradient editor should look like this:



Change the **Merge mode** on the **Layers** tab of the **Fractal Properties** tool window to **Screen**. The *TIA* layer now shows through the white filaments of the wave trap.

Learn more about...
Merge modes



Next: Layer 3 - Box Trap

Layer 3 - Box Trap

Let's do some fun things with gradient transparency — **Add** a new layer and **Rename** it to **Box Trap**.

Change the **Trap Shape** parameter on the **Outside** tab to **Box**.

Learn more about...
Transparent gradients

Switch back to the **Layers** tab and **Shift-click** the **Visibility** icon on the *Box Trap* layer to toggle the other two layers off.

This will help us to better see what we're doing with this layer.

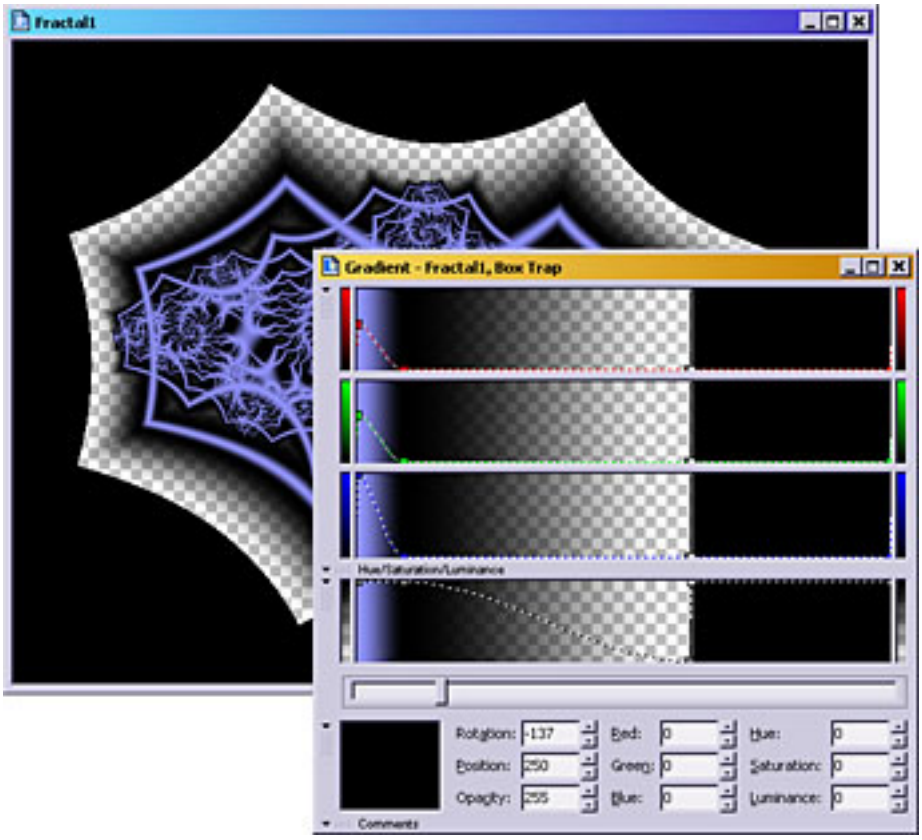
Since the Waves trap tendrils are white, let's make the Box trap shape a different color. In the gradient editor, edit the set of white control points so that the **Red**, **Green**, and **Blue** settings are **145**, **147**, and **253**, respectively.

Select **Link Color and Opacity** from the **Gradient** menu. This allows us to move and edit the color and opacity curves simultaneously.

Insert a new point in the gradient editor. Set the **Opacity** of this control point to **0**. Also set the **Red**, **Green**, and **Blue** settings to **0** to create Black.

Now **Insert** another control point to the right of that one. Change its **Opacity** to **255** and make it black, also. Click and drag this point until it is positioned just to the right of the transparent point.

Although the exact location of the transparent areas may differ slightly, your image and gradient editor will look similar to this:



The gray and white checkerboard on both the gradient and the fractal layer indicates areas of transparency.

To see how this works, change the **Merge Mode** of the *Box Trap* layer to **Normal** and then **Shift-Click** its **Visible** icon to toggle the other layers on and off. Notice that the underneath layers are only visible in the checkerboarded area of the top layer.

Next: Fine-tuning the gradient

Fine-tuning the gradient

We now have five control points in our gradient. The two on the left (bluish-purple and black) control the box trap structure in the center of our image. The next two, one transparent and one opaque, create a sharp scalloped line outside of the box trap structure. And the fifth (black/opaque) control point is positioned at the far right of the gradient editor.

Tip!

You can resize the gradient editor to make it easier to edit control points that are closely spaced together.

Insert a new control point somewhere between the second and third points. Color it black, with **0** opacity.

Click and drag this new point slowly to the left and watch how the spaces inside the box trap structure become transparent. Place this point just to the right of the second (black) control point.

Hold down the **Ctrl** key and click on the second (black/opaque) and third (black/transparent) control points. This selects both control points, allowing them to be moved together.

Learn more about...

Keyboard shortcuts for gradient editors

Since we want to maintain their color and opacity values as they are moved, hold the **Shift** key down and drag the two points left and right. Notice that moving the two points to the right makes the shapes fatter, and to the left, thinner.

Find a location for these two points that appeals to you, then click elsewhere on the gradient to deselect them.

Now, let's work more with the next two control points — those that control the outer, scalloped edge. We're going to add a little sculpted edge to the scalloped frame.

To the right of the fourth (black/transparent) and fifth (black/opaque) points, **Insert** a new control point. Make it white and set its **Opacity** to **255**. Move it close to the fourth and fifth points.

Learn more about...

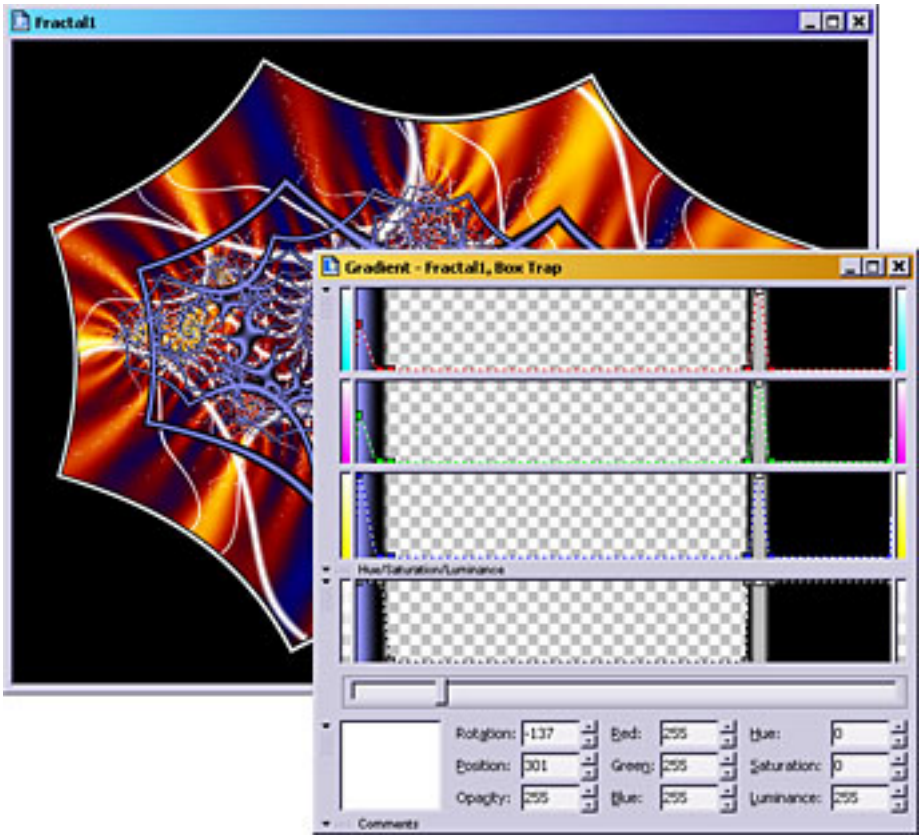
Editing gradients

Insert one more point to the right of the white one. Make this one black and fully opaque, also. Move it close to the white point.

Experiment with the spacing of these two newest points -- dragging them a little to the right and left to see how they affect the width of the scalloped edging. Find an arrangement that appeals to you.

Now select and move the grouping of our four scalloped edge control points, maintaining their spacing and coloring. **Ctrl-click** each to select and add them to the group. Hold the **Shift** key as you drag them right or left to position the edging. Find a position that appeals to you.

Shift-click this layer's **Visible** icon to toggle all the layers on. Your image should look something like this:



Save your image as a parameter and/or a fractal file. Name it ***Masked Julia***.

Next: Layer 4 - Gaussian Integer

Layer 4 - Gaussian Integer

We're almost ready to learn about masking, but first we need to add one more layer.

In the Layers tab of the Fractal Properties tool window, **Add** a new layer and **Rename** it to ***Gaussian Integer***.

Replace the current **Outside** coloring with ***Gaussian Integer***.

No changes to the parameters are needed but we do need to work with the gradient a bit. Many of the control points we added in the last layer are not needed here. We want to keep the first two control points on the left side of the gradient. They are, respectively, bluish-purple/opaque and black/opaque.

Learn more about...

The *Gaussian Integer* coloring algorithm

We won't need the third (black/transparent) point, so click on it, **right-click** in the gradient editor, and select **Delete** from the menu.

We also want to keep the black/opaque point at the very right of the gradient editor. But we can delete the group of four points which control the scalloped frame. **Ctrl-click** to select each of them, **right-click** in the gradient editor and select **Delete** from the menu.

Tip!

Most right-click commands are also available in the Gradient pull-down menu and on the toolbar.

Now, to make the little dots a little bigger, click and drag the second (black) control point to the right, somewhere around the **Position** of **40**.

Next: Adding a mask layer

Adding a mask layer

So now we've got these little bluish-purple dots covering the entire image. We could make the black areas transparent or change the merge mode to allow us to see the underneath layers, but wouldn't it be great if we could have the dots appear only in the solid black areas outside the scalloped frame?

Editing the transparency of the gradient won't accomplish this, nor will changing the merge mode or layer transparency. What we need to do is create a **Mask** for this layer which has the same shape as the scalloped edge in the *Box Trap* layer.

Go to the **Layers** tab of the **Fractal Properties** tool window.

Click on the ***Box Trap*** layer and then click the **Add layer** button.

This adds the new layer between the *Box Trap* and *Gaussian Integer* layer.

Rename this layer ***Mask***.

But it isn't a mask layer yet. We need to associate it with the *Gaussian Integer* layer.

To turn the layer into a mask, click the **Use as Mask** button.

Look at your image and notice how the dots no longer appear inside the scalloped frame (except on the box trap structure inside, which we'll fix in a minute).

Also notice on the layer list that the *Gaussian Integer* and *Mask* layers now share a **Visible** icon. If you **shift-click** this icon to toggle the other layers off, you will clearly see which areas are visible and which are made transparent by the mask layer.

Next: Editing the mask

Editing the mask

Now let's edit the mask itself. To make this easier, we need to make the mask layer visible on its own temporarily.

Learn more about...
Working with masks

Click on the ***Mask*** layer and then on the **Show Mask Only** button.

Masks are always shown in black and white — never any colors. White represents the areas that are transparent and black represents the opaque, masked areas.

Looking at our *Mask* layer and its gradient, can you see what we need to do in order to clear out the center of the scalloped frame?

Since the first two control points on the left are white, and they correspond with the inner structure on the *Box Trap* layer, they are the ones we need to edit. Drag them downward, making them black, so that the mask looks like this:

Click the **Show Mask Only** button again (so it is no longer down) and make sure that the bottom three layers are now visible.

You should see the rippling of the *TIA* layer, the white tendrils of the *Wave Trap* layer, the bluish-purple structure of the *Box Trap* layer, and the dots of the *Gaussian Integer* layer — masked to only appear outside of the scalloped edge.

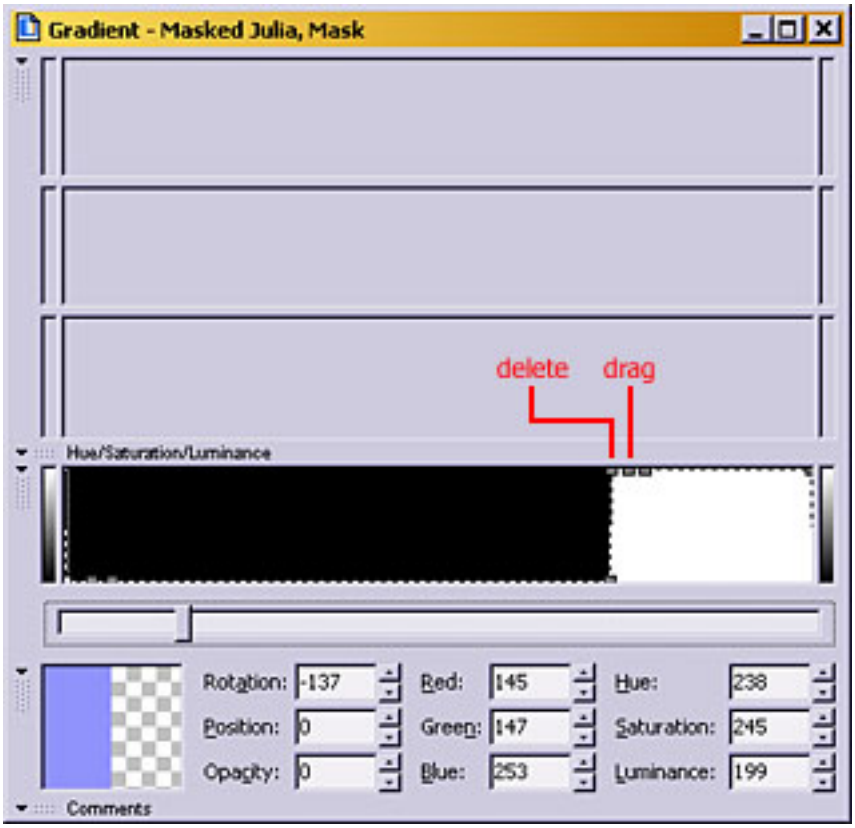
Tip!

When working with masks, you'll often toggle the **Show Mask Only** button on and off to alternatively work on the mask and judge its effect on the final image.

What's missing, though, is the little white edging we created around the scalloped frame.

With all the layers still visible, click again on the ***Mask*** layer. There are still some control points on its gradient which are preventing us from seeing the white edging.

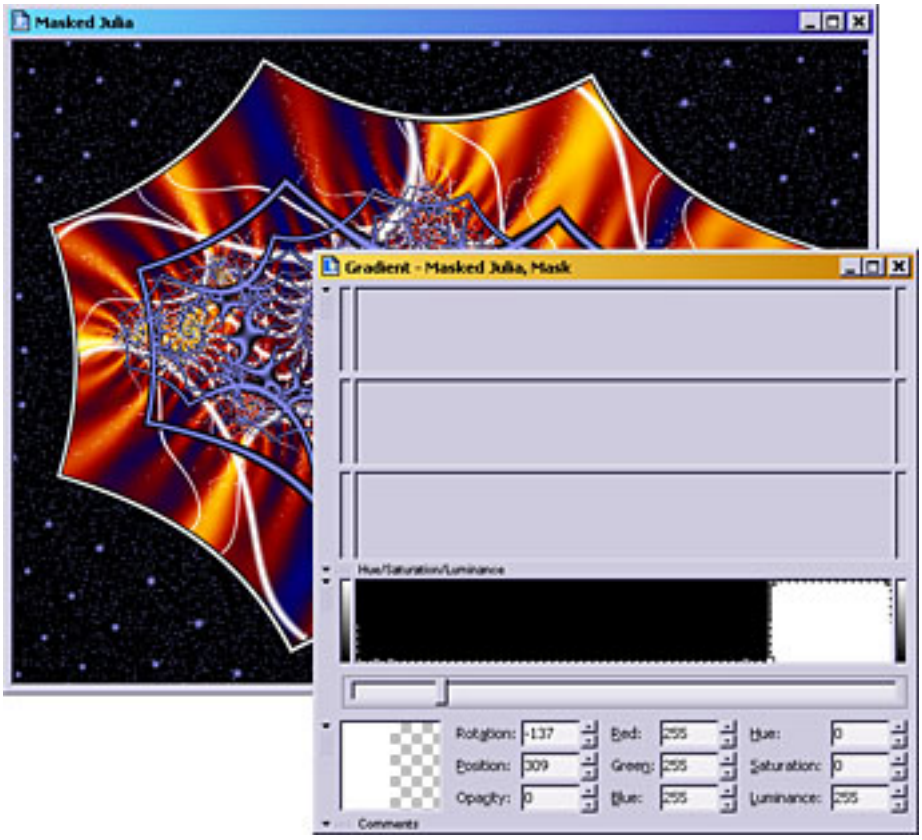
Locate the two white points indicated in the screenshot below:



Click on the first (left) of these two points and **delete** it.

Click on the second point and drag it downward (making it black) and to the right, just next to the white control point.

You should now see the white edging from the *Box Trap* layer along the scalloped frame.



Next: [Rendering the image]

Rendering the image

Now that our image is complete, save it again, in either the parameter or fractal file format you chose earlier.

There is one other method of saving images that you will want to use on occasion. If you want to make a larger render than is practical onscreen or render the best-quality image, you will want to use Ultra Fractal's **Render to Disk** feature.

Learn more about...
Rendering images

For fun, let's make a render of this image that you can use as your desktop wallpaper.

To start the disk render, select **Render to Disk** from the **Fractal** menu.

In the **Destination File** field, Ultra Fractal will suggest a file name for the rendered image. Write it down so you'll know where the image is going to be saved.

Make sure that **Bitmap image (*.bmp)** is the selected **File Type**.

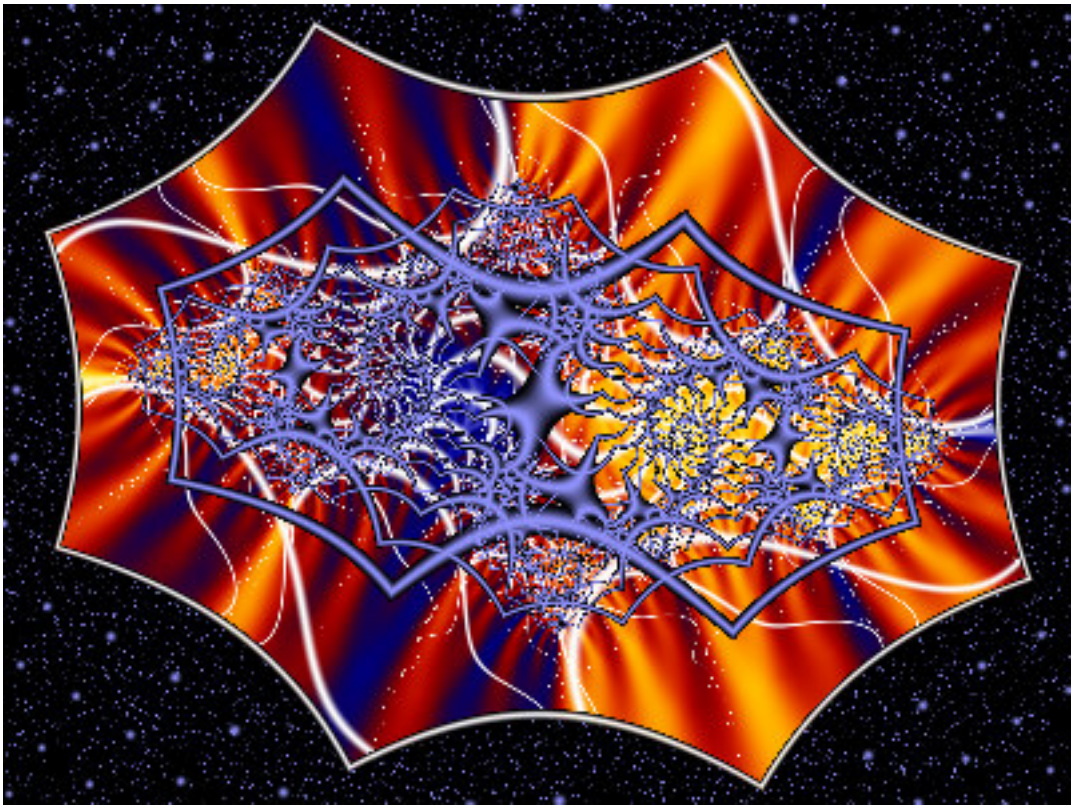
In the **Size** field, enter the **Width** and **Height** of your Windows desktop (for instance, **1024** and **768**).

*If you do not know your desktop setting, minimize Ultra Fractal and **right-click** on your Windows desktop. Select **Properties**. Click on the **Settings** tab and look for the **Screen Area** size selected.*

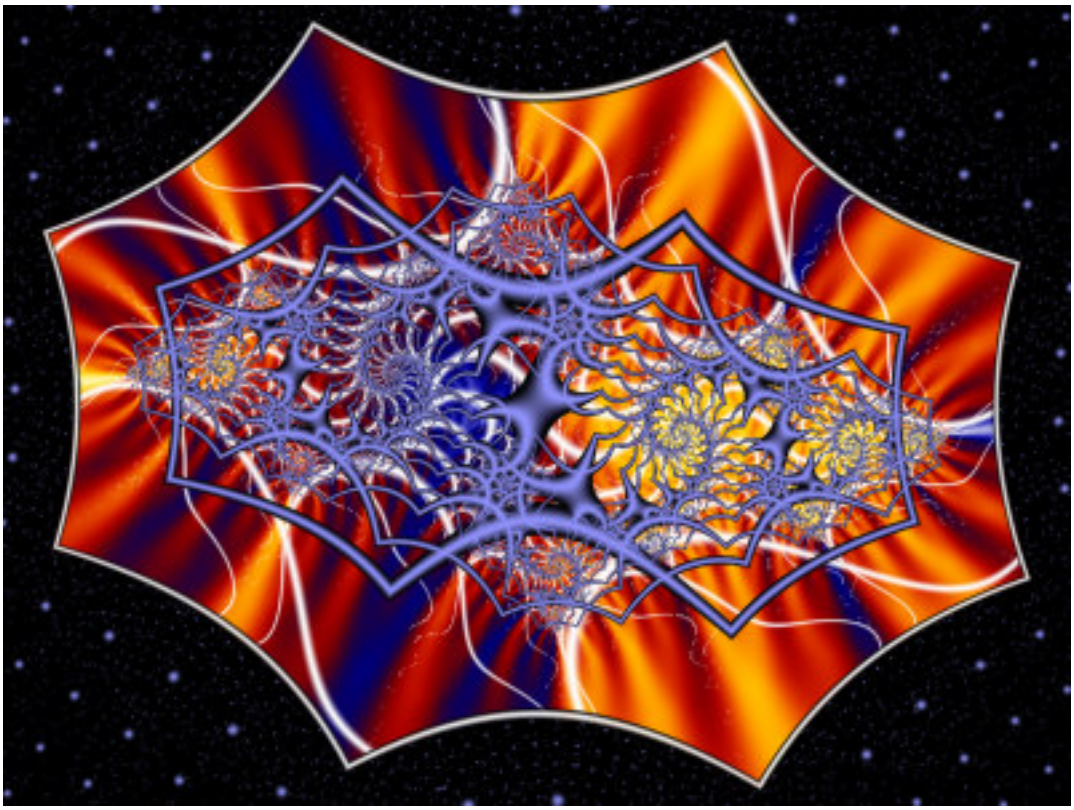
In most cases, the **Anti-aliasing** setting of **Normal** is sufficient.

The difference between an exported and an anti-aliased render of this image is demonstrated in the two examples below:

Learn more about...
Anti-aliasing



Exported



Rendered to disk with anti-aliasing

Notice how much smoother and cleaner the second image is. Fine filaments, like the white wave tendrils, are much nicer when the image is anti-aliased.

***Note**: Remember that all exported and rendered images made with an evaluation copy of Ultra Fractal 3 will be marked with* Evaluation Copy *text. Please purchase your copy of the software!*

You can accept all the other default settings in the Render to Disk tool window so click **OK** to start the render.

As the render starts, you'll notice that the **Render to Disk** tool window on the right side of your screen opens. This window monitors and shows the progress of the render.

When the render is complete, right-click on the Windows desktop and select **Properties**. On the Background tab, click the Browse button and locate the rendered image. (Usually, it will have been saved as *My Documents\Masked Julia.bmp*). Click **OK**.

Next: Some final thoughts

Some final thoughts

These tutorials are intended to introduce many of the features of Ultra Fractal 3. They, by no means, cover all of the program's capabilities. The creative possibilities, particularly in the use of masking layers, are endless.

You are encouraged to work through the tutorials more than once, to become familiar with the program's user interface and the various concepts and skills introduced in them. As you become more comfortable, try experimenting with different parameter values and settings; move layers around and alter their gradients; use different merge modes and opacities. If you'll take the time, at first, to explore what's possible using just these tutorial images, you will have a much better idea of how to achieve the effects you desire when you strike out on your own.

And lastly, many people are loathe to read Help files, often because the software is poorly documented and the Help isn't very helpful. Ultra Fractal is quite different in this regard and you'll find its extensive Help files to be easy to read and full of information.

All tutorials were written by Janet Parke. Living in Memphis, USA, Janet is a widely respected fractal artist and also a ballet teacher. She has been working with Ultra Fractal since the first beta releases in 1998. For some examples of her work, visit her online galleries at www.parkenet.org/jp/ufhome.html. You'll also find a lot of Ultra Fractal resources and information there.

What are fractals?

Ultra Fractal creates images of fractals. Fractal images are created by repeatedly calculating a fractal formula. Although these formulas are purely mathematical, the resulting pictures are often very beautiful and complex.

Ultra Fractal goes a long way toward hiding the mathematical stuff. Instead, you focus on the fractals themselves, the way they're combined, and how they are colored. This enables you to turn your fractals into true works of art.

This chapter will explain the basics of fractals, and why they're so interesting.

Next: Self-similarity

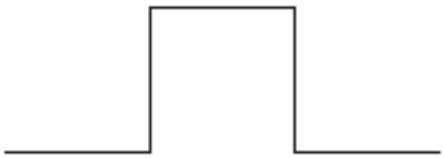
See Also

Tutorials
Workspace
Fractal windows

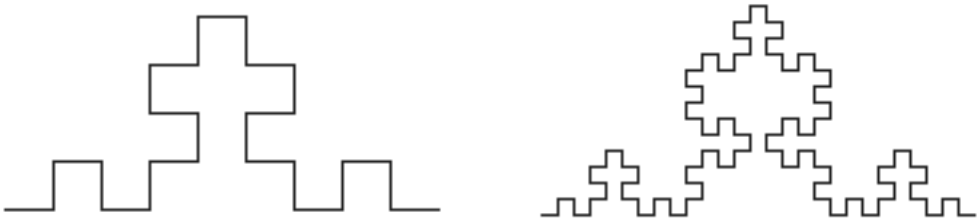
Self-similarity

There are various definitions of what a fractal is. One of the easiest is that a fractal is usually self-similar. That means that it repeats itself. For an example, look at the following fractal.

This is a Van Koch fractal. It is based on a very simple shape.



To create the fractal, the flat lines are replaced by the entire shape itself.



This process is repeated again and again to create an infinitely complicated fractal. Still, every part of the fractal contains the original shape. We say that the fractal is self-similar. Most fractals in Ultra Fractal are calculated differently, but the principle of self-similarity still applies.

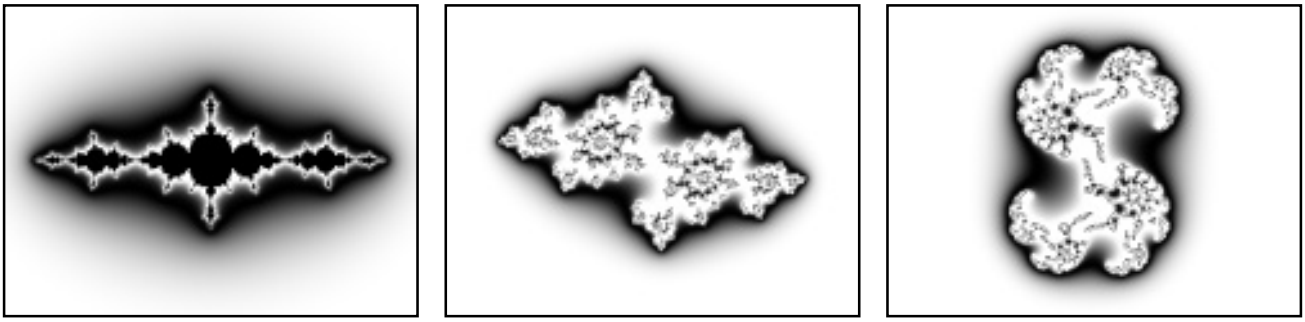
This is also the reason that it's so popular to zoom into fractals: there are always more details to be discovered, no matter how far you zoom.

Next: Julia sets

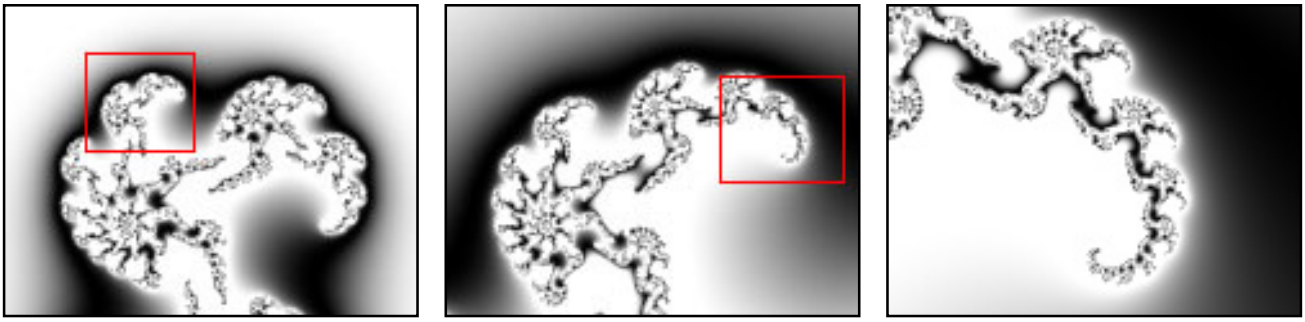
See Also
What are fractals?

Julia sets

One of the most basic fractal types is the family of Julia sets, discovered by the French mathematician Gaston Julia during the first World War. Julia sets are created by a simple formula with one complex parameter called **c** or **seed**. This parameter can be varied to create many variations. Here are a few examples.



Julia sets are also self-similar, as illustrated by the following zooms into the last image above. The first zoomed image shows the top of the original. Further zooms are illustrated by the small red rectangles in the images.



The same spiral-like shape is repeated over and over again.

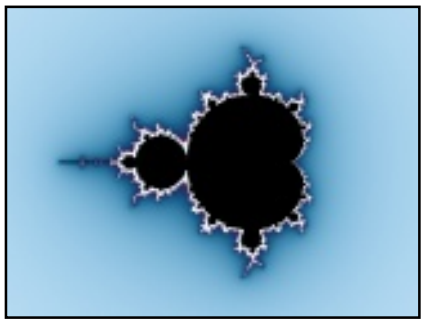
It can be difficult to find good values of the **c** parameter. Fortunately, the Mandelbrot set, which is discussed next, can help you with that.

Next: The Mandelbrot set

See Also
What are fractals?
Julia

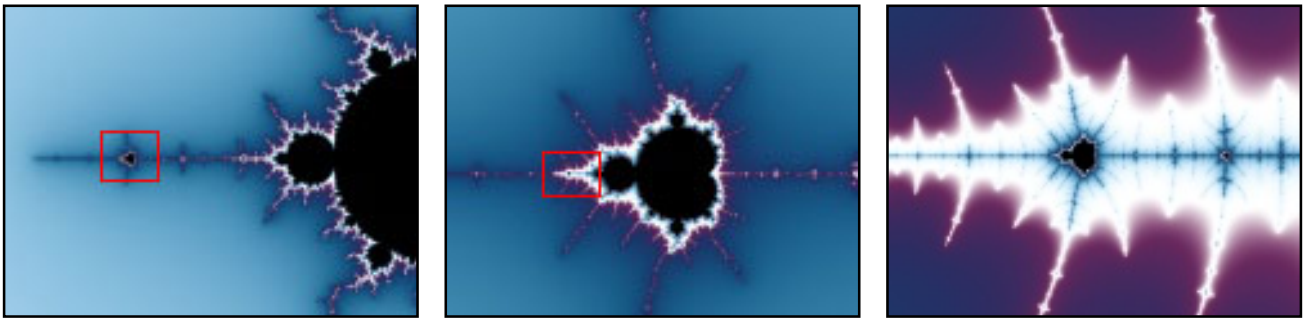
The Mandelbrot set

The Mandelbrot set, discovered in 1980 by Benoit Mandelbrot, is probably the most famous fractal. Like Julia sets, it is generated by a very simple formula, but it is incredibly complex.



The Mandelbrot set is loosely self-similar: parts of the original fractal appear again when zooming in, but often deformed and with different ornaments. This is what makes it so rewarding to zoom into this fractal: you never know what you will see next.

This is illustrated by the following short zoom, starting at the very left of the Mandelbrot set shown above. As you zoom in, you see copies of the original Mandelbrot set, but with different surroundings.



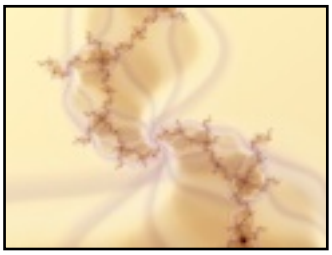
Another interesting aspect of the Mandelbrot set is that it's actually a map of all Julia sets. Each point corresponds to a Julia set. Points inside the Mandelbrot set (here shown as black) are **connected** Julia sets; points outside the Mandelbrot set tend to give more disorganized Julia sets.

With the switch feature in Ultra Fractal, you can easily pick a point of a Mandelbrot fractal to see the corresponding Julia set. This is the best way to discover interesting Julia sets.

Next: Fractals today

See Also
What are fractals?
Mandelbrot
Julia sets

Fractals today



While Ultra Fractal is pretty good at exploring the classic fractal types discussed so far, it can do much more than that. There are many more fractal types to choose from, and you can even write your own fractal formulas (or use formulas written by other people). Most fractal types are variations on the Mandelbrot and Julia sets.

Each fractal type can be combined with various coloring algorithms, each capable of coloring the fractal in a different way. Transformations can be added to distort the shape of the fractal. Colors are easy to change and tweak with the gradient editor. On top of that, you can use multiple layers to combine different fractals or different coloring methods to form the final image.

Because of these changes, fractals have grown from a mathematical curiosity to a respected form of art. There are fractal exhibitions in museums and galleries all over the world. There is a large number of online galleries on the web, where you can purchase prints and posters from various fractal artists.

Next: Where to start

See Also

What are fractals?
Fractal windows

Where to start

Now that you know a bit more about fractals, you're probably wondering how to produce these with Ultra Fractal. By default, Ultra Fractal opens with a standard Mandelbrot fractal, so the easiest way is to take this fractal and start zooming.

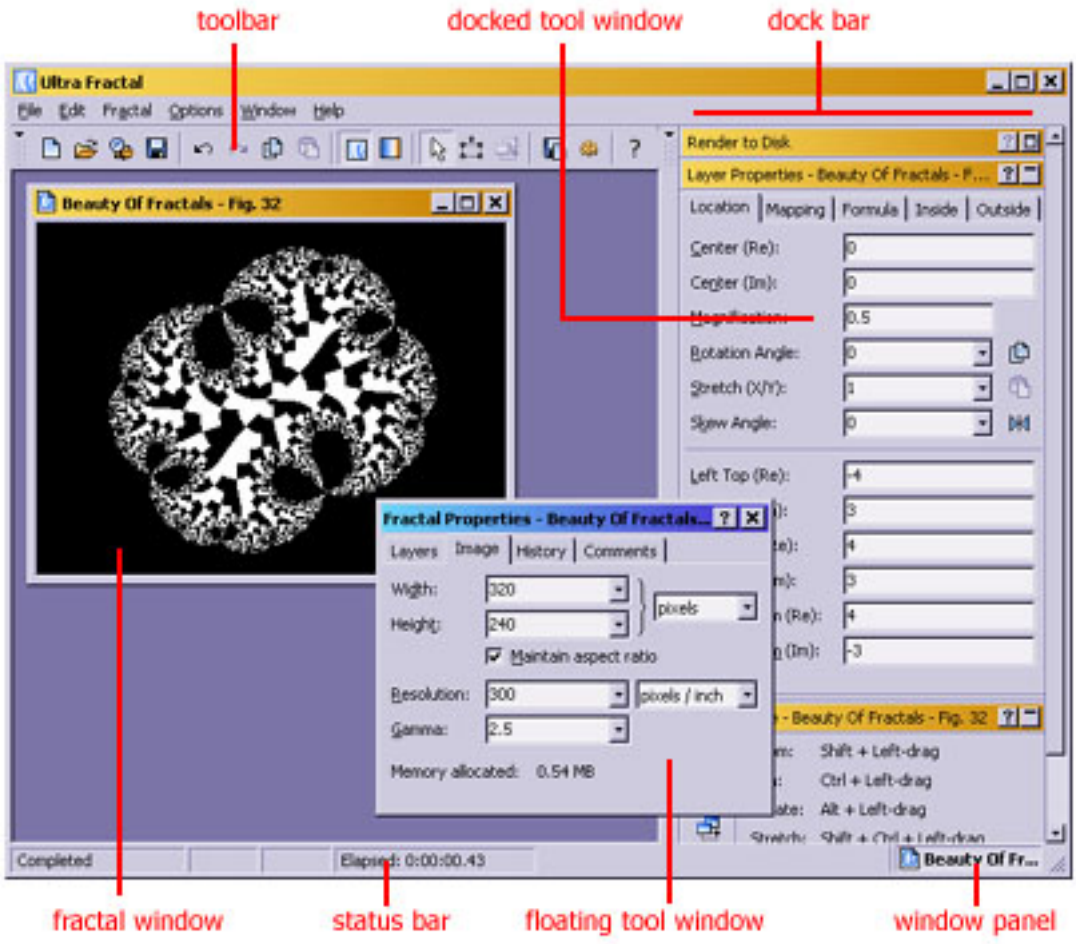
Click and drag inside the fractal window to open the selection box. Drag and resize it, and then double-click inside the selection box to zoom in.

Ultra Fractal has many more possibilities, but it's a good idea to start with simple zooming to get a feeling for what fractals are and how Ultra Fractal works. Also, be sure to work through the tutorials to learn more.

See also
Tutorials
Workspace

Workspace overview

Ultra Fractal has one main application window that contains all open documents, such as fractals, gradients, and formula files. Secondary windows, called **tool windows**, edit the properties of fractals and provide access to other functionality.



The workspace contains the following elements:

- **Document windows** contain the documents that you work on, such as fractals and gradients. In the screen shot above, the fractal window is an example of a document window.
- The buttons on the **toolbar** provide access to frequently-used commands. Usually, these commands can also be accessed through the **pull-down menu** directly above the toolbar. The toolbar can be hidden and restored by clicking Toolbar on the Options menu.
- The **dock bar** is a place to store tool windows, to keep them from using too much screen space. Tool windows can be dragged into and out of the dock bar at any time. Tool windows in the dock bar are called **docked tool windows**. They can also be collapsed so you only see the title bar. To hide and restore all tool windows and the dock bar, click Tool Windows on the Options menu or press F12.
- **Floating tool windows** are tool windows that float freely over the screen, instead of being in the dock bar. This is useful if you use a tool window a lot, or to place some tool windows on a secondary monitor if you have one.
- The **status bar** provides additional information about the active document window, such as the elapsed calculation time for a fractal. To hide and restore the status bar, click Status Bar on the Options menu.
- The **window panel** is an area in the status bar that lists all open document windows, much like the Windows task bar. To bring a document window to the foreground, click on its button in the window panel. To hide and restore the window panel, click Window Panel on the

Options menu.

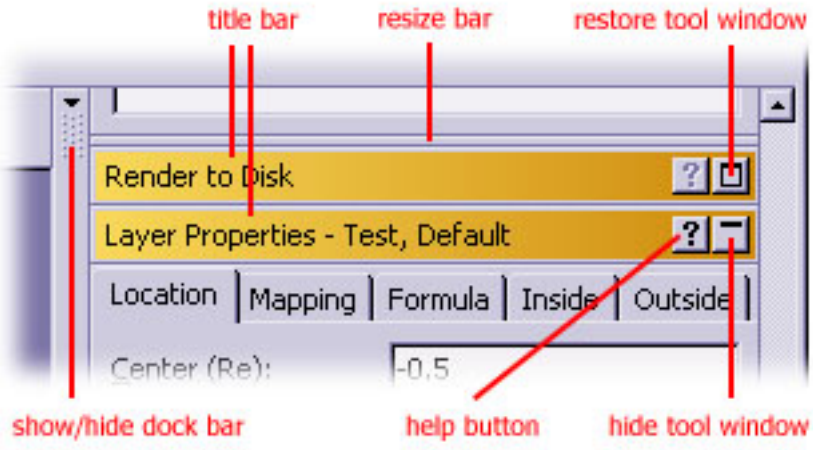
Next: Working with tool windows

See Also

Tutorials
Fractal windows
Gradients

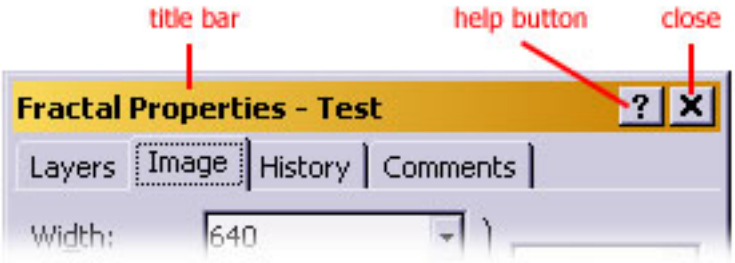
Working with tool windows

Most of the functionality in Ultra Fractal is accessed through the various tool windows. All tool windows are resizeable. They can be put in the dock bar to save screen space, or they can float on the screen for easy access.



With docked tool windows:

- Use the **title bar** to drag a tool window out of the dock bar to change it into a floating tool window.
- Drag the **resize bar** up and down to change the height of a tool window.
- Click the **hide tool window** button to temporarily hide a tool window, so there's more space for the other windows. The tool window collapses to show only the title bar.
- Click the **restore tool window** button to restore a hidden tool window.
- Click the **help button** and then click a control inside the tool window to get context-sensitive help.
- Click the **show/hide dock bar** button to hide the entire dock bar temporarily. Drag the vertical bar to the left and right to change the width of the dock bar.



With floating tool windows:

- Use the **title bar** to drag the tool window around. Drop it on the dock bar to change it into a docked tool window.
- Click the **help button** and then click a control inside the tool window to get context-sensitive help.
- Click the **close button** to hide the tool window. To show it again, click Tool Windows on the Window menu, and then click the name of the tool window.
- Right-click on the title bar and click Decrease Opacity to make the tool window transparent, so you can see the windows beneath it. (This works only with Windows 2000 and XP.)

In general:

- Click Tool Windows on the Window menu for a menu listing all tool windows. Click the name of a tool window to show and hide it. Right-clicking the dock bar will also show this menu.
- Click Tool Windows on the Options menu or press F12 to hide and restore all tool windows.

Next: Tool windows overview

See Also

Workspace overview
General keyboard shortcuts

Tool windows overview

There are two categories of tool windows in Ultra Fractal. Most tool windows work with the active fractal document, but there are also stand-alone tool windows that work indepently.

Tool windows that work with the active fractal document:

- The Layer Properties tool window edits the active layer of the fractal. This is where you do most of the work, for example changing fractal types or experimenting with parameters.
- The Fractal Properties tool window edits the properties that apply to the entire fractal, such as the image size and the layers that it contains.
- The Fractal Mode tool window controls what happens and provides feedback when you click and drag inside the fractal window.
- The Statistics tool window shows additional information about the fractal and the calculation process.
- The Color Cycling tool window animates the colors in the fractal.

Stand-alone tool windows:

- The Network tool window manages the computers that are connected to Ultra Fractal for distributed fractal calculations.
- The Render to Disk tool window manages background calculations of disk render jobs.
- The Compiler Messages tool window collects warnings and errors generated by the formula compiler when you select or reload a formula.

See Also
Working with tool windows
Workspace overview

Layer Properties tool window

The Layer Properties tool window edits the active layer in the active fractal document. The active layer is set in the Layers tab of the Fractal Properties tool window. The title bar shows the layer currently being edited.

The Layer Properties tool window contains five tabs:

- The **Location** tab specifies the coordinates of the layer. The coordinates define which portion of the fractal is visible. The coordinates are shown in two different forms: as the center coordinate with magnification, and as the coordinates of the corners of the layer. Although it's possible to enter coordinates directly here, you will usually use the zooming, panning and rotating capabilities of the fractal window instead. The Location tab is useful for copying locations from one layer to another with the Copy and Paste buttons.
- The **Mapping** tab contains a list of geometric transformations that are applied to the layer. These are used to transform the shape of a fractal.
- The **Formula** tab specifies the fractal formula (fractal type) that is used by the layer. The fractal formula defines the shape of the fractal.
- The **Inside** and **Outside** tabs specify how the data from the fractal calculations is interpreted to obtain the final coloring of the layer. By selecting different coloring algorithms here and adjusting the parameters, many different images can be created with the same fractal formula.

To understand how the controls on the tabs work together, it helps to remember that in a way, the calculation "flows" through the tabs from left to right, starting with the location, and ending with the coloring algorithms.

For more information on a specific control, click the help button in the title bar of the tool window, and then click the control.

See Also
Keyboard shortcuts for the Layer Properties tool window
Tool windows

Fractal Properties tool window

The Fractal Properties tool window edits properties of the entire active fractal document. It contains four tabs:

- The **Layers** tab manages the layers in the fractal. Here, you can control how the layers are merged together to produce the final image. The properties of individual layers are edited by the Layer Properties tool window.
- The **Image** tab specifies the dimensions of the fractal window. It's important to remember that the fractal window is really only a preview. Use the Render to Disk feature to create final images at any size, independent of the size of the fractal window.
- The **History** tab shows the previous states of the fractal. It allows you to go back any number of steps in time, without recalculations. See Fractal history list.
- The **Comments** tab provides a space for you to type comments on the fractal, such as copyright information. It also contains the credits list that automatically tracks the artists that have worked on the fractal, so everyone receives proper credit.

For more information on a specific control, click the help button in the title bar of the tool window, and then click the control.

See Also
What are fractals?
Keyboard shortcuts for the Fractal Properties tool window
Tool windows

Fractal Mode tool window

The Fractal Mode tool window controls how mouse operations are interpreted by the active fractal window. Use the buttons on the left to select the mode you want to use:

- In **Normal mode**, click and drag while holding down the Shift, Ctrl, or Alt keys to zoom, pan, rotate, skew, and stretch the fractal. Clicking and dragging without holding down a shift key enters Select mode by default. Double-click to zoom in twice. All mouse bindings are customizable in the Mouse tab of the Options dialog. The Fractal Mode tool window shows the current bindings.
- In **Select mode**, a selection box is used to zoom. The area inside the box is expanded to fill the entire fractal window when you zoom in. The Fractal Mode tool window shows a preview of the new fractal, and contains additional options.
- **Switch mode** is used to switch from Mandelbrot-like fractals to their Julia counterparts. This is possible because the Mandelbrot set is actually a map of Julia sets. Move the mouse cursor over the fractal and the Fractal Mode tool window will show a preview of the Julia set that corresponds to the point under the cursor. Click to open a new fractal with this Julia set.

For more information on a specific control, click the help button in the title bar of the tool window, and then click the control.

See Also

Normal mode
Select mode
Switch mode
Tool windows

Statistics tool window

The Statistics tool window shows additional information on the active fractal window.

The **General** tab shows the calculation progress of the fractal at the top. At the bottom, several statistics on the active layer are shown, such as the precision of the calculations used, the percentage of pixels that were actually calculated (not guessed), and the iteration limits of the pixels calculated so far.

The **Iterations** tab shows a histogram with detailed information on how the iterations values are distributed. You can use this information to estimate a good value for the Maximum Iterations setting in the Formula tab of the Layer Properties tool.

For more information on a specific control or statistic, click the help button in the title bar of the tool window, and then click the control.

See Also
Arbitrary precision
Maximum iterations
Tool windows

Color Cycling tool window

The Color Cycling tool window rotates the colors of the layers in the active fractal. Click on one of the buttons to start cycling the colors. Move the slider to change the cycling speed.

What color cycling does is repeatedly moving the Rotation slider of the gradients of the editable layers in the fractal. This rotates the gradients in the layers, reproducing the "palette animation" effect that is well-known from older 256-color fractal programs.

Color cycling is also possible without the Color Cycling tool window: right-click inside the fractal window to open a pop-up menu, click the Gradient submenu and then click Cycle Colors Forward or Cycle Colors Backward.

For more information on a specific control, click the help button in the title bar of the tool window, and then click the control.

See Also
Gradients
Tool windows

Network tool window

The Network tool window manages connections to other computers on the network. Ultra Fractal can then use these computers to distribute fractal calculations, so they're performed much faster.

With the list of connections in the tool window, you can add, rename, edit, and delete connections. Connections can also be activated and deactivated. By clicking on a connection, you can see its status, how long it has been connected, and how many pixels per second are calculated by the connected computer on average.

It's important to understand that the network tool window shows and edits the connections, but it does not "own" them. So, even when you hide or close the tool window, the connected computers will still continue to be used.

For more information on a specific control, click the help button in the title bar of the tool window, and then click the control.

See Also
Network calculations
Tool windows

Render to Disk tool window

The Render to Disk tool window manages render jobs. Fractals can be rendered to disk to create high-resolution images with better quality than is possible in the fractal window. Each render command creates a render job that is subsequently performed in the background. The Render to Disk tool window shows the list of render jobs that are still to be finished.

Render jobs are calculated from the top of the list to the bottom (new jobs are added at the bottom). You can add, delete, pause, and resume render jobs. Multiple jobs can be calculated simultaneously.

It's important to understand that the Render to Disk tool window shows and edits the render jobs, but it does not "own" them. So, even when you hide or close the tool window, the jobs will still continue to be calculated normally.

For more information on a specific control, click the help button in the title bar of the tool window, and then click the control.

See Also

Exporting and rendering

Render jobs

Tool windows

Compiler Messages tool window

The Compiler Messages tool window collects warning and errors generated by the compiler when you select or reload a formula. These messages are intended for formula authors. If you encounter errors in a formula that you didn't write, it's best to contact the author of the formula.

The tool window attaches itself to the most recently compiled formula. It also shows any run-time messages generated by the attached formula when it is used for fractal calculations. Run-time messages can be used for debugging purposes.

Double-click a message to open the line of code that corresponds to the message in the formula editor, so you can inspect the code and correct the error. Click the Help on Error button to get help about the selected message.

For more information on a specific control, click the help button in the title bar of the tool window, and then click the control.

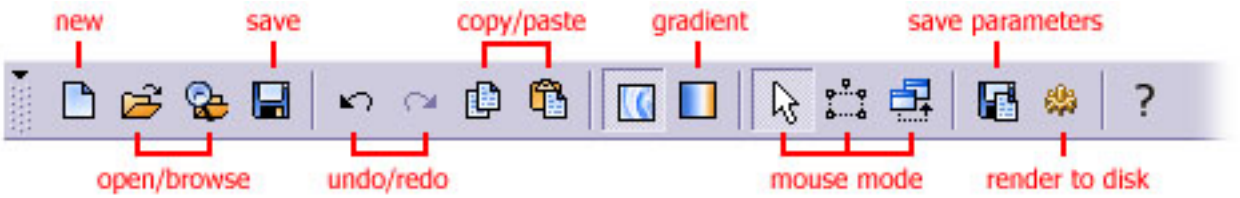
See Also

Writing formulas
Debugging
Tool windows

Fractal windows

Fractal windows contain the fractals that you work on in Ultra Fractal. While you edit the fractal using the Fractal Properties and Layer Properties tool windows, the fractal window is continually updated to show the result of your changes. Although fractal windows are resizeable, this won't change the size of the fractal itself. Use the Image tab in the Fractal Properties tool window to resize the fractal.

The toolbar contains commands to edit and save the fractal:



- The **New** button creates a new fractal from scratch. To duplicate the current fractal instead, click Duplicate on the File menu.
- The **Open** and **Browse** buttons open files from disk.
- The **Save** button saves the fractal to disk. See Opening and saving fractals.
- The **Undo** and **Redo** buttons can undo and redo your previous actions. See Fractal history list.
- The **Copy** and **Paste** buttons copy fractal parameters to and from the Clipboard. See Copying and pasting fractals.
- The **Gradient** button opens the gradient editor associated with the fractal window to edit the colors of the fractal.
- The **mouse mode** buttons show and select the active mouse mode. The mouse mode determines what happens when you click and drag inside the fractal window. There are three mouse modes:
  - Normal mode
  - Select mode
  - Switch mode
- The **Save Parameters** button saves the fractal to a parameter set. See Parameter files.
- The **Render to Disk** button starts rendering the fractal to disk, creating a high-resolution image with better quality than possible in the fractal window. See Render to disk.

The commands on the toolbar are duplicated on the File, Edit, and Fractal pull-down menus. Frequently used commands are also on the menu that pops up when you right-click inside the fractal window.

Next: Normal mode

See Also
Keyboard shortcuts for fractal windows
Exporting and rendering
Workspace

Normal mode

The mouse mode determines what happens when you click and drag inside the fractal window. By default, a fractal window is in Normal mode.

To put the fractal window in Normal mode, click **Normal Mode** on the Fractal menu, or make sure the Normal mode button in the toolbar is down.

In Normal mode, you can zoom, pan, rotate, stretch, and skew the fractal simply by clicking and dragging inside the fractal window. Before you click, hold down one of the Ctrl, Shift, or Alt keys to indicate what you want to do.

To:	**Do this:**
Zoom	Hold down Shift, click and drag
Pan	Hold down Ctrl, click and drag
Rotate	Hold down Alt, click and drag
Stretch	Hold down Shift and Ctrl, click and drag
Skew	Hold down Ctrl and Alt, click and drag
Enter Select mode	Click and drag

While still holding down the left mouse button, move the mouse around to make adjustments. The fractal window continually shows a preview of the result. In the status bar, additional information is shown, such as the current rotation angle.

The status bar also shows extra keys that you can hold down for fine adjustments or to constrain rotation to 45° increments, for example. To use them, first release the key that you've been holding down (still holding down the left mouse button) and then press and hold down the appropriate key.

When you're ready, release the mouse button and the fractal will recalculate to apply your changes. To cancel the operation while you're still holding down the left mouse button, briefly click the right mouse button. If you've already released the mouse button, click **Undo** on the Edit menu to undo the operation.

Notes

- The actions shown in the table are the default actions. Use the Mouse tab in the Options dialog (click Options on the Options menu) to customize them. The Fractal Mode tool window always shows the current bindings.
- If the fractal contains multiple layers, only the editable layers are affected.

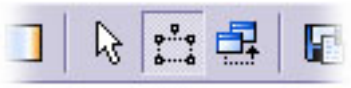
Next: Select mode

See Also
Fractal windows

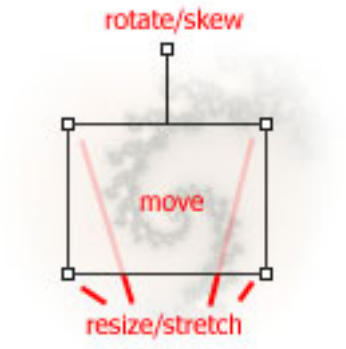
Select mode

The mouse mode determines what happens when you click and drag inside the fractal window. In Select mode, a selection box is used for zooming, panning, rotating, stretching, and skewing.

To enter Select mode from Normal mode, simply click and drag inside the fractal window. Alternatively, click **Select Mode** on the Fractal menu, or make sure the Select mode button in the toolbar is down.



In the fractal window, a selection box appears.



The area inside the selection box will be magnified to fill the fractal window when you zoom in. You can manipulate the selection box by dragging the handles and edges.

To:	**Do this:**
Move the selection box	Click inside the box and drag
Resize the selection box	Drag the edges or the handles at the corners
Rotate the selection box	Drag the top handle
Stretch the selection box	Hold down Ctrl and drag the edges or the handles at the corners
Skew the selection box	Hold down Ctrl and drag the top handle
Cancel	Click outside the selection box

When you're ready, double-click inside the selection box to zoom in. To zoom out, hold down Ctrl while double-clicking. Alternatively, right-click inside the fractal window to open a menu with the following commands:

Zoom In	Magnifies the area inside the selection box to fill the fractal window
Zoom Out	Shrinks the area of the fractal window to fill the selection box
Crop	Resizes the fractal window to fill the selection box
Reset	Restores the default position of the selection box
Resize Fractal	Resizes the fractal window to match the aspect ratio of the selection box
Stretch Fractal	Stretches the fractal window to fit the selection box

The Fractal Mode tool window shows a preview of the resulting fractal. The buttons in the tool window select what you want to do: zoom in, zoom out, or crop. They duplicate the menu commands listed above, except that they are not applied until you click the Apply button in the tool window.

Notes

- While the selection box is visible, the status bar provides additional information, such as the current magnification and rotation angle.
- If the fractal contains multiple layers, only the editable layers are affected.

Next: Switch mode

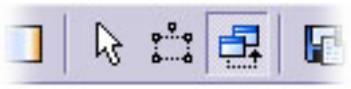
See Also

Tutorial: Learning basic skills
Keyboard shortcuts in Select mode
Fractal windows

Switch mode

The mouse mode determines what happens when you click inside the fractal window. In Switch mode, a mouse click switches between related fractal types.

To enter Switch mode, click **Switch Mode** on the Fractal menu, or make sure the Switch Mode button on the toolbar is down.



Switching is typically used with Mandelbrot and Julia-like fractals. The Mandelbrot set is actually a map of Julia sets. Each point in the Mandelbrot set corresponds to a unique Julia set. The shape of this Julia set reminds of the immediate surroundings of the corresponding point in the Mandelbrot set.

If you enter Switch mode while looking at a Mandelbrot set and move the mouse cursor over the fractal window, the Fractal Mode tool window shows a preview of the corresponding Julia set. Click to open a new fractal window with this Julia set, so you can further explore it.

Notes

- Sometimes the preview remains static while you're moving the mouse cursor. In this case, the fractal is not a map of the fractal to switch to. This is the case when you're working with a Julia set. Just click anywhere to switch to the corresponding Mandelbrot set.
- If the fractal has multiple layers, Ultra Fractal uses the active layer for switching.
- The Mouse tab in the Options dialog contains several options for Switch mode, such as the option to open the Julia set in the same fractal window, to copy the coloring of the original fractal, and so on.
- The fractal formula contains switch settings that control how Switch mode works. Refer to the compiler documentation if you want to add switching support to your own formulas.

Next: Opening and saving fractals

See Also

Tutorial: Learning basic skills
Fractal windows

Opening and saving fractals

Fractals are saved to fractal files (*.ufr). A fractal file contains one fractal, complete with the calculated pixels and all the information required to restore it. Because the calculated pixels are saved as well, fractal files can become quite large. However, the fractal doesn't have to be recalculated when opening the file.

To save a fractal to a fractal file, click Save on the File menu. If the fractal hasn't been saved before, a file dialog will pop up, where you can type a name for the fractal.

To open a previously saved fractal file, click Open on the File menu. In the file dialog, set the File type input box to Fractal files and select the fractal you want to open. The fractal will be opened in a new fractal window.

At the bottom of the File menu, there is a list of recently opened files. Simply click the name of a file to open it.

Fractal files are a good choice if you want to save fractals for your own reference, for example to a hard disk or CD. However, if you want to share your fractals with other Ultra Fractal users, it's easier to use parameter files or copying and pasting.

Fractal files are saved in a proprietary format. If you want to import your fractals in graphics software such as Adobe Photoshop, you need to export or render the fractal first.

Next: Parameter files

See Also

Tutorial: Learning basic skills
Browsers
Fractal windows

Parameter files

Fractals can be saved as parameter sets as well as in fractal files. Parameter sets are much smaller than fractal files because they do not contain the calculated pixels. That means that the fractal has to be recalculated when a parameter set is opened. Parameter sets are ideal for sharing fractals with other users on the Internet.

Parameter sets are stored in parameter files. A parameter file (*.upr) can contain any number of parameter sets. This makes it easy to store and organize collections of parameter sets. Parameter files are stored as plain text and can be opened in text editors such as Notepad.

To save a parameter set, click Save Parameters on the File menu. The Save Parameters browser will open. You can save the parameter set in an existing parameter file or in a new file. Type the name of the file and the title of the parameter set and click Save.

To open a previously saved parameter set, click Browse on the File menu. This opens a modeless browser. Select the parameter file that contains the parameter set that you want to open, and then double-click the parameter set inside the file.

Browsers are also used to organize and manage parameter sets and parameter files (as well as other files that contain multiple entries, such as formula files). See Browsers.

Notes

- By checking the **Save Formulas** checkbox when saving a parameter set, the formulas used by the fractal are embedded in the parameter file. When opening the parameter set, they will be installed if they're not already present in the formulas folder. Check this when you're going to send the parameter file to another user (but not on the mailing list).
- Parameter sets larger than 2 KB are saved in a compressed format. To save them without compression, click Options on the Options menu, and uncheck "Compress parameter sets larger than 2 KB" in the Fractal tab. This is necessary if you want to edit the parameter files manually.
- Ultra Fractal can also import most Fractint parameter sets in PAR files (*.par). They can be opened just like other parameter files.

Next: Copying and pasting fractals

See Also

Quick Start Tutorial
Fractal windows

Copying and pasting fractals

Fractals can easily be shared between fractal windows and even between Ultra Fractal users by copying them to the Windows Clipboard.

To copy a fractal to the Clipboard, click **Copy** on the Edit menu. The Clipboard now contains a parameter set describing the fractal in plain text format. You can paste it into another fractal window, but you can also share it with other Ultra Fractal users just by pasting it into an email message (for example in Outlook).

To paste a fractal on the Clipboard into an open fractal window, click **Paste** on the Edit menu.

To open a fractal that you've received via email, select the entire parameter set in the email message:

and then copy it to the Clipboard (in most email software, such as Outlook, press Ctrl+C). Now open a new fractal window in Ultra Fractal (click **New** > **Fractal** on the File menu), and click **Paste** on the Edit menu to paste the parameter set into the fractal window.

Notes

- Click **Copy Formulas** on the Edit menu to copy a fractal to the Clipboard, including the formulas that it uses. This enables other users to open it regardless of the formulas that they have installed on their computer. Don't use this option on the mailing list, though.

Next: Fractal history list

See Also

Ultra Fractal mailing list
Parameter files
Fractal windows

Fractal history list

Every fractal has a history list. The history list stores previous states of the fractal, so you can easily undo and redo your changes. Because the calculated pixels are saved as well, the fractal doesn't have to be recalculated when undoing changes. This gives you the freedom to explore in the knowledge that you can always effortlessly go back to a previous state, without having to wait.

To go back to the previous state of the fractal, click Undo on the Edit menu.

To cancel an Undo operation, click Redo on the Edit menu.

The History tab in the Fractal Properties tool shows a list of previous states of the fractal, complete with previews and descriptions. To go back to a previous state, simply click it.

Next: Full screen mode

See Also
Fractal windows

Full screen mode

A fractal window can be maximized to full screen mode so you can see and explore the fractal without being distracted by other windows.

To enter full screen mode, click **Full Screen** on the Fractal menu. The fractal will now appear full screen. To go back to the normal fractal window, right-click to open a pop-up menu and click Full Screen again.

In full screen mode, a limited number of operations are available through the pop-up menu. You can fully use Normal mode, Select mode and Switch mode to explore the fractal, although without the help of the Fractal Mode tool window. The menu also offers undo and redo commands.

The Gradient submenu provides some additional commands to alter the colors of the fractal. Although this submenu is also available in the normal fractal window, it's especially useful in full screen mode, where you can't access the gradient editor.

Randomize	Randomizes the colors of the gradient. There are four different options.
Adjust Colors	Opens a dialog to adjust the colors of the gradient. See Adjusting gradients.
Cycle Colors	Cycles the colors of the gradient forward or backward. See Color Cycling.

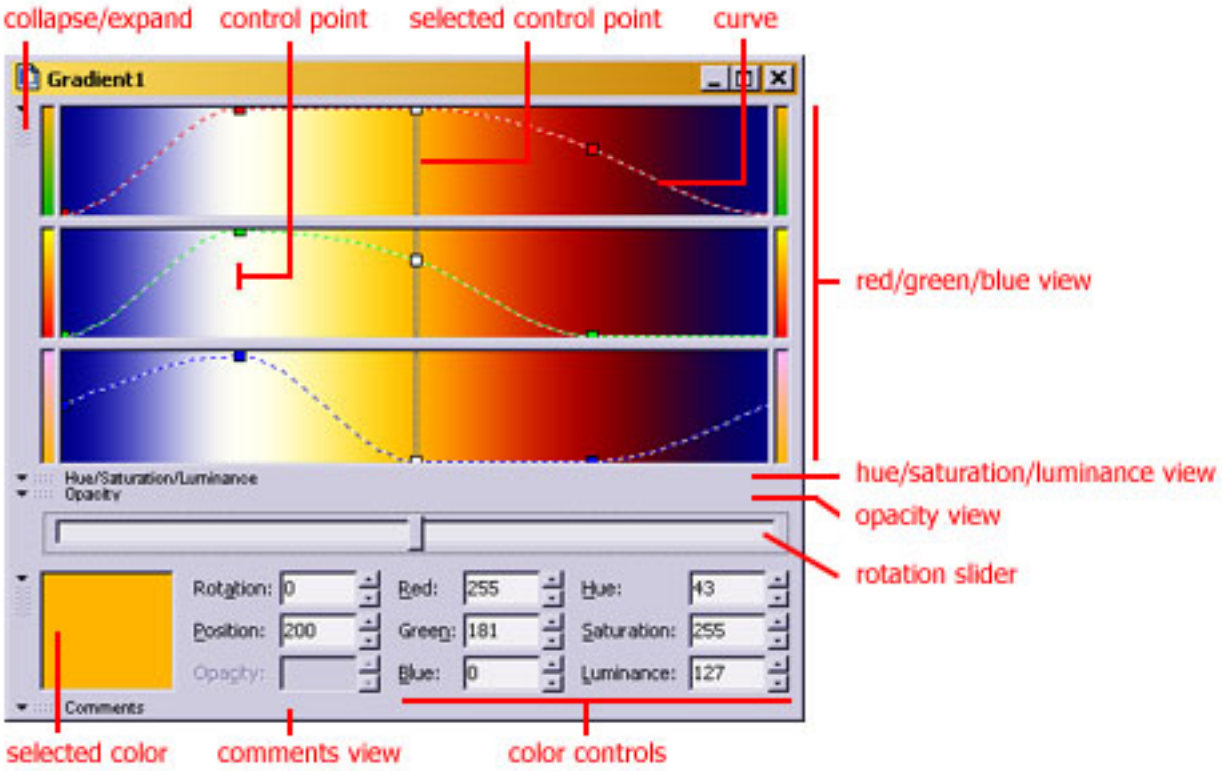
See Also
Fractal windows

Gradients

Gradients contain coloring information for fractals. Each layer in a fractal has its own gradient. Gradients can also be edited and saved separately (not linked to a fractal).

To open the gradient editor associated with a fractal window, click Gradient on the Fractal menu. This gradient editor can be recognized because it shows the name of the fractal and the active layer in the title bar. When the gradient is edited, the fractal window immediately redraws itself to show the new colors.

To open a stand-alone gradient editor, click New on the File menu, and then click Gradient.



The gradient editor provides various views on the gradient. Each view can be collapsed and expanded by clicking the button on the left of it. There are five views:

Red/Green/Blue	Edits the gradient in the RGB color model
Hue/Saturation/Luminance	Edits the gradient in the HSL color model
Opacity	Edits the transparency of the gradient
Controls	Allows you to fine-tune the selected control point by entering values manually
Comments	Provides a place to type comments

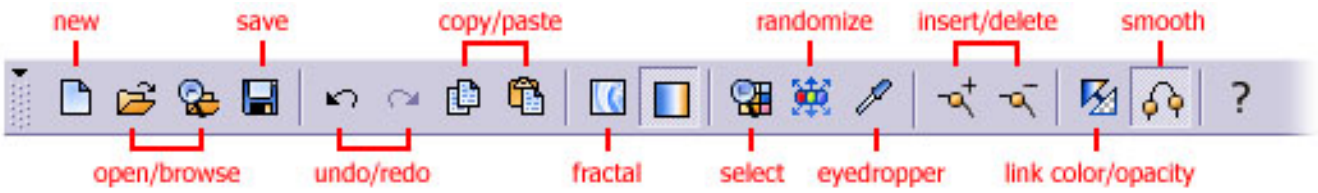
The rotation slider is placed outside the collapsible views, so it's always visible. It rotates the gradient to change the way the colors are mapped onto the fractal.

Next: Gradient toolbar

See Also

Gradient toolbar

The toolbar for the gradient editor contains commands to edit and save the gradient:



- The **New** button creates a new fractal from scratch. To create a new gradient, click New on the File menu and then click Gradient. To duplicate the existing gradient, click Duplicate on the File menu.
- The **Open** and **Browse** buttons open files from disk.
- The **Save** button saves the gradient to disk. See Opening and saving gradients.
- The **Undo** and **Redo** buttons can undo and redo changes to the gradient.
- The **Copy** and **Paste** buttons copy gradients to and from the Clipboard. This is useful for copying gradients between layers or between fractals.
- The **Fractal** button activates the fractal window that owns the gradient editor. This button is not available with stand-alone gradient editors. Together with the **Gradient** button next to it, you use these buttons to switch back and forth between the fractal window and the gradient editor.
- The **Select Color**, **Randomize Color**, and **Eyedropper** buttons change the color of the selected control point. See Editing gradients.
- The **Insert** button adds a new control point. The **Delete** button removes the selected control point.
- The **Link Color and Opacity** button links and unlinks the color and opacity parts of the gradient. See Transparent gradients.
- The **Smooth Curves** button controls how curves between control points are interpolated: linearly or smoothly.

The commands on the toolbar are duplicated on the File, Edit and Gradient pull-down menus. Frequently used commands are also on the menu that pops up when you right-click inside the gradient editor.

Next: How gradients work

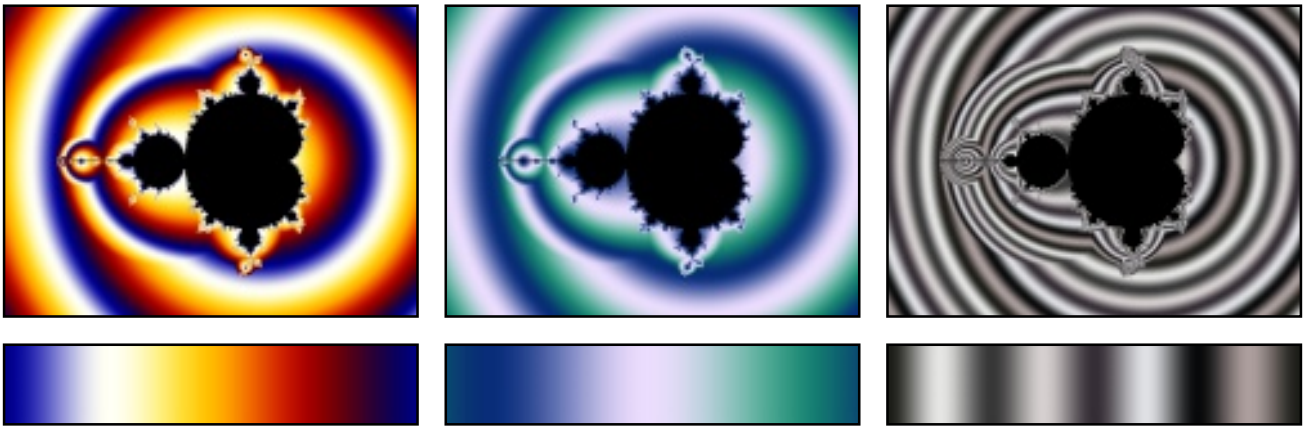
See Also
Keyboard shortcuts for gradient editors
Gradients

How gradients work

When Ultra Fractal calculates a fractal, it does not immediately calculate a color for each pixel. Instead, it calculates an intermediate **index value**. The index value is a single floating-point number that is returned by the selected coloring algorithm.

The gradient translates index values to colors. Since only the index values are stored, the colors can be changed without having to recalculate the fractal. To put it another way, the coloring algorithm defines the distribution of the colors, the gradient defines the colors themselves.

Here's an example. It's the same fractal with three different gradients, shown below each fractal.



The fractal contains only colors from the gradient. In addition, you can also recognize the color transitions from the gradient in the fractal. This is because most coloring algorithms, such as the one used here, create smooth ranges of index values. Note how the gradient wraps around at the endpoints to create smoothly colored images.

Note that with direct coloring algorithms, the coloring algorithm directly calculates the color of a pixel, and the gradient is used differently (it can be used by the coloring algorithm, but it doesn't have to).

Next: Editing gradients

See Also
Gradients

Editing gradients

The colors in the gradient are edited by dragging the control points. You can use either the Red/Green/Blue view or the Hue/Saturation/Luminance view. They both edit the same control points, but with different color models. You can resize the gradient editor for more accurate positioning of the control points.

Click a control point to select it. Hold down Shift or Ctrl and click to select multiple control points. Click on the curve background to deselect all control points. To draw a rectangle around control points to select them, click on the curve background and drag.

Drag a control point to change its color and position. To change only the position or only the color, hold down Shift while dragging. In the Controls view, you can manually enter the color and position of the control point for fine-tuning.


Click **Insert** on the Edit menu, and then click somewhere in the gradient editor to insert a new control point there. You can also just hold down Ctrl while clicking on the curve background.


Click **Delete** on the Edit menu to delete the selected control point.


Right-click in the gradient editor and click **Select Color** to open a dialog box to change the color of the selected control point. This is an alternative to dragging the control point itself.


Right-click in the gradient editor and click **Randomize Color** to set the color of the selected control point to a random value.


Right-click in the gradient editor and click **Eyedropper** to pick the color of the selected control point from any open gradient editor or fractal window. Click Eyedropper again to cancel.


Click **Smooth Curves** on the Gradient menu to toggle between linear interpolation and smooth interpolation for the curves. This affects how the gradient is colored between control points.


Click **Undo** on the Edit menu to undo the changes you've made. The history list of the gradient is independent from the fractal history list, but it is reset when undoing changes to the fractal.

Next: Transparent gradients

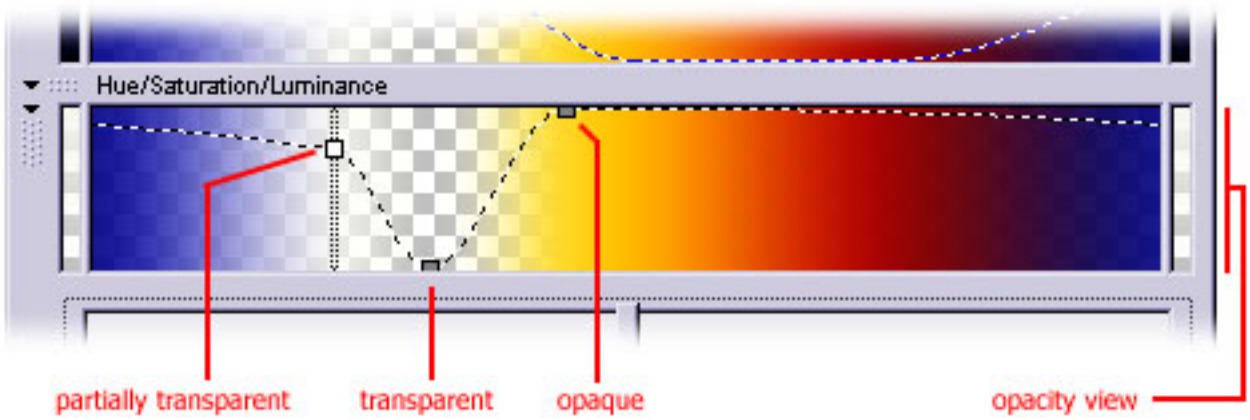
See Also

Tutorial: Learning basic skills
Tutorial: Working with layers
Keyboard shortcuts for gradient editors
Gradients

Transparent gradients

The gradient defines not only the colors of a layer, but also the transparency. An opacity value is associated with every color to make it more or less transparent. By default, all opacity values are set to 255, which makes them completely opaque.

Use the Opacity view to edit the opacity of the gradient. The opacity curve can be edited independently from the color curves (they don't necessarily share the same control points). To edit the curve, click on the Opacity view to activate it, and drag the control points, just like when you edit the color curves. Drag a control point up to make it opaque, drag it down to make it transparent.



The pattern of blocks shows the transparency of the gradient. This pattern is also visible in the fractal window unless there's a layer below the current layer that is completely opaque (in this case the underlying layer is shown).

Many gradient commands work only on the active curve or curves. For example, when the opacity curve is active, the Smooth Curves command (click Smooth Curves on the Gradient menu) will adjust the curvature of the opacity curve instead of the color curves. Only the active curve shows control points.

You can link the color curves and the opacity curve so they share the same control points. To link them, click Link Color and Opacity on the Gradient menu. This will adjust the opacity curve to give it the same control points as the color curves. You can now edit the opacity and color curves simultaneously.

Next: Adjusting gradients

See Also

Tutorial: Working with layers
Tutorial: Masking
Layers
Masks
Gradients

Adjusting gradients

To edit the gradient, you usually manipulate individual control points. However, there are also several commands that adjust the entire gradient. These commands will work on the active curves (color or opacity), or both when they're linked together (see Transparent gradients).

Click Adjust Colors on the Gradient menu to open the Adjust dialog. This dialog allows you to change the color balance, hue, saturation, brightness, and contrast of the entire gradient. For example, by moving the Saturation slider in the HSL tab completely to the left, you can create a grayscale version of the gradient.

Click Randomize on the Gradient menu to randomize the gradient. This fills the gradient with a random number of control points, all with random colors.

Click Randomize Bright or Randomize Misty for a different selection of colors.

Click Randomize Custom to open a dialog with a variety of options for randomizing the gradient. Here, you can randomize for example only the positions of the control points, or choose from specific ranges of values for the colors.

Click Reverse on the Gradient menu to reverse (mirror) the positions of the control points, so the leftmost point will appear on the right, and the rightmost point on the left.

Click Invert on the Gradient menu to invert the colors or opacity values of the control points. This is often useful with the opacity curve, to invert what's transparent and what's opaque.

Next: Opening and saving gradients

See Also

Editing gradients
Gradients

Opening and saving gradients

Gradients are saved in gradient files (*.ugr). A gradient file is a plain text file that can contain any number of gradients, so you can store and organize sets of gradients.

To save a gradient, click **Save** on the File menu. The Save Gradient browser will open. You can save the gradient in an existing gradient file or in a new file. Type the name of the file and the title of the gradient and click Save.

To open a previously saved gradient, click **Browse** on the File menu. This opens a modeless browser. Select the gradient file that contains the gradient that you want to open, and then double-click the gradient inside the file. The gradient will be opened in a new stand-alone gradient editor.

To open a gradient in the active gradient editor, click **Replace** on the File menu instead. This is useful if you want to use the saved gradient in a fractal.

Notes

- When saving a gradient, you can choose to save only the color or opacity parts of the gradient with the **Save Color** and **Save Opacity** checkboxes.
- Another way to open gradients is to click **Open** on the File menu and select a gradient file. A modal browser window will open, showing the gradients in the file. Double-click a gradient to open it.
- Palette files in Fractint's MAP format (*.map) can be opened just like other gradient files.

See Also

Browsers

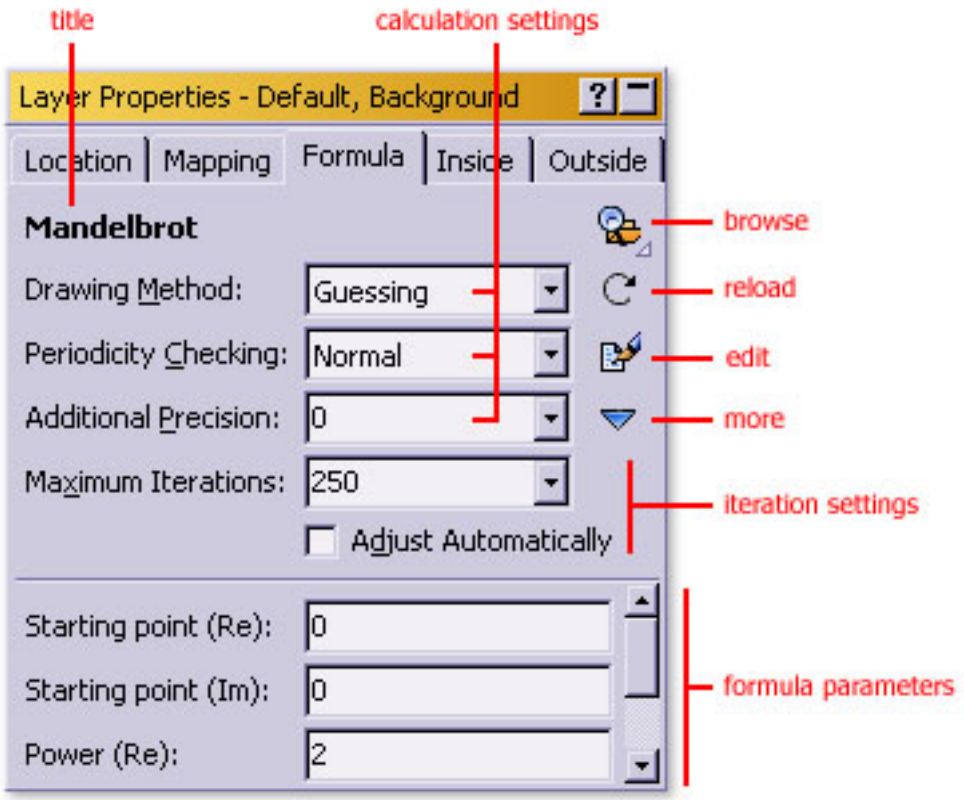
Parameter files

Gradients

Fractal formulas

The fractal formula creates the basic shape and form of a fractal. Ultra Fractal comes with a number of standard formulas that you can use. You can also download additional formulas from the Internet and even write your own formulas.

Fractal formulas are managed in the Formula tab of the Layer Properties tool window.



- At the top, the **title** of the fractal formula is shown. Hold the mouse cursor over the title to see the entry identifier and the file name of the formula.
- The **Browse** button opens a modal browser to select another fractal formula.
- The **Reload** button reloads the fractal formula from disk and recalculates the layer.
- The **Edit** button opens the fractal formula in the formula editor.
- The **More** button shows a menu with additional commands.
- The **calculation settings** specify how the fractal should be calculated. See Working with fractal formulas.
- The **iteration settings** specify how many iterations should be used. See Maximum iterations.
- The **formula parameters** are additional parameters specific to the selected fractal formula. See Formula parameters.

Next: Working with fractal formulas

See Also

Quick Start Tutorial
Coloring algorithms
Transformations
What are fractals?

Working with fractal formulas

You work with fractal formulas in the Formula tab of the Layer Properties tool window. This tab also contains global calculation settings for the layer, since these are closely related to the selected fractal formula.

Fractal formulas are stored in fractal formula files (*.ufm). Each file can contain multiple formulas.

To select a fractal formula, click the **Browse** button. This opens a modal browser that shows the formula files and formulas on your computer. Double-click on a formula to select it.

Hold down the Browse button to open a menu with predefined fractal formulas. Click a formula to select it. Click Define to edit the list of predefined fractal formulas.

Some formulas contain additional help. To access it, click the **More** button, and then click Help.

The Formula tab is divided into two panes. The top pane contains various global calculation settings.

Drawing Method

Selects how the pixels are calculated.

- **Guessing** starts with a low-resolution preview, and then gradually increases the resolution while trying to guess pixels instead of calculating them. This is the fastest option, but also the least accurate.
- **Multi-pass Linear** also starts with a low-resolution preview, but it calculates all pixels instead of guessing them.
- **One-pass Linear** calculates all pixels from top to bottom.

For maximum accuracy, use one of the linear drawing methods.

Periodicity Checking

Specifies the amount of periodicity checking used. Periodicity checking can greatly enhance the speed at which inside areas are calculated. **Rough** is the fastest option, but also the least accurate. **Off** turns off periodicity checking completely for the highest accuracy.

Some fractal formulas don't work well with periodicity checking, in which case you'll have to turn it off.

Additional Precision

Specifies how many extra digits of precision should be used for calculations. See Arbitrary Precision.

The top pane also contains the iteration settings. The bottom pane contains the formula parameters. These parameters are specific to the selected fractal formula.

Next: Maximum iterations

See Also

Fractal formulas

Standard fractal formulas

Maximum iterations

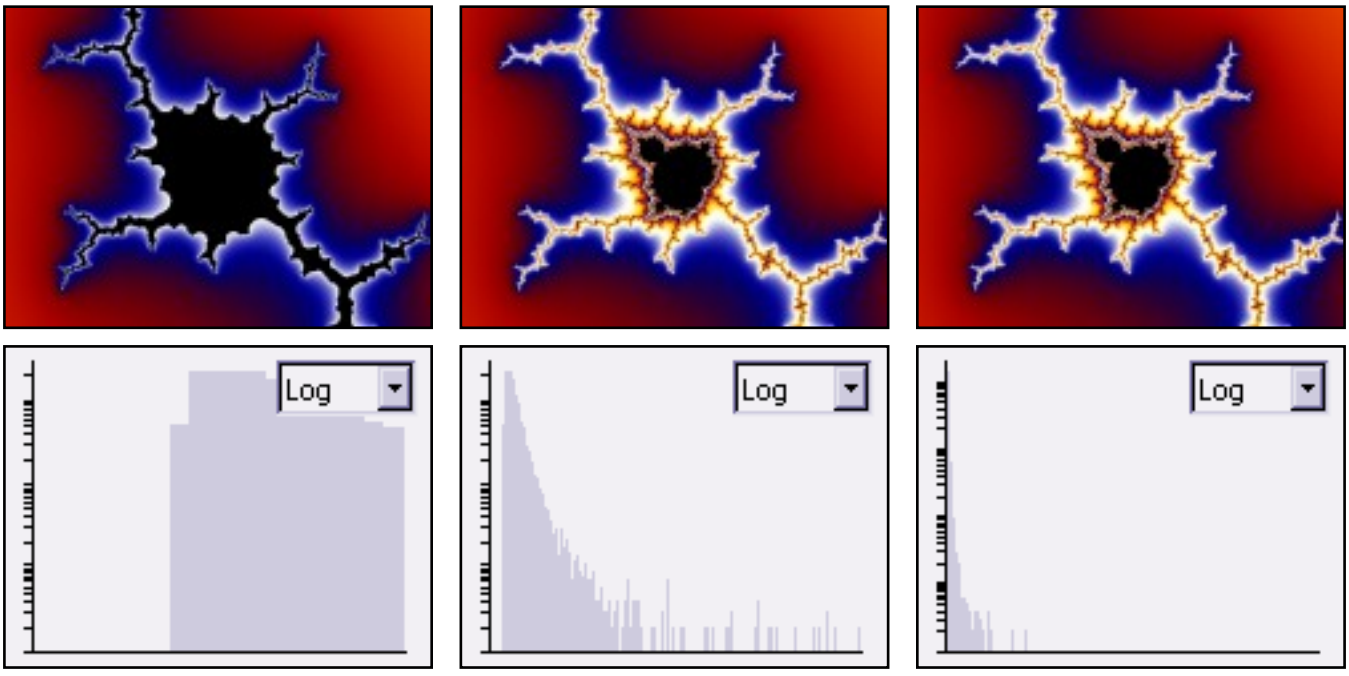
To calculate a pixel in a fractal, Ultra Fractal iterates the selected fractal formula. It executes it multiple times, each time using the result from the previous calculation as input.

The formula is iterated until the maximum iteration count is reached, or until the bail-out condition (specified by the fractal formula) is met. If the bail-out condition is met, the pixel is colored as an outside pixel. Otherwise, it is colored as an inside pixel.

Sometimes, many iterations are necessary to reach the point where the bail-out condition is satisfied. If the maximum iteration count is too small, the pixel will be incorrectly colored as an inside pixel because the bail-out point is not reached. On the other hand, if the iteration count is too large, many iterations will be performed for the pixels that are inside, and the fractal will be calculated slowly.

The **Maximum Iterations** setting on the Formula tab of the Layer Properties tool window specifies the maximum iteration count. To help you find a good value, the Statistics tool window shows a histogram of the iteration values on its Iterations tab.

This example illustrates the influence of the maximum iterations setting:



Maximum iterations: **20** Maximum iterations: **200** Maximum iterations: **2000**

We see the same image three times, with three different values for the maximum number of iterations. Below each image, the iterations histogram from the Statistics tool window is shown.

The first image clearly suffers from a low value for the maximum iterations setting. By increasing it, we obtain the second image, which looks much better. Further increasing the value does not change the image much, so we conclude that 200 is a good value in this case.

Notes

- The histogram can aid you in deciding whether or not you have to change the maximum iterations value. If most of the iterations end up on the left side (as with the middle image) you're probably safe. If they're all at the far left side, the value is probably too high (which

makes the fractal slower to calculate). If there are many iterations on the right side, the value is too low. Move the mouse pointer over the tool window to see the corresponding iteration values.

- Experiment with the maximum iterations setting to learn how to use it. Sometimes, a (too) low value can also be artistically pleasing.
- By checking the **Adjust Automatically** checkbox on the Formula tab, Ultra Fractal automatically adjusts the maximum iterations value when zooming in or out. This can be helpful, but it is not fool-proof: you may need to adjust the value manually every once in a while.

Next: Formula parameters

See Also

Fractal formulas

Working with fractal formulas

Inside and outside

Formula parameters

The bottom pane on the various tabs of the Layer Properties tool window shows parameters that are specific to the selected transformation, fractal formula, or coloring algorithm. There are six types of parameters:

- **Complex** parameters consist of a real and an imaginary value. They appear as two input boxes labeled with "(Re)" and "(Im)" after the name of the parameter. Right-click one of the input boxes to open a menu with additional options.
- **Floating-point** parameters specify a single floating-point value (such as -0.2 or 3.14).
- **Integer** parameters specify an integer value (such as -2 or 3).
- **Enumerated** parameters appear as a drop-down box. They are typically used to select one of various behaviors, or to choose between a number of options.
- **Color** parameters specify a color and are typically used only by direct coloring algorithms. They appear as a color swatch. Click it to adjust the color. Right-click it to open a menu with additional options.
- **Boolean** parameters appear as a checkbox. They are used to turn options on or off.

Many formulas require a bit of experimentation with the parameters to learn how to use them. For new users, it's best to stick to the standard formulas and learn how to use these first.

Some formulas (such as the standard formulas) contain additional help. To access it, click the **More** button, and then click **Help**.

To copy the formula settings (including parameter values) between layers, click the **More** button, and then click **Copy** or **Paste**.

To reset all parameters to their default values, click the **More** button, and then click **Reset Parameters**.

Notes

- Most formulas contain help for individual parameters. To see it, click the **?** button in the title bar of the tool window, and then click a parameter.
- There is an eyedropper feature for complex parameters and color parameters that allows you to select the value of the parameter from any open fractal window. To use the eyedropper, right-click the parameter and click **Eyedropper** in the menu that appears. Move the mouse cursor over a fractal window to see the values that will be used. Click to apply the current value, or right-click the parameter and click **Eyedropper** again to cancel.
- You can easily copy complex values from one parameter to another. Right-click a complex parameter and click **Copy Complex Value** or **Paste Complex Value**. You can also copy coordinates between the Location tab and a complex parameter in this way. To copy a color parameter, right-click it and click **Copy** or **Paste**.

Next: Arbitrary precision

See Also
Fractal formulas
Working with fractal formulas

Arbitrary precision

Ultra Fractal can perform fractal calculations with almost any desired precision. This enables you to zoom as deep as you want, without hitting a precision limit. This is called arbitrary precision (or deep zooming).

Three types of precision are available:

- **Double** is the fastest and the least precise method. It supports magnifications up to about 10^{10} (1E10, or 10 billion). It has a precision of 15-16 decimals.
- **Extended** is slightly more precise and a little slower, supporting magnifications up to about 10^{16}. It has a precision of 19-20 decimals.
- **Arbitrary** is much slower, but it supports magnifications up to 10^{4000}. Its precision can be scaled from 20 to 10,000 decimals.

Ultra Fractal automatically selects the best precision type, depending on the current magnification and the selected fractal formula, transformations, and coloring algorithms. It calculates the number of decimals required and selects the fastest precision type that can support it.

You can verify the number of decimals required and the selected precision type in the General tab of the Statistics tool window.

Sometimes, you may want to adjust the number of decimals to force Ultra Fractal to use a different precision type, or to change the number of decimals used with the Arbitrary precision type. The **Additional Precision** input box on the Formula tab of the Layer Properties tool window allows you to do this.

The value in the Additional Precision input box is added to the default number of decimals required. Positive values will increase the precision; negative values will decrease it. Keep an eye on the Statistics tool window to see the effect.

Notes

- It's generally not a good idea to try to use the additional precision to achieve artistic effects, since they would rely on artefacts in the current implementation, and might be broken by future versions.
- Some older formulas rely on the Extended precision that was always used by Ultra Fractal 2. In this case, you can adjust the additional precision (looking at the Statistics tool window) until the Extended precision type is used.
- To use Arbitrary precision always (or never), click Options on the Options menu and choose the desired option in "Use arbitrary precision" on the Fractal tab.

Next: Public formulas

See Also
Fractal formulas

Public formulas

Ultra Fractal comes with a set of standard fractal formulas, transformations, and coloring algorithms. They are easy to use and well documented. However, when you get more experienced, you will want to work with more different formulas.

Most of the custom formulas written for Ultra Fractal are available through a public formula database on the Internet (formulas.ultrafractal.com). Here, you can download a complete set of formulas, browse the collection, and add your own formulas.

You can download formulas from the database from within Ultra Fractal. This will automatically download new and updated formulas and install them appropriately.

To start updating your collection of public formulas, click **Update Public Formulas** on the Options menu. You can select what to download: the weekly or monthly update, or the full collection. Ultra Fractal will automatically select the most appropriate option depending on how long ago you last updated the formulas.

The downloaded formulas will be installed in the Public formulas folder. By default, its location is My Documents\Ultra Fractal 3\Formulas\Public. It is always located under the main Formulas folder.

The formulas will be installed according to the following rules:

- If a formula file already exists in the Public formulas folder or in a subfolder, it will be overwritten. If the existing file is newer than the downloaded file, you will be prompted for confirmation.
- If a formula file does not exist yet, it will be created in the Public formulas folder.
- If a formula file already exists outside the Public formulas folder, it will not be updated or overwritten. These files are listed as skipped. If you're a formula author, you can thus avoid overwriting your own files when updating the formulas by placing them outside the Public formulas folder.

When all files are downloaded and installed, a short summary of the changes is shown. Details can be found in the Update.log file created in the Public formulas folder.

Notes

- You're free to organize the public formulas in subfolders in the Public formulas folder, for example to put files that you don't use often in a separate folder. The files will still be updated correctly.
- To change the location of the Public formulas folder, click Options on the Options menu, and then click the Folder tab.
- The formula database also contains text files with documentation and parameter files with examples. These are also copied to the Public formulas folder.
- If you have a dial-up connection, make sure you're connected to the Internet before updating your formulas. Otherwise, Ultra Fractal might not be able to connect to the formula database (it doesn't dial in automatically).
- When opening a parameter set that uses formulas that cannot be found, you can directly download the file from the formula database.

Next: Standard formulas

See Also
Transformations

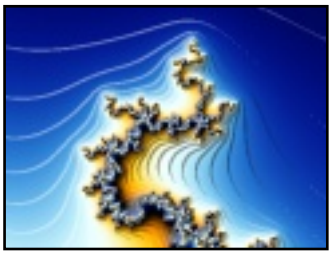
Standard fractal formulas

Ultra Fractal comes with a set of standard fractal formulas. They are located in the file Standard.ufm in the Formulas folder. It contains the following formulas:

- Embossed (Julia, Mandelbrot, Newton)
- Julia
- Julia (Built-in)
- Lambda (Julia, Mandelbrot)
- Magnet 1 and 2 (Julia, Mandelbrot)
- Mandelbrot
- Mandelbrot (Built-in)
- Newton
- Nova (Julia, Mandelbrot)
- Phoenix (Julia, Mandelbrot)
- Slope (Julia, Mandelbrot, Newton)

See Also
Standard transformations
Standard coloring algorithms
Fractal formulas
Public formulas

Embossed (Julia, Mandelbrot, Newton)



The Embossed formulas are modifications of the classic Mandelbrot, Julia, and Newton fractals that create 3D bevel effects with contour lines.

They should be combined with the Emboss coloring algorithm. This coloring algorithm correctly translates the results from the Embossed fractal formulas to colors in the gradient.

For best results, use a black-to-white gradient such as **Emboss** in Standard.ugr. This will create a grayscale image with shaded contour lines. You can then combine this with other layers to add colors while retaining the 3D effect. For the merge mode of the layer with the Embossed formula, try Soft Light or Hard Light.

The formulas provide the following parameters for the 3D effects:

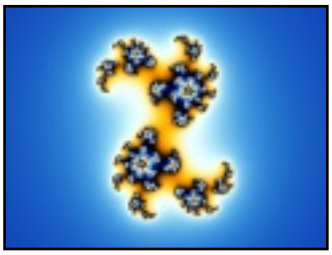
Emboss Type	Specifies what kind of information from the fractal calculations is used to create the embossing effect. This changes the shape and place of the contour lines.
Light Angle	This is the angle of the apparent light source, in degrees. The default value 0 corresponds to light from above. Positive values rotate the light source in clockwise direction.
Contour Size	Specifies the relative size of the contour lines. When zooming in, the size in pixels of the contour lines appears to stay the same.

The other parameters are described in the topics for the regular (non-Embossed) formulas.

Note: when rendering embossed fractals, use non-adaptive anti-aliasing to ensure that the contour lines are anti-aliased correctly.

See Also
Slope (Julia, Mandelbrot, Newton)
Standard formulas

Julia



Julia sets are closely related to the well-known Mandelbrot set. In fact, the Mandelbrot set is a map of Julia sets. For each point in the Mandelbrot set, there exists a unique Julia set.

Use the Switch feature to select a Julia set by moving the mouse cursor over a Mandelbrot fractal. The most interesting Julia sets are found at points close to the edge, where the colors change quickly.

Julia sets are strictly self-similar and less complex than the Mandelbrot set. Still, they can be strikingly beautiful, and they're certainly very interesting to explore.

The formula provides the following parameters:

Julia seed

This parameter specifies the point in the Mandelbrot set that corresponds to the current Julia set. It defines the shape and behavior of the Julia set. Use the Switch feature to select good values.

Power

Specifies the exponent. The default value is (2, 0), resulting in the classic equation.

$$z = z^2 + c$$

Try (3, 0) and (4, 0) and so on to increase the symmetry order. Non-integer values for the real part of the exponent or non-zero values for the imaginary part will distort the fractal.

Bailout value

Specifies the magnitude of z that will cause the formula to stop iterating. To obtain "true" Julia sets, this should be set to 4 or larger. Larger values tend to smooth the outside areas.

Some coloring algorithms require specific bail-out values for good results.

Note: The Julia formula is also available as a more efficient built-in formula with fewer options. See Julia (Built-in).

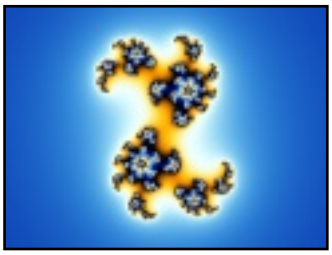
See Also

Lambda (Julia, Mandelbrot)

Julia sets

Standard formulas

Julia (Built-in)



This is a built-in version of the Julia formula. Julia sets are closely related to the well-known Mandelbrot set. In fact, the Mandelbrot set is a map of Julia sets. For each point in the Mandelbrot set, there exists a unique Julia set.

Use the Switch feature to select a Julia set by moving the mouse cursor over a Mandelbrot fractal. The most interesting Julia sets are found at points close to the edge, where the colors change quickly.

Julia sets are strictly self-similar and less complex than the Mandelbrot set. Still, they can be strikingly beautiful, and they're certainly very interesting to explore.

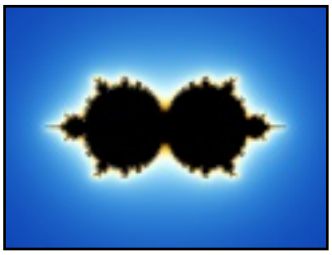
The formula provides the following parameters:

Julia seed	This parameter specifies the point in the Mandelbrot set that corresponds to the current Julia set. It defines the shape and behavior of the Julia set. Use the Switch feature to select good values.
Bailout value	Specifies the magnitude of z that will cause the formula to stop iterating. To obtain "true" Julia sets, this should be set to 4 or larger. Larger values tend to smooth the outside areas. Some coloring algorithms require specific bail-out values for good results.

Note: The Julia formula is also available as a normal formula that is less efficient, but offers more options. See Julia.

See Also
Julia sets
Standard formulas

Lambda (Julia, Mandelbrot)



The Lambda formula is an alternative version of the equation for Julia fractals. While it is capable of creating the same Julia sets, the corresponding Mandelbrot version looks different.

Because the Mandelbrot version is a map of Julia sets, this allows you to find Julia sets with the Switch feature in a different way than with the usual Mandelbrot set. It is easier to find good spirals and other interesting Julia sets.

The formulas provide the following parameters:

Start Value
(Mandelbrot only)

For the standard Lambda Mandelbrot set, this should be set to (0.5, 0). Other values create distorted shapes that can be interesting, but they're usually not as well-formed as the standard set.

For well-formed sets, the real value should be set to 1 divided by the real value of the exponent. For example, use (0.25, 0) if Exponent is set to (4, 0).

Julia Seed
(Julia only)

This parameter specifies the point in the Mandelbrot version that corresponds to the current Julia set. It defines the shape and behavior of the Julia set. Use the Switch feature to select good values.

Specifies the exponent. The default value is (2, 0), resulting in the classic equation.

c * z * (1 - z)

Exponent

Try (3, 0) and (4, 0) and so on to increase the complexity of the fractal. Non-integer values for the real part of the exponent will interpolate between these well-formed sets. If the imaginary part is not zero, the fractal will be further distorted.

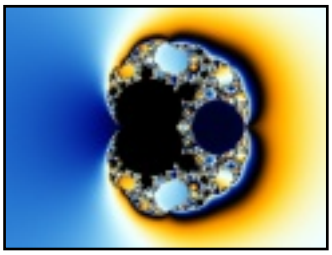
Specifies the magnitude of z that will cause the formula to stop iterating. To obtain well-formed fractals, this should be set to 4 or larger. Larger values tend to smooth the outside areas.

Bailout

Some coloring algorithms require specific bail-out values for good results.

See Also
Julia sets
Standard formulas

Magnet 1 and 2 (Julia, Mandelbrot)



The magnetic fractal types are created by a formula that models the way magnets behave under high temperatures. This leads to fractal pictures that are similar to the classic Mandelbrot and Julia sets, but with more complex patterns and numerous Mandelbrot set miniatures.

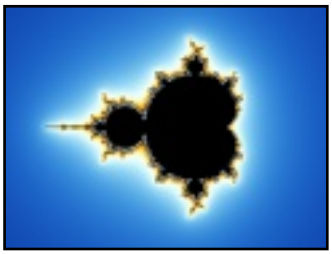
There are two common magnetic fractal types. Type 2 is more complex than type 1. Both types are available as Mandelbrot and Julia versions, so you can use the Mandelbrot version as a map to switch to the corresponding Julia fractals.

The formulas provide the following parameters:

Perturbation (Mandelbrot only)	For the standard fractals, this should be set to (0, 0). Other values create distorted shapes that can be interesting, but they're usually not as well-formed.
Parameter (Julia only)	This parameter specifies the point in the Mandelbrot version that corresponds to the current Julia set. It defines the shape and behavior of the Julia set. Use the Switch feature to select good values.
Bailout value	Specifies the magnitude of z that will cause the formula to stop iterating. Use a value above 30 to obtain well-formed fractals.

See Also
Standard formulas

Mandelbrot



The Mandelbrot set is the most well-known fractal type. Although it is calculated by a simple formula, it is incredibly complex. As you zoom in, more and more ever-changing detail becomes visible, such as little "baby" Mandelbrot sets and all kinds of spirals.

Because the Mandelbrot set lends itself well to basic zooming and exploring, it is a good starting point if you're new to fractals.

The formula provides the following parameters:

Starting point

For the standard Mandelbrot set, this should be set to (0, 0). Other values create distorted shapes that can be interesting, but they're usually not as well-formed as the standard set. Try (0, -0.6), for example.

Power

Specifies the exponent. The default value is (2, 0), resulting in the classic equation.

$$z = z^2 + c$$

Try (3, 0) and (4, 0) and so on to increase the number of main "buds". Non-integer values for the real part of the exponent will interpolate between these well-formed sets. If the imaginary part is not zero, the fractal will be further distorted.

Bailout value

Specifies the magnitude of z that will cause the formula to stop iterating. To obtain the "true" Mandelbrot set, this should be set to 4 or larger. Larger values tend to smooth the outside areas.

With the Basic coloring algorithm and the Color Density set to 4, try the bail-out values 4 and then 16 to see the difference.

Some coloring algorithms require specific bail-out values for good results.

Notes

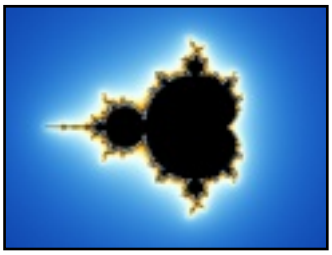
- The Mandelbrot set is also available as a more efficient built-in formula with fewer options. See Mandelbrot (Built-in).
- The Mandelbrot set also acts as a map of Julia sets. Use Switch mode to switch to related Julia sets.

See Also

The Mandelbrot set

Standard formulas

Mandelbrot (Built-in)



This is a built-in version of the standard Mandelbrot set: the most well-known fractal type. Although it is calculated by a simple formula, it is incredibly complex. As you zoom in, more and more ever-changing detail becomes visible, such as little "baby" Mandelbrot sets and all kinds of spirals.

Because the Mandelbrot set lends itself well to basic zooming and exploring, it is a good starting point if you're new to fractals.

The formula provides the following parameters:

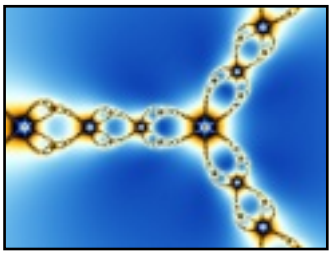
Starting point	For the standard Mandelbrot set, this should be set to (0, 0). Other values create distorted shapes that can be interesting, but they're usually not as well-formed as the standard set. Try (0, -0.6), for example.
Bailout value	Specifies the magnitude of z that will cause the formula to stop iterating. To obtain the "true" Mandelbrot set, this should be set to 4 or larger. Larger values tend to smooth the outside areas. With the Basic coloring algorithm and the Color Density set to 4, try the bail-out values 4 and then 16 to see the difference. Some coloring algorithms require specific bail-out values for good results.

Notes

- There is also a version of the Mandelbrot set as a normal formula (not built-in). Although it is less efficient, it offers more options, and it is better at handling very large bail-out values. See Mandelbrot.
- The Mandelbrot set also acts as a map of Julia sets. Use Switch mode to switch to related Julia sets.

See Also
The Mandelbrot set
Standard formulas

Newton



The Newton fractal is generated by Newton's method for solving polynomial equations. Different equations are available by changing the parameters.

It is a simple and attractive fractal type. Newton fractals are strictly self-similar, so they're not very interesting zooming subjects. Instead, try a few different coloring algorithms to decorate them in various ways.

The formula provides the following parameters:

Exponent

Specifies the exponent of the equation to be solved. The default value is (3, 0), resulting in the equation:

$$z^3 + Root$$

Try (4, 0), (5, 0) and so on to increase the symmetry order. Non-integer values for the real part of the exponent will interpolate between these. If the imaginary part is not zero, the fractal will be further distorted.

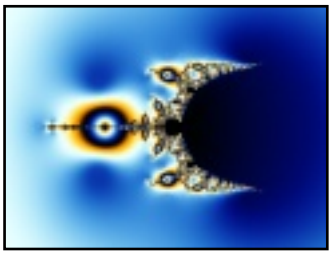
Root

Specifies the root of the equation. This tends to rotate and magnify the fractal.

See Also

Nova (Julia)
Standard formulas

Nova (Julia, Mandelbrot)



The Nova fractal is a modified Newton fractal. The Julia version can be used as a normal Newton fractal, but there are all kinds of other possibilities with intriguing spirals.

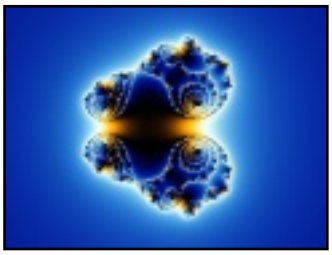
Use the Nova (Mandelbrot) formula to switch to interesting Nova (Julia) sets. The standard Newton fractals can be found in the empty circle to the right.

The formulas provide the following parameters:

Start Value (Mandelbrot only)	For well-formed fractals, this should be set to (1, 0). Other values create distorted shapes that can be interesting, but they're usually not as well-formed.
Julia Seed (Julia only)	This parameter specifies the point in the Mandelbrot version that corresponds to the current Julia version. It defines the shape and behavior of the fractal. Use the Switch feature to select good values.
Exponent	Increase the real value of the exponent to create more complex fractals. Non-integer real values and non-zero imaginary values create irregular fractals.
Bailout	Specifies the magnitude of z at which the formula will stop iterating. Since z converges to a fixed value, smaller values will give more detailed images.
Relaxation	This can be used to influence the convergence of the fractal. Changing this parameter will twist and transform the fractal.

See Also
Standard formulas

Phoenix (Julia, Mandelbrot)



The Phoenix fractal is a modification of the classic Mandelbrot and Julia sets. The Phoenix (Julia) type is particularly interesting, with beautiful shapes and lots of spirals.

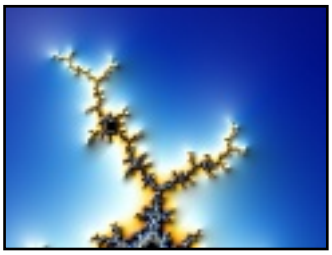
Use the Phoenix (Mandelbrot) formula to switch to interesting Phoenix (Julia) sets.

The formulas provide the following parameters:

Start Value (Mandelbrot only)	For well-formed fractals, this should be set to (0, 0). Other values create distorted shapes that can be interesting, but they're usually not as well-formed.
Julia Seed (Julia only)	This parameter specifies the point in the Mandelbrot version that corresponds to the current Julia version. It defines the shape and behavior of the fractal. Use the Switch feature to select good values.
Exponent 1	Increase the real value of the exponent to create more complex fractals with more symmetry. Non-integer real values and non-zero imaginary values create irregular fractals.
Exponent 2	By default, this is set to (0, 0). Use other values to create more complex, twisted fractals.
Distortion	Sets how strong the effect of the previous iteration is upon the current iteration. Set this to (0, 0) to obtain standard Mandelbrot and Julia sets.
Bailout	Specifies the magnitude of z at which the formula will stop iterating. Higher values will give smoother images with more detail.

See Also
Standard formulas

Slope (Julia, Mandelbrot, Newton)



The Slope formulas are modifications of the classic Mandelbrot, Julia, and Newton fractals that can create various 3D lighting effects.

They should be combined with the Lighting coloring algorithm. For each pixel, the Slope formula calculates a "height" value that is passed to Lighting, which performes the final lighting calculations.

For best results, use a black-to-white gradient such as **Lighting** in Standard.ugr. This will create a grayscale image with highlights and shadows. You can then combine this with other layers to add colors while retaining the 3D effect. For the merge mode of the layer with the Slope formula, try Soft Light or Hard Light.

The formulas provide the following parameters for the 3D effects:

Orbit Separation	To determine proper lighting for a particular point, the Slope formulas test two orbits that are close together. This parameter specifies how close they should be. Smaller values give better results, especially for zoomed-in images. Avoid to use values that are too small for the current precision range.
Height Value	Specifies how the apparent height of each pixel will be calculated. Smooth images can be obtained with **potential** and **distance estimator**. The other options will produce images with sharper edges.
Height Transfer	This function will be applied to the height value before calculating the slope. It can be used to reduce (**log**) or exaggerate (**exp**) certain ranges of height values. The default **linear** option will not change the height value.
Height Pre-Scale	Scales the height value before it is processed by the transfer function.
Height Post-Scale	Scales the height value further after it has been processed by the transfer function. When zooming in, you should reduce this to make sure the highlights and shadows do not become too large.
Every Iteration	If selected, the height value is calculated every iteration, which is much slower. This is only necessary if you're combining the Slope formula with a coloring algorithm that processes every iteration, such as Orbit Traps. The normal Lighting algorithm doesn't need it.

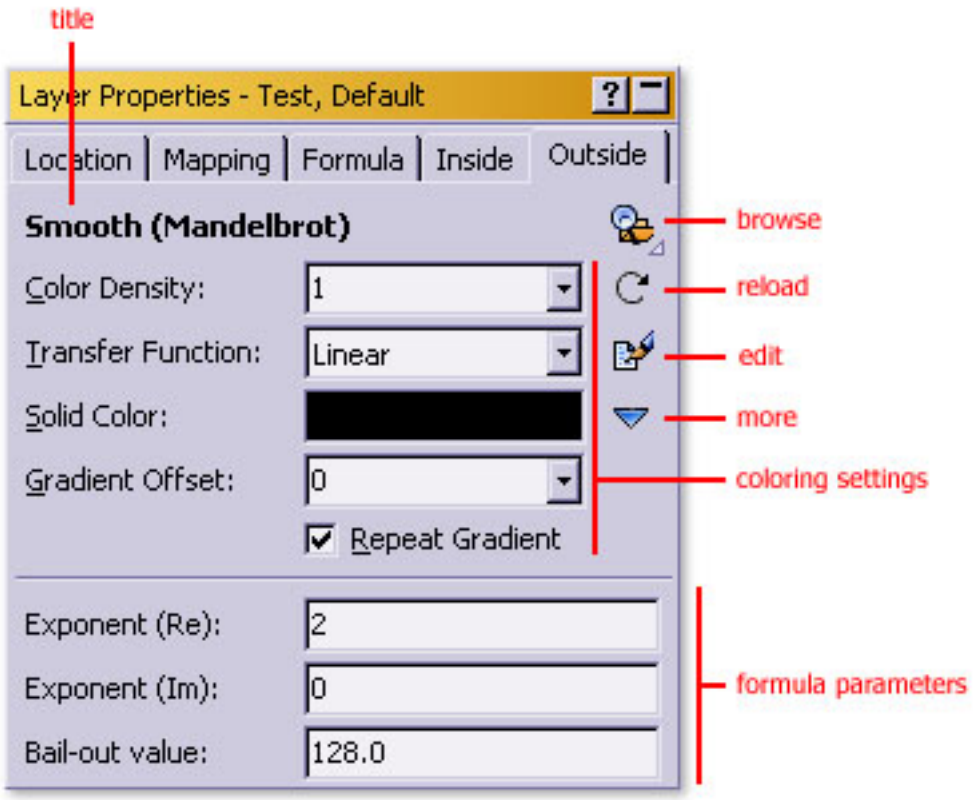
The other parameters are described in the topics for the regular (non-Slope) formulas.

See Also
Embossed (Julia, Mandelbrot, Newton)
Standard formulas

Coloring algorithms

Coloring algorithms define how fractals are colored. The fractal formula creates the basic shape of the fractal, and coloring algorithms provide ways to color that shape. This gives you the flexibility to freely combine coloring algorithms with any fractal formula.

Coloring algorithms are managed in the Inside and Outside tabs of the Layer Properties tool window.



- At the top, the **title** of the coloring algorithm is shown. Hold the mouse cursor over the title to see the entry identifier and the file name of the coloring algorithm.
- The **Browse** button opens a modal browser to select another coloring algorithm.
- The **Reload** button reloads the coloring algorithm from disk and recalculates the layer.
- The **Edit** button opens the coloring algorithm in the formula editor.
- The **More** button shows a menu with additional commands.
- The **coloring settings** specify how the information from the coloring algorithm must be interpreted to color the fractal. See Coloring settings.
- The **formula parameters** are additional parameters specific to the selected coloring algorithm. See Formula parameters.

Next: Inside and outside

See Also

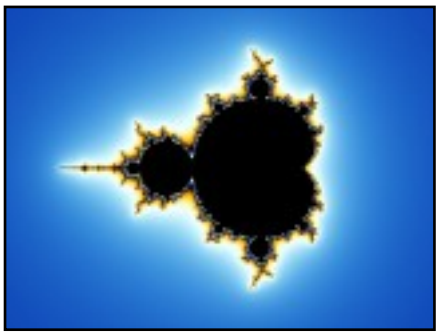
Quick Start Tutorial
Standard coloring algorithms
Fractal formulas
Transformations

Inside and outside

To calculate a pixel in a fractal, Ultra Fractal iterates the fractal formula selected in the Formula tab of the Layer Properties tool window. The formula is executed multiple times, each time using the result from the previous calculation as input.

The formula is iterated until the maximum iteration count (set in the Formula tab) is reached, or until the bail-out condition (specified by the fractal formula) is met. If the bail-out condition is met, the pixel is colored as an outside pixel. Otherwise, it is colored as an inside pixel.

Most classic fractal types, such as the Mandelbrot set, are actually a set of points. A pixel can either be inside or outside the set. If a pixel is inside, it belongs to the Mandelbrot set, for example.



In this image of the Mandelbrot set, the inside area is black. The outside area is colored according to the number of iterations required to meet the bail-out condition.

By iterating the fractal formula, Ultra Fractal decides whether a pixel is inside or outside the set. The pixels that are inside are colored according to the settings in the Inside tab of the Layer Properties tool window. The pixels that are outside are colored according to the settings in the Outside tab.

The Inside and Outside tabs are identical and provide the same options and settings. Since the outside area is usually the most interesting area, you'll probably use the Outside tab more often.

Notes

- Some coloring algorithms can only be used in the Inside tab, or only in the Outside tab.
- Some fractal formulas can change the meaning of inside and outside areas. For example, they can be intended to work together with a special outside coloring algorithm, and ignore the settings for inside areas. This is usually noted in the comments at the top of the formula.

Next: Working with coloring algorithms

See Also
Maximum iterations
Coloring algorithms

Working with coloring algorithms

You work with coloring algorithms in the Inside and Outside tabs of the Layer Properties tool window. These tabs select the inside and outside coloring algorithms and contain additional coloring settings.

Coloring algorithms are stored in coloring algorithm files (*.ucl). Each file can contain multiple coloring algorithms.

To select a coloring algorithm, click the **Browse** button. This opens a modal browser that shows the coloring algorithm files on your computer and the coloring algorithms that they contain. Double-click on a coloring algorithm to select it.

Hold down the Browse button to open a menu with predefined coloring algorithms. Click a coloring algorithm to select it. Click Define to edit the list of predefined coloring algorithms.

Some coloring algorithms contain additional help. To access it, click the **More** button, and then click Help.

Coloring algorithms interpret the calculations performed by the fractal formula selected in the Formula tab and visualize parts of these calculations. Each coloring algorithm uses the information from the calculations in a different way.

Coloring algorithms do not directly calculate colors (except for direct coloring algorithms). Instead, they produce a floating-point **index value** that is converted to a color by the gradient.

Typically, the index value 0 produces the left-most color in the gradient, and 0.5 produces the color in the middle. The index value usually wraps around, so 1 produces the left-most color again. The coloring settings in the Inside and Outside tabs can be used to tweak this.

Next: Coloring settings

See Also
Coloring algorithms
Standard coloring algorithms
How gradients work

Coloring settings

The Inside and Outside tabs of the Layer Properties tool window select the inside and outside coloring algorithms. They also contain additional coloring settings.

These coloring settings specify how the **index value** returned by the selected coloring algorithm is interpreted by the gradient.

Color Density

Specifies how quickly the colors in the gradient follow each other. Values larger than 1 increase the color density. Values below 1 decrease the color density. The color density must be larger than 0.

The index value is multiplied by the color density.

Transfer Function

Selects a transfer function that translates the index value, multiplied by the color density value, to an entry in the gradient.

- **None** returns the solid color, ignoring the coloring algorithm.
- **Linear** directly returns the index value.
- **Sqr** squares the index value. When the index value increases, the color density appears to increase as well.
- **Sqrt** returns the square root of the index value. This decreases the apparent color density as the index value increases.
- **Cube** cubes the index value. The color density increases faster than when using Sqr.
- **CubeRoot** returns the cubed root of the index value. The color density decreases faster than when using Sqrt.
- **Log** returns the natural logarithm of the index value. The color density decreases even faster than when using CubeRoot.
- **Exp** calculates e^{index}. The color density increases even faster than when using Cube.
- **Sin** returns the sine of the index value. The result never exceeds -1...1 and it repeats itself when the index value increases.
- **ArcTan** returns the inverse tangent of the index value. The result approaches ½ pi when the index value becomes very high

Solid Color

Specifies the solid color, which can be used for special purposes. See Solid color.

Gradient Offset

Specifies an optional offset in the gradient. This value is added to the index value after applying the Transfer function. Since the gradient contains 400 entries, the offset value can range from 0 to 399.

You can achieve the same effect by rotating the gradient, but the offset can be specified for Inside and Outside coloring algorithms separately.

Repeat Gradient

Specifies if the gradient must be repeated. When checked, the index value will wrap around when it reaches 1. So, index values of 0, 1, 2, and 3 all map to the same gradient index. Otherwise, the index value is limited to 1, so all colors in the gradient are only used once.

Next: Solid color

See Also
Coloring algorithms
Working with coloring algorithms
Gradients

Solid color

In the Inside and Outside tabs of the Layer Properties tool window, you can specify a solid color. The solid color can be used by coloring algorithms for special purposes.

To change the solid color, click on the **Solid Color** swatch in the Inside or Outside tab. By default, it is set to black, but you can choose any color. You can also change the opacity. By setting the opacity to 0, the solid color and thus the areas colored with the solid color will become transparent, so the lower layers will become visible.

By setting the **Transfer function** to **None**, the entire inside or outside area is filled with the solid color. This is useful if you don't want to use a coloring algorithm for that area. If you use a transparent solid color, the area will become transparent.

For example, you can use this if you want to color the inside area with a different gradient. Duplicate the layer and make the inside solid color in the top layer transparent. Now, you can change the gradient for the lower layer. Only the inside area of the lower layer, and the outside area of the top layer will be visible.

Notes

- If you make the solid color transparent, layer transparency will be enabled automatically. See Transparent layers.
- Setting the Transfer function to None will not disable the coloring algorithm. For maximum efficiency, make sure the None coloring algorithm is selected as well.

Next: Direct coloring algorithms

See Also
Coloring algorithms
Solid color (transformations)

Direct coloring algorithms

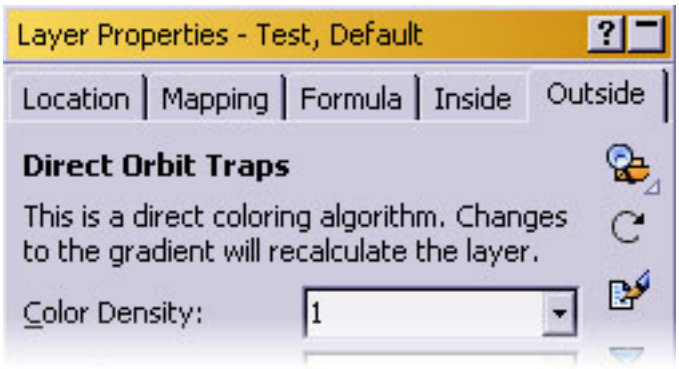
Normal coloring algorithms return an index value that is looked up in the gradient to produce a color for each pixel. This enables you to easily change the colors by editing the gradient. On the other hand, it limits the colors that can appear in the layer to the colors available in the gradient.

Unlike normal coloring algorithms, direct coloring algorithms directly return a color for each pixel. They are more powerful because they can return any desired color, and perform sophisticated merging operations internally.

Direct coloring algorithms can access the gradient and use its colors, but they're not limited to those colors. Editing the gradient will cause the layer to be recalculated. You can still use the coloring settings (such as Color Density) to change the appearance of the gradient.

Note that because the coloring algorithm decides how the gradient is used, the resulting colors in the layer may or may not be directly related to the colors in the gradient.

You can tell when a direct coloring algorithm is selected in the Inside or Outside tab because a small message is inserted above the coloring settings.



An example of a direct coloring algorithm is Direct Orbit Traps.

Next: Standard coloring algorithms

See Also

Coloring algorithms
Working with coloring algorithms

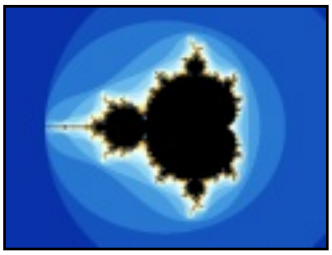
Standard coloring algorithms

Ultra Fractal comes with a set of standard coloring algorithms. They are located in the file Standard.ucl in the Formulas folder. It contains the following coloring algorithms:

- Basic
- Binary Decomposition
- Decomposition
- Direct Orbit Traps
- Distance Estimator
- Emboss
- Exponential Smoothing
- Gaussian Integer
- Gradient
- Lighting
- None
- Orbit Traps
- Smooth (Mandelbrot)
- Triangle Inequality Average

See Also
Standard fractal formulas
Standard transformations
Coloring algorithms
Public formulas

Basic



The Basic coloring algorithm implements four simple and classic ways of coloring the outside areas of a fractal. It's useful for reproducing fractals created with older fractal software.

The **Coloring Type** parameter selects how the fractal should be colored.

The **Iterations** option colors a pixel according to the number of iterations that were necessary for the fractal formula to bail out (to decide that it's an outside pixel). This is the oldest method used to color fractals. It creates images with bands of solid colors. To smoothen the bands, use the Smooth (Mandelbrot) coloring algorithm.

The **Real**, **Imaginary**, and **Sum** options use the last value of z in combination with the number of iterations to color pixels. They create smooth, true-color images. Good results are usually obtained if the bail-out parameter of the fractal formula is not set too high. Try 4, for example.

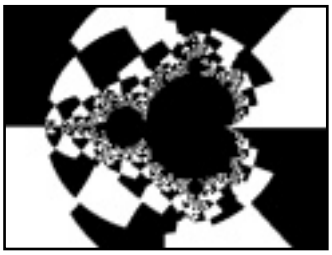
See Also

Binary Decomposition

Distance Estimator

Standard coloring algorithms

Binary Decomposition



The Binary Decomposition coloring algorithm uses just two colors from the gradient. It colors fractals according to the "angle" of the last value of z from the fractal formula. This results in quite abstract and elegant images.

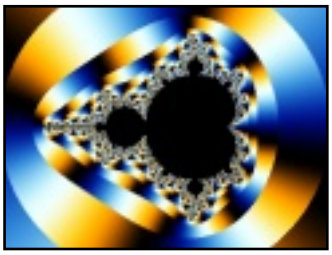
The two colors used are at the beginning and at the middle of the gradient.

There is one parameter that selects between two different flavors of the same algorithm. Each option creates different patterns. The second option reproduces the coloring used for many fractals in the classic Beauty of Fractals book.

It often works well to combine this coloring algorithm with other layers that contain more different colors. Furthermore, low values (for example 4) for the bail-out parameter of the fractal formula usually give the best results.

See Also
Basic
Decomposition
Standard coloring algorithms

Decomposition



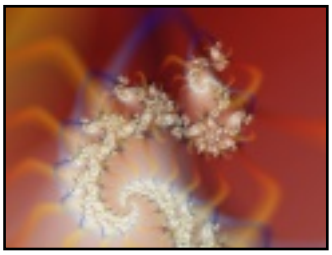
The Decomposition coloring algorithm colors fractals according to the "angle" of the last value of z from the fractal formula. The angle is decomposed and distributed over the full range of the gradient.

This coloring algorithm tends to create circular bands all over the image that contain all colors from the gradient. Low values (for example 4) for the bail-out parameter of the fractal formula usually give the best results.

With convergent fractal types, such as Newton or Nova, Decomposition usually does not create smoothly colored images, but it can still be interesting.

See Also
Basic
Binary Decomposition
Standard coloring algorithms

Direct Orbit Traps



The Direct Orbit Traps coloring algorithm is a direct coloring algorithm. This means that it the resulting images are not limited to the colors in the gradient. It creates softly shaded, pastel-like images.

Direct Orbit Traps works by calculating a color for every iteration. These colors are merged together to obtain the final color for each pixel. This is like using multiple layers within a single coloring algorithm.

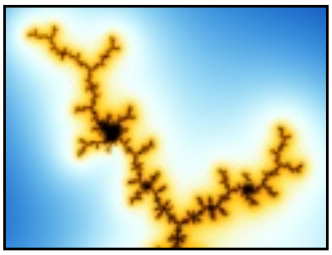
The colors are taken from the gradient and merged onto the background color. If you change the gradient, the layer is recalculated with the new colors. It can sometimes be difficult to predict the effect of changes to the gradient, because the gradient colors are merged with each other and with the background color.

Most of the parameters are shared with Orbit Traps. There are some additional parameters that specify how the colors from each iteration are merged:

Base Color	Specifies the background color. All other colors are merged on top of the background, so the background color interacts with the colors from the gradient. The background color can also be transparent.
Trap Color Merge	Specifies the merge mode used to merge colors on top of the background. All layer merge modes are supported here. Remember to adjust the background color so it will work well with the selected merge mode. For example, use a dark background color with **Screen**, and a light background color with **Multiply**.
Additional Alpha	If set to **distance**, the opacity of the color calculated for each iteration is reduced according to the distance from the trap shape. This can create very soft and smooth images.
Trap Merge Opacity	Sets the opacity (between 0 and 1) of the color calculated for each iteration. The opacity of the gradient is also taken into account, just like when merging layers.
Trap Merge Order	Sets the order in which traps are merged. The **bottom-up** option merges later iterations on top of the existing iterations, while the **top-down** option merges later iteration underneath the existing iterations.

See Also
Orbit Traps
Standard coloring algorithms

Distance Estimator



The Distance Estimator coloring algorithm estimates the distance between a pixel and the boundary of the fractal (for example the boundary of the Mandelbrot set). The pixel is colored accordingly.

This coloring algorithm is especially good at showing the thin connecting lines and miniatures that exist everywhere in the Mandelbrot set. It works correctly for divergent fractal formulas like Mandelbrot, Julia, and Phoenix.

The **Exponent** parameter should be set to match the exponent or power of the fractal formula (this is usually also a parameter). Higher values (like 128) for the bail-out parameter of the fractal formula give the best results.

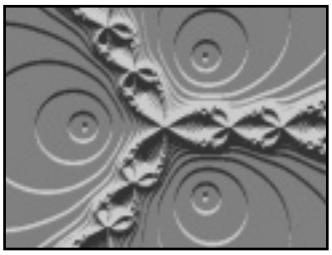
See Also

Basic

Decomposition

Standard coloring algorithms

Emboss

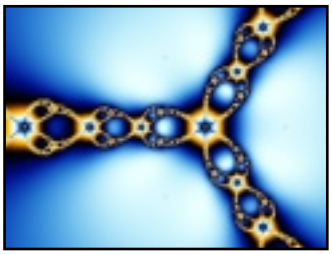


The Emboss coloring algorithm interprets results from one of the Embossed fractal formulas to create fractals with 3D contour lines. It is unlikely to give good results with other fractal formulas.

See Embossed (Julia, Mandelbrot, Newton) for more information.

See Also
Lighting
Standard coloring algorithms

Exponential Smoothing



The Exponential Smoothing coloring algorithm creates smoothly colored outside areas. It works well for both convergent and divergent fractal types, which means that it can be combined with almost any fractal formula.

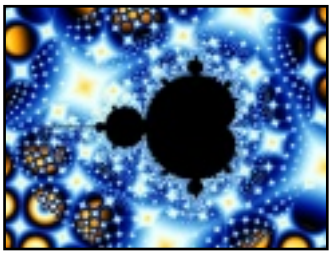
Fractal formulas like Mandelbrot, Julia, and Phoenix have only divergent orbits, while types like Newton and Nova have only convergent orbits. The Magnet fractal formulas have both divergent and convergent orbits.

With the **Color Divergent** and **Color Convergent** parameters, you can enable coloring for divergent and convergent orbits. You should always enable at least one option. The formula runs slightly faster if you don't enable an option that is unnecessary (only Magnet-like fractals require both parameters to be enabled).

The **Divergent Density** parameter can be used to tweak the color density for divergent parts of a fractal. It's only useful when both divergent and convergent orbits exist in the fractal.

See Also
Smooth (Mandelbrot)
Standard coloring algorithms

Gaussian Integer



The Gaussian Integer coloring algorithm colors fractals according to how the calculated orbits are related to Gaussian integers.

Gaussian integers are complex numbers normalized to integer values. This coloring algorithm examines the values of z calculated by the fractal formula, and tests them against nearby Gaussian integers.

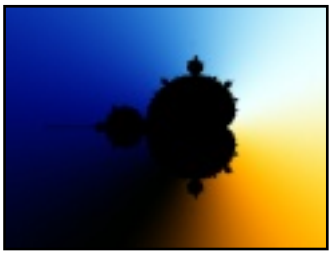
The resulting images are richly textured, containing many circles, dots, and stars. By tweaking the provided parameters, many variations are possible.

The following parameters are available:

Integer Type	Specifies the rounding method to use to find the nearest Gaussian integer. The **round(z)** option usually gives smoother images than the other options.
Color By	Selects how the color of each pixel is determined. For example, it can be colored by the minimum distance from a value of z to the nearest Gaussian integer.
Normalization	Chooses between several ways of normalizing the distance to the nearest Gaussian integer. If you select **factor** or **f(z)**, an additional parameter will appear that specifies the normalization factor or function to use.
Randomize	If checked, a small randomization factor is added to each value of z before examining its behavior. Additional parameters will appear to specify the amount of randomization and a seed value. Each seed value will give different randomization patterns.

See Also
Orbit Traps
Standard coloring algorithms

Gradient



The Gradient coloring algorithm ignores the information from the fractal formula and fills the fractal with all colors from the gradient.

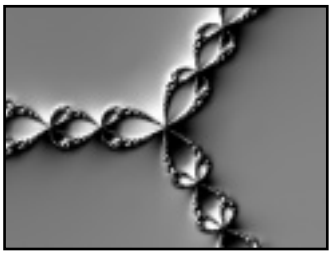
To obtain a completely filled image, select the Gradient coloring algorithm in both the Inside and the Outside tabs of the Layer Properties tool window. This ensures that all pixels are colored in the same way.

The Gradient Type parameter selects how the gradient should be displayed: linear (from left to right), radially, or as a cone. Use zooming and panning to reposition the gradient as desired.

This coloring algorithm is handy for creating special effects with multi-layer images. You can, for example, use it in a mask together with a suitable transparent gradient to show only selected portions in a regular pattern of the layer that is masked.

See Also
Standard coloring algorithms

Lighting

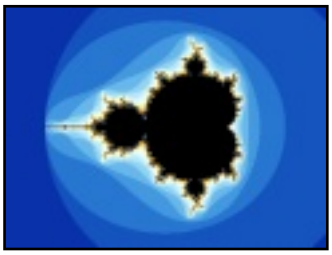


The Lighting coloring algorithm interprets results from one of the Slope fractal formulas to create fractals with 3D lighting effects. It will probably not give very good results with other fractal formulas.

See Slope (Julia, Mandelbrot, Newton) for more information.

See Also
Emboss
Standard coloring algorithms

None

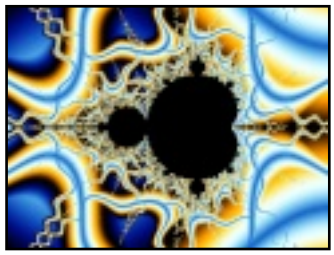


The None coloring algorithm is the simplest coloring algorithm available. It is loaded by default in Ultra Fractal when a new fractal is created.

None reproduces the standard iterations coloring algorithm found in most fractal software.

See Also
Basic
Standard coloring algorithms

Orbit Traps



The Orbit Traps coloring algorithm is an extremely versatile general-purpose coloring algorithm. It can be applied to almost any fractal formula with good results, on both the Inside and Outside tabs.

Orbit Traps works by examining the value of z (as calculated by the fractal formula) for each iteration. It tests how close z is to a fixed shape (the orbit trap), and colors the pixel according to the closest distance, for example.

The possibilities are almost unlimited because there are so many combinations of parameters available. It's a good idea to take some time to explore the different options in here.

The following parameters are available:

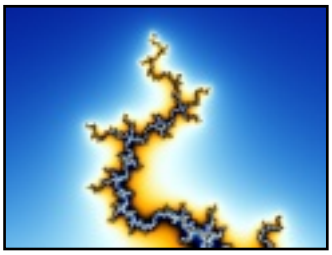
Trap Shape	Specifies the shape of the orbit trap. Some options may not look too exciting with the default settings of the other parameters, but try changing Trap Coloring and Trap Mode in that case. Not all options work equally well with all fractal types.
Diameter	Specifies the diameter or size of the trap. Larger values usually create decorations further away from the center of the fractal.
Order	Specifies the order for the trap, such as the number of leaves for the pinch trap shape. It depends on the trap shape how this is interpreted. Larger values usually give more complex traps.
Frequency	Specifies the frequency of ripples or waves (where applicable). Larger values create "busier" trap shapes with more frills.
Trap Coloring	This parameter selects what information is gathered at each iteration. This is later filtered and combined to produce the final color. Selects how the values gathered at each iteration are interpreted to produce a color. For example, the magnitude at the closest distance to the trap shape is used if Trap Coloring is set to **magnitude**, and Trap Mode to **closest**.
Trap Mode	Experiment to see which combinations work well together. Some trap modes only work well with specific trap coloring settings, for example. The **trap only** option will show the trap shape only. This is useful for learning how the other options work.
Threshold	Specifies the width of the trap area, used for most trap modes.
Trap Center	Specifies the center of the trap shape. Values other than (0, 0) will distort the trap shape into the direction of the trap center. Use the eyedropper to select good values for this parameter.
Aspect Ratio	Changes the aspect ratio of the trap shape. Values larger than 1 will stretch the trap horizontally; values smaller than 1 will stretch it vertically.
Rotation	Rotates the trap shape in clockwise direction (specified in degrees).
Use Solid Color	If checked, areas outside the trap shape will be colored with the solid color (allowing them to be transparent).

If a parameter is not visible, it does not apply to the currently selected trap shape or trap mode.

See Also

Tutorial: Masking
Direct Orbit Traps
Standard coloring algorithms

Smooth (Mandelbrot)



The Smooth (Mandelbrot) coloring algorithm creates smoothly colored outside regions with fractal formulas such as Mandelbrot and Julia.

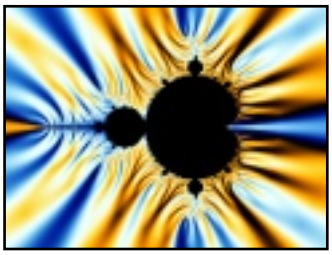
It works with most divergent fractal formulas. For Newton and Nova fractals, use Exponential Smoothing instead.

There are two parameters available: **Exponent** and **Bail-out value**. These should be set to match the corresponding parameters of the fractal formula. Otherwise, the coloring will not be perfectly smooth.

Usually, the best results are obtained when the Transfer Function in the Outside tab is set to **Log**.

See Also
Basic
Standard coloring algorithms

Triangle Inequality Average



The Triangle Inequality Average coloring algorithm creates smoothly colored fractals with large flame-like patterns that extend from the fractal outwards.

Because it uses the same smoothing as Smooth (Mandelbrot), it only works with most divergent fractal formulas, such as Mandelbrot and Julia.

There are two parameters available: **Exponent** and **Bailout**. These should be set to match the corresponding parameters of the fractal formula. Otherwise, the coloring will not be smooth.

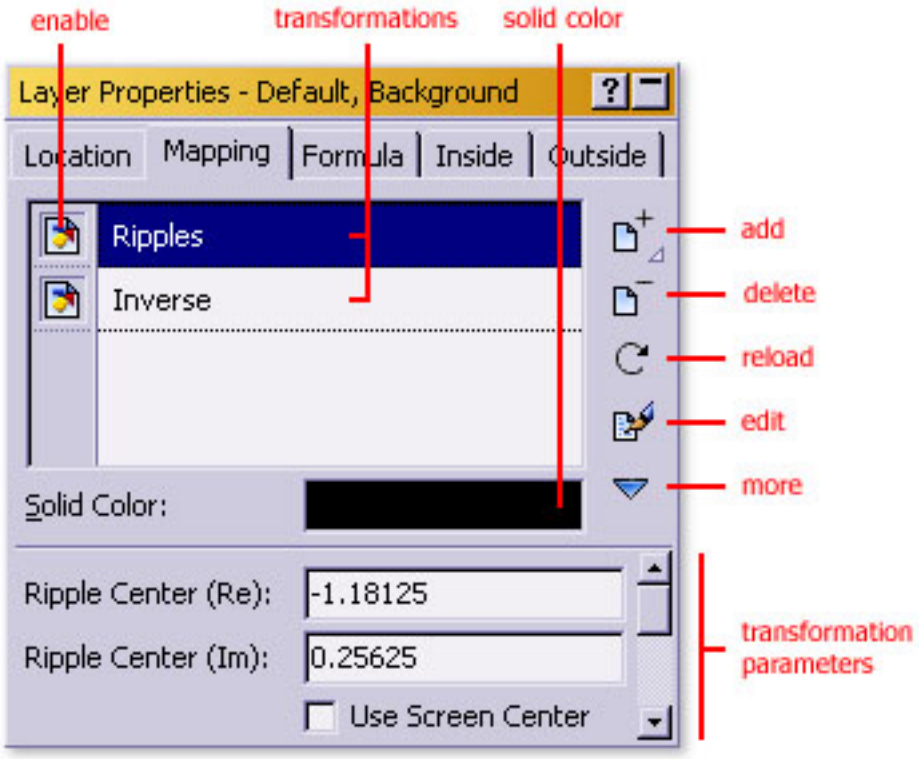
Use very large bail-out values for good results. The default value 1e20 (a 1 with 20 zeroes) is a good starting point. The Mandelbrot (Built-in) formula cannot handle such large values, so use the non-built-in Mandelbrot instead.

See Also
Orbit Traps
Standard coloring algorithms

Transformations

Transformations globally transform and warp the shape of a fractal. You can combine various transformations to create complex effects. Of course, you can also write your own transformations.

Transformations are managed in the Mapping tab of the Layer Properties tool window:



- The **Add** button opens a modal browser to select a new transformation. The transformation is then added to the list.
- The **Delete** button removes the selected transformation from the list.
- The **Reload** button reloads the selected transformation from disk and recalculates the layer.
- The **Edit** button opens the selected transformation in the formula editor.
- The **More** button shows a menu with additional commands.
- The **Enable** icon before a transformation quickly enables and disables the transformation.
- The **Solid Color** swatch specifies the solid color for the selected transformation. The solid color can be used by a transformation for special purposes. See Solid color.
- The **transformation parameters** are additional parameters specific to the selected transformation. See Formula parameters.

Next: Working with transformations

See Also

Tutorial: Learning about transformations
Standard transformations
Fractal formulas
Coloring algorithms

Working with transformations

You work with transformations in the Mapping tab of the Layer Properties tool window. The Mapping tab shows a list with the transformations used by the active layer.

Transformations are stored in transformation files (*.uxf). Each file can contain multiple transformations.

To add a transformation, click the **Add** button. This opens a modal browser that shows the transformation files on your computer and the transformations that they contain. Double-click on a transformation to add it.

Hold down the Add button to open a menu with predefined transformations. Click a transformation to add it. Click Define to edit the list of predefined transformations.

To remove the selected transformation, click the **Delete** button.

To rename the selected transformation, click it again or press F2 (like in Windows Explorer).

To change the order in which transformations appear in the list, drag them up or down. See Multiple transformations.

The **Enable** icon before each transformation enables and disables it. Use it to temporarily disable a transformation so you can judge its effect, or adjust other transformations.

Some transformations contain additional help. To access it, click the **More** button, and then click Help.

Right-click inside the list of transformations to open a menu with frequently used commands.

The bottom pane of the Mapping tab contains parameters specific to the selected transformation. These parameters work the same as the parameters for fractal formulas. See Formula parameters.

Next: Multiple transformations

See Also

Tutorial: Learning about transformations
Transformations
Standard transformations
Public formulas

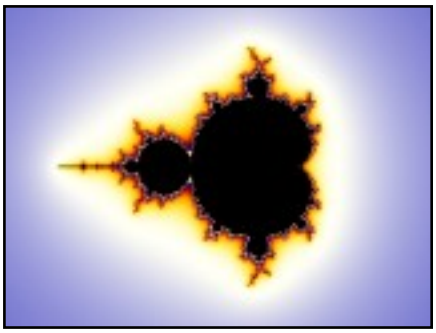
Multiple transformations

Ultra Fractal lets you combine multiple transformations to achieve more complex effects. With more than one transformation, the order in which the transformations appear in the list in the Mapping tab of the Layer Properties tool window is important.

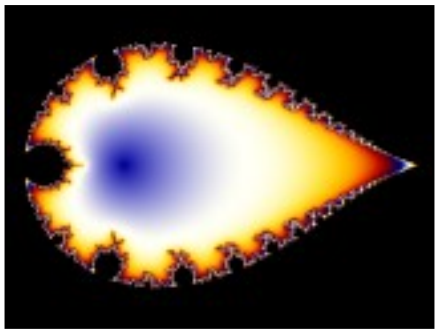
You can view a transformation as if it transforms the image of the layer as produced by the fractal formula and the coloring algorithms. (In fact, it works differently, but you can ignore that unless you're writing your own transformations.)

The transformations are then processed from the bottom of the list to the top. So, if you have two transformations, the top one works on the "image" produced by the second transformation.

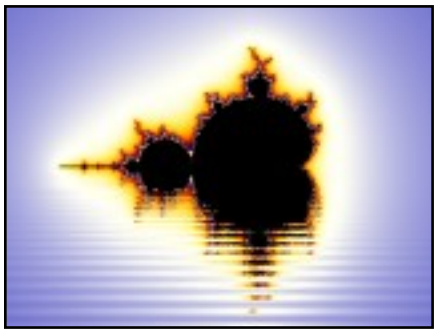
Here is an example to illustrate this:



Original



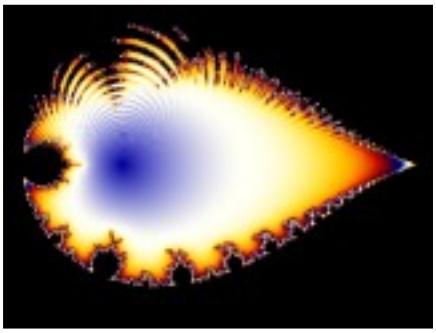
Inverse



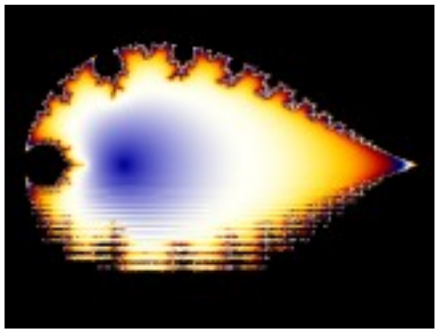
Lake

Two variations on the original image are shown. The first uses the Inverse transformation that turns an image "inside out". The second variation uses the Lake transformation that mirrors the image horizontally and creates the illusion of water ripples.

What happens if we combine the two transformations?



First **Lake**, then **Inverse**



First **Inverse**, then **Lake**

If we put Inverse above Lake, we get the first image. If we put Lake on top instead, the second image is produced. This shows that a transformation works on the intermediate result produced by the transformations below it.

Notes

- You can freely experiment with the order of the transformations by dragging them up or down in the list.

- When you add a new transformation, it is always inserted above the selected transformation, so it works on the intermediate image produced by that transformation.

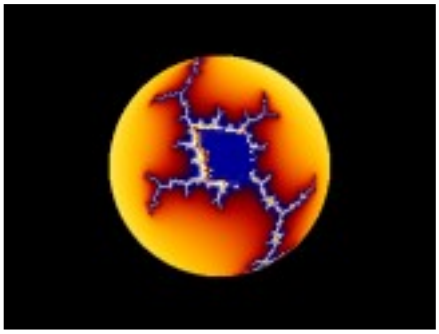
Next: Solid color

See Also
Transformations
Working with transformations

Solid color

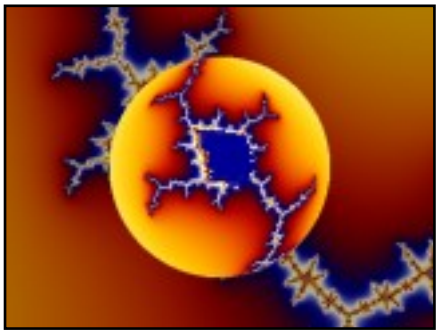
In the Mapping tab of the Layer Properties tool window, you can specify a solid color for each transformation. A transformation can use this color for special purposes.

For example, a transformation that maps a fractal onto a plane in 3D space also needs to color the area that's above or below the plane. This area is usually colored with the solid color.



This example shows a simple fractal mapped onto a sphere with the 3D Mapping transformation. The area outside the sphere is given the solid color (in this case black).

To change the solid color, click on the **Solid Color** swatch in the Mapping tab. By default, it is set to black, but you can choose any color. You can also change the opacity. By setting the opacity to 0, the solid color and thus the solid areas will become transparent, so the lower layers will become visible.



In effect, the transformation not only transforms the shape of the fractal, but also generates a mask for the layer.

Some transformations are only intended to create masks, and do not transform the pixels at all. You should use them with a transparent solid color. An example is the Clipping transformation.

Notes

- If you make a solid color transparent, layer transparency will be enabled automatically. See Transparent layers.
- The masks created with transformations always have sharp edges. For soft masking with more control over the masking shapes, use layer masks instead. See Masks.

Next: Standard transformations

See Also

Transformations

Working with transformations

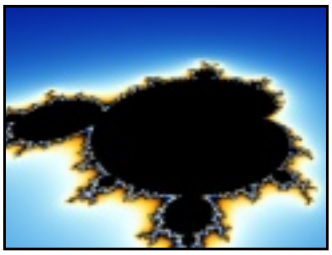
Standard transformations

Ultra Fractal comes with a set of standard transformations. They are located in the file Standard.uxf in the Formulas folder. It contains the following transformations:

- 3D Mapping
- Aspect Ratio
- Clipping
- Glass Hemisphere
- Inverse
- Kaleidoscope
- Lake
- Mirror
- Ripples
- Twist

See Also
Standard fractal formulas
Standard coloring algorithms
Transformations
Public formulas

3D Mapping



The 3D Mapping transformation maps a fractal onto a three-dimensional shape, such as a plane or a sphere.

Once this transformation is in effect, normal zooming and panning will just move the 3D shape around with the fractal on it. If you want to zoom into the fractal as it is mapped onto the shape, use the **Fractal Center**, **Fractal Magnification**, and **Fractal Rotation** parameters.

To use the rotation and translation parameters effectively, you need to understand the left-handed 3D coordinate system used by the transformation. Here, the X-axis points to the left, the Y-axis points upwards, and the Z-axis points into the screen. So, if you use a positive Z-translation, the 3D shape will appear to move away, into the screen.

The following parameters are available:

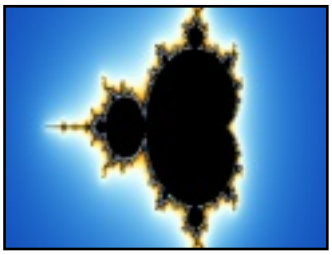
Shape	Selects the type of 3D shape that the fractal is mapped onto.
X Rotation **Y Rotation** **Z Rotation**	Rotates the 3D shape around the X, Y, or Z axis. To predict the direction of rotation, hold up your left hand with your thumb pointing into the positive axis direction (for example, to the left for X rotation). Your (curled) fingers now show the direction of positive rotation around that axis.
X Translation **Y Translation** **Z Translation**	Moves the shape around in 3D space. You always need some positive Z translation to move the shape "into" the screen, otherwise you will be "inside" the shape and it won't be visible. With the plane shape, use a negative Y translation to look down upon it.
Fractal Center **Fractal Magnification** **Fractal Rotation**	Specifies the location of the fractal as it is mapped onto the shape. When adding the transformation, the current coordinates will be used (remember to reset the location to get a proper view of the 3D shape). The easiest way to specify a location is to copy the coordinates from the Location tab of a different fractal window that contains the same fractal formula without the 3D Mapping transformation.

See Also

Tutorial: Learning about transformations

Standard transformations

Aspect Ratio



The Aspect Ratio transformation can be used to create fractals for media with non-square pixels. You should add it to all layers of the fractal.

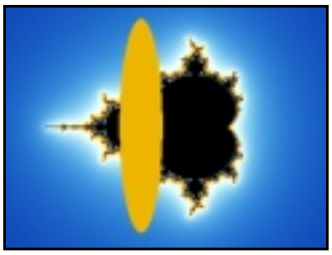
The **Aspect Ratio** parameter specifies the aspect ratio (height / width) of the final media. The final media is the computer screen or printed poster that will eventually display the fractal. If the value of the parameter is equal to the height divided by the width of the fractal window, no stretching occurs.

For example, suppose you'd like to display a fractal on a 15" x 10" screen that has a resolution of 400 x 300 pixels. Here, the pixels are wider than tall. You would set the width and height of the fractal window to 400 x 300 to obtain the desired size. Then, set the **Aspect Ratio** parameter of this transformation to 0.6667 (10" / 15").

Most computer monitors and printers have square pixels. In this case, you don't need to use this transformation. If you just want to stretch the fractal, use the **Stretch** parameter in the Location tab of the Layer Properties tool window instead.

See Also
Standard transformations

Clipping



The Clipping transformation cuts a geometric shape out of a fractal. The shape is filled with a solid color. It can also be transparent, to make parts of the underlying layers visible.

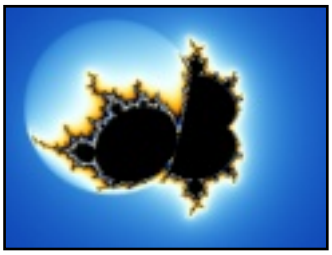
Both rectangular and circular shapes are available. You can choose to cut either the region inside or outside the shape. This makes the Clipping transformation also useful for creating frames.

The following parameters are available:

Center	Specifies the coordinates of the center of the clipping shape. Use the eyedropper (right-click and click Eyedropper) to select the center by clicking inside the fractal window.
Right Edge	Specifies the coordinates of the right edge of the clipping shape. Use the eyedropper to select this.
Top Edge	Specifies the coordinates of the top edge of the clipping shape. Use the eyedropper to select this.
Shape	Selects the type of shape to use. If you select **circle** or **square**, the Top Edge parameter is ignored.
Allow Rotation	If checked, the shape is allowed to rotate. In this case, the Right Edge parameter also defines the rotation to use.
Region	Selects whether to cut the region outside the clipping shape, or inside the clipping shape.
Screen-Relative	If checked, all coordinates are interpreted as relative to the screen. This makes it harder to enter coordinates (because you can no longer use the eyedropper), but it preserves the location of the clipping shape relative to the screen when zooming.

See Also
Tutorial: Learning about transformations
Standard transformations

Glass Hemisphere



The Glass Hemisphere transformation displays the fractal as though it is viewed through a spherical lens.

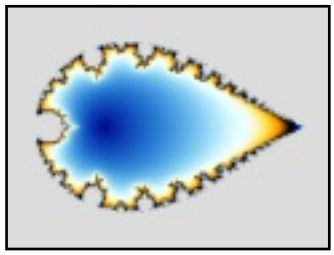
The location, size, and apparent refractive index of the lens can be changed. The refractive index adjusts the strength of the lens.

The following parameters are available:

Refractive index	Specifies the refractive index of the lens. You can use this to simulate various glass-like materials. Larger values will increase the strength of the lens.
Width	Specifies the width of the lens in fractal coordinates.
Center	Specifies the coordinates of the center of the lens. Use the eyedropper (right-click and click Eyedropper) to select the center by clicking inside the fractal window.
Use Screen Center	If checked, the center of the screen is used instead of the Center parameter, so the lens is always centered on the screen, even when zooming in.

See Also
Standard transformations

Inverse



The Inverse transformation turns a fractal inside out. The original center of the fractal is put infinitely far away, and points that were far away end up near the center.

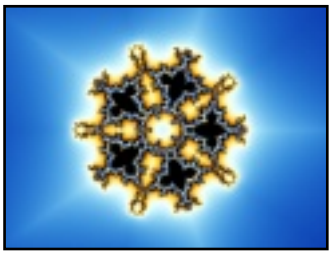
This can change the shape of the fractal in unexpected ways. The example image shows the Inverse transformation applied to a standard Mandelbrot set. (The inside areas of the Mandelbrot set are colored gray.)

The following parameters are available:

Radius	Specifies the radius of the inversion circle. The transformation inverts all points around this circle. Larger values will simply magnify the inverted fractal.
Center	Specifies the coordinates of the center of the inversion circle. This will drastically change the shape and form of the fractal. Use the eyedropper (right-click and click Eyedropper) to select the center by clicking inside the fractal window.
Use Screen Center	If checked, the center of the screen is used instead of the Center parameter, so the inversion circle is always centered on the screen. This can give unexpected effects when zooming in.

See Also
Standard transformations

Kaleidoscope



The Kaleidoscope transformation fills the screen with rotated copies of a small radial slice of the fractal, creating a kaleidoscope effect.

By tweaking the parameters, you can simulate many different kinds of symmetry. By default, the slices are aligned and mirrored to make the edges match, but there are also other options that produce sharp transitions.

Try experimenting with the **Center** and **Rotation angle** parameters to obtain good results. Some sections of the fractal lend themselves much better to the kaleidoscope effect than others.

The following parameters are available:

Symmetry Order	Sets the symmetry order. This is the number of times the slice of the fractal is copied and rotated to obtain the final image.
Symmetry Mode	Selects the symmetry mode to use. Only the **reflective** option is guaranteed to produce seamless images. Use the **slice only** option to view the slice of the fractal that is used as a base for the symmetry effect.
Center	Specifies the coordinates of the symmetry center. Together with the Rotation angle parameter, this selects the slice of the fractal that is used. Try changing this to see the various effects that are possible. Use the eyedropper (right-click and click Eyedropper) to select the center by clicking inside the fractal window.
Use Screen Center	If checked, the center of the screen is used instead of the Center parameter, so the symmetry center is always centered on the screen. This can give unexpected effects when zooming in.
Rotation angle	Rotates the fractal before determining the slice that will be used as a base for the symmetry effect. This can drastically change the resulting image.

See Also
Mirror
Standard transformations

Lake

The Lake transformation mirrors the fractal in a rippled lake. The top part of the fractal is not altered, but below the water level, everything is mirrored.

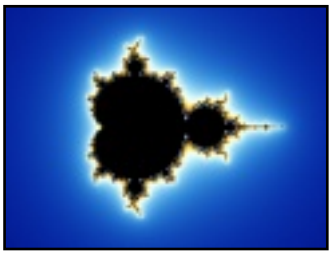
By changing the parameters, you can adjust the height and rotation of the water level, and change the size and frequency of the waves.

The following parameters are available:

Water level	Selects the water level. Only the imaginary part of this parameter is used. Use the eyedropper (right-click and click Eyedropper) to select the water level by clicking on a point inside the fractal window.
Use screen center	If checked, the water level is always centered on the screen. In this case, the Water level parameter is ignored.
Rotation angle	Rotates the water level. To rotate the fractal instead of the water, also enter the same value in the Rotation angle parameter on the Location tab.
Use Location tab angle	If checked, the rotation angle from the Location tab is used instead of the Rotation angle parameter. This ensures that the water level is always horizontal.
Amplitude	Specifies the amplitude of the waves.
Frequency	Specifies the frequency of the waves.

See Also
Ripples
Standard transformations

Mirror



The Mirror transformation mirrors the fractal along an arbitrary axis. It can be useful for mirroring effects with multiple layers.

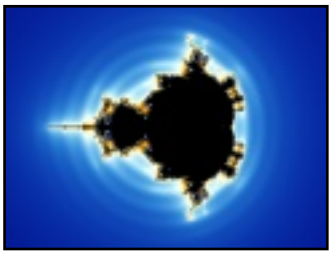
There are presets for a horizontal and a vertical reflection axis, but you can also specify any angle. The center of the axis is configurable, too.

The following parameters are available:

Reflection Axis	Selects the reflection axis. The axis points into the mirroring direction, so it is perpendicular to the imaginary mirror. Select **arbitrary** to specify any angle for the axis.
Reflection Angle	Specifies the rotation angle of the reflection axis, in degrees.
Center	Selects the center of the reflection axis. Use the eyedropper (right-click and click Eyedropper) to select a point by inside the fractal window.
Use screen center	If checked, the reflection center is always centered on the screen. In this case, the Center parameter is ignored.

See Also
Kaleidoscope
Standard transformations

Ripples



The Ripples transformation adds a water ripple effect to the fractal. The center, strength, and frequency of the ripples are adjustable.

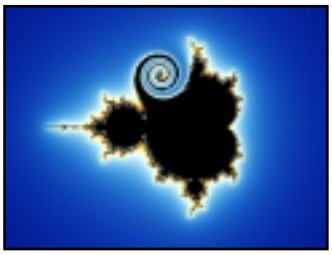
Interesting interference effects are obtained by adding multiple Ripple transformations to a fractal, with different center and strength values.

The following parameters are available:

Ripple Center	Specifies the center of ripples. Use the eyedropper (right-click and click Eyedropper) to select this by clicking on a point inside the fractal window.
Use Screen Center	If checked, the ripple center is always centered on the screen. In this case, the Ripple Center parameter is ignored.
Ripple Strength	Specifies the strength of the ripples. Larger values give a larger distortion.
Ripple Frequency	Specifies the frequency of the ripples. Larger values will create more and smaller ripples.
Ripple Fade	Specifies how soon the ripples fade out. Larger values cause the ripples to fade out over a larger distance (so more ripples are visible).
Ripple Type	Selects how the ripples distort the fractal. The default **Forward and Back** option gives the most natural water-like effect, but the other options are also interesting.

See Also
Lake
Twist
Standard transformations

Twist



The Twist transformation adds a twisted spiral to the fractal. It distorts a small part of the fractal in the form of a spiral, like a vortex.

The center, strength, and size of the vortex are adjustable. This transformation is often combined with the Ripples transformation to obtain interference effects.

The following parameters are available:

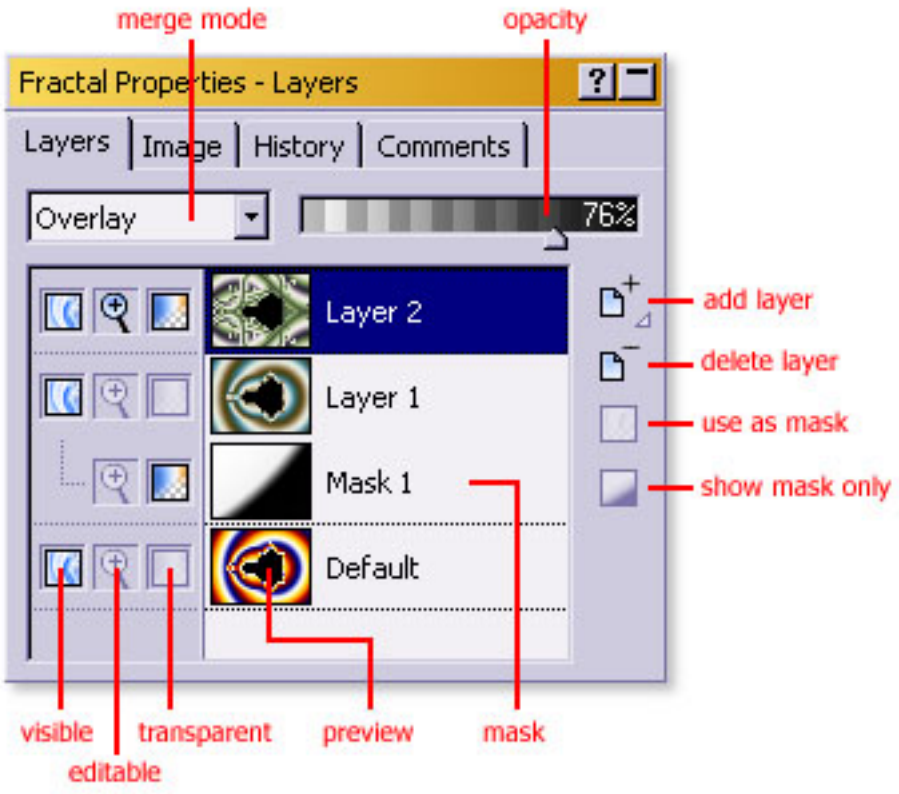
Twist Center	Specifies the center of the twisted spiral. Use the eyedropper (right-click and click Eyedropper) to select this by clicking on a point inside the fractal window.
Strength	Specifies the strength of the twist. Larger values create more strongly twisted spirals.
Decay Factor	Specifies how soon the spiral loses its strength. Larger values decrease the size of the spiral.

See Also
Lake
Standard transformations

Layers

One of Ultra Fractal's key features is the ability to use multiple layers. Each layer contains a separate fractal image. By using multiple layers, you can achieve many special and wonderful effects that are not possible with single-layer images.

Layers are managed in the Layers tab of the Fractal Properties tool window:



The layers list shows all layers of the active fractal window, complete with previews. It also selects the active layer. The active layer is edited by the Layer Properties tool window and the gradient editor.

- The **Add** button duplicates the active layer and adds it to the list of layers. Hold down the button longer for a menu with predefined layers. You can also define your own predefined layers here.
- The **Delete** button deletes the active layer.
- The **Merge Mode** input box selects the merge mode of the active layer.
- The **Opacity** slider selects the opacity of the active layer.
- The **Visible**, **Editable** and **Transparent** icons before each layer toggle the visibility, editability, and transparency of the layer. See Working with layers.
- The **Use as Mask** button turns a layer into a mask and back. The **Show Mask Only** button makes it easier to edit a mask. See Masks.

Next: How layers are merged

See Also
Tutorial: Working with layers
Keyboard shortcuts for the Fractal Properties tool window

How layers are merged

Within a multi-layered fractal, Ultra Fractal merges the different layers to create the resulting image. This image appears in the fractal window. The layers are merged by superimposing them.

Ultra Fractal starts with the bottom layer and places the second layer on top of it. The third layer (if any) is in turn placed on top of the result, and so on. If a layer is completely opaque, the layers below it will be hidden. If a layer is completely transparent, it will not be visible.

Most layers will be more or less transparent, so they are visible while still allowing the lower layers to shine through. There are four ways to make layers transparent:

- Reduce the opacity of the layer. By default, the opacity is set to 100%, making the layer fully opaque. Move the opacity slider to the left to make the active layer more transparent.
- Change the merge mode of the layer. By default, the merge mode is set to Normal. The other merge modes create special effects that allow lower layers to be partially visible even if the opacity of the layer is set to 100%. See Merge modes.
- Make only parts of the layer transparent. The previous two options affect the entire layer. You can, however, also change the opacity of only certain areas in the layer. See Transparent layers.
- Add a mask to the layer. The mask allows even more control over which areas of the layer will be transparent. See Masks.

Of course, you can freely mix these options. It is common, for example, to use a merge mode like Hard Light and set the opacity to less than 100%.

Next: Working with layers

See Also
Layers
Tutorial: Working with layers

Working with layers

Layers are managed in the Layers tab of the Fractal Properties tool window.

Click the **Add** button to add a new layer, duplicating the active layer.
Hold down the Add button to open a menu with predefined layers. Click a predefined layer to add it. Click Define to edit the list of predefined layers.

Click the **Delete** button to delete the active layer.

The **Merge mode** drop-down box selects the merge mode of the active layer. The merge mode determines how the layer is combined with the layers below it.

The **Opacity** slider selects the opacity of the active layer. Move it to the left to make the layer less visible (more transparent). Move it to the right to make it more opaque.

To rename the active layer, click it again or press F2 (like in Windows Explorer).

To change the order in which the layers appear in the list, drag them up or down. This affects layer compositing, of course.

Before each layer, a row of icons appears. These icons toggle various properties.

The **Visible** icon toggles the visibility of the layer. Use it to temporarily hide a layer, so you can more clearly see the other layers.

The **Editable** icon selects whether a layer is editable. Only editable layers are affected by zooming operations. By default, all layers are editable, so if you want to zoom in on only one layer, you should clear this icon on the other layers first.

The **Transparent** icon selects whether transparent areas in a layer are visible. See Transparent layers.

Click a layer in the list of layers to activate it. Many tool windows (such as the Layer Properties tool window) and the gradient editor work with the active layer. So, by changing the active layer in the list of layers, you change what's being edited by these other tool windows.

Notes

- By holding down Shift while clicking on the **Visible**, **Editable**, or **Transparent** icons, you toggle all other layers instead. If you want to see just one layer, for example, Shift-click its **Visible** icon and all other layers will be turned off. Shift-click it again to show all layers.
- If a layer is not editable, its properties can still be changed with the Layer Properties tool window.
- To copy a layer to another fractal window, drag it from the list of layers to the fractal window.
- Right-click in the list of layers to open a menu with frequently used commands. This menu also contains **Copy** and **Paste** commands that are another way of copying layers to other fractal windows.

Next: Merge modes

See Also
Tutorial: Working with layers
Keyboard shortcuts for the Fractal Properties tool window

Merge modes

The **Merge mode** drop-down box at the top of the Layers tab of the Fractal Properties tool window selects the merge mode of the active layer. The merge mode defines how the layer is combined with the underlying layers to achieve the final image.

Normal	Directly returns colors from the layer. Use this if you don't want any special effects.
Multiply	Multiplies the layer with the underlying layers. The result is always a darker color, thus darkening the underlying layers.
Screen	Multiplies the inverse of the layer with the inverse of the underlying layers. The result is always a lighter color, thus brightening the underlying layers. Screen is the inverse of Multiply.
Overlay	Multiplies or screens the colors, depending on the color in the underlying layers. Creates color blending effects between the layer and the underlying layers.
Hard Light	Multiplies or screens the colors, depending on the color in the layer. Emphasizes the dark and light regions in the layer, while the areas with medium brightness become transparent. Useful if the layer contains shadows or embossing effects.
Soft Light	Darkens or lightens the colors, depending on the color in the layer. Creates an effect similar to Hard Light, but with less emphasis on the dark and light areas in the layer.
Darken	Returns the darkest of the color in the layer and the color in the underlying layers.
Lighten	Returns the lightest of the color in the layer and the color in the underlying layers.
Difference	Returns the difference between the layer and the underlying layers. Often creates unusual and unexpected color transitions.
Hue	Returns the hue of the layer, and the saturation and luminance of the underlying layers. Colors the underlying layers with the hue of the layer.
Saturation	Returns the saturation of the layer, and the hue and luminance of the underlying layers. Changes the saturation of the underlying layers depending on the layer.
Color	Returns the hue and saturation of the layer, and the luminance of the underlying layers. Colors the underlying layers with the layer. The underlying layers control the brightness of the resulting image.
Luminance	Returns the luminance of the layer, and the hue and saturation of the underlying layers. The layer controls the brightness of the underlying layers. Luminance is the inverse of Color.
Addition	Directly adds the layer to the underlying layers, limiting the resulting colors at white (255, 255, 255).
Subtraction	Directly subtracts the layer from the underlying layers, limiting the resulting colors at black (0, 0, 0). Difference is similar, but returns the absolute value after subtracting.
HSL Addition	Adds the layer to the underlying layers using the HSL color model. Creates unusual effects.
Red	Returns the red part of the layer, and the green and blue parts of the underlying layers.
Green	Returns the green part of the layer, and the red and blue parts of the underlying layers.
Blue	Returns the blue part of the layer, and the red and green parts of the underlying layers.

The best way to learn how to use the different merge modes is to experiment. Also try to use various settings of the Opacity slider and see how it controls the intensity of the merging effects.

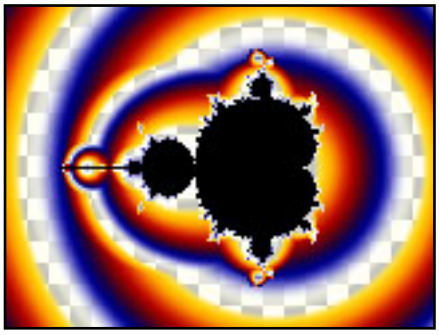
Next: Transparent layers

See Also
How layers are merged

Transparent layers

To make a layer transparent, you can use the **Opacity** and **Merge mode** settings, but these work on the entire layer. You can also make only certain parts of a layer transparent, which gives you more artistic control.

The easiest way to create transparent areas in a layer is to use a transparent gradient. The transparent parts of the gradient will create transparent areas in the layer. If you make all the other layers invisible, a pattern of blocks will show the transparent areas.



Another way of creating transparent areas is to use the Solid Color setting of transformations and coloring algorithms. Solid colors with an opacity value of less than 255 create transparent areas. Many transformations, such as Clipping in Standard.uxf, use this to create masking effects.

The **Transparent** icon before the layer toggles transparent areas on and off. Use it to quickly verify the transparent areas and to see what difference they make to the final image. By default, transparency is off, but it's automatically turned on when you make changes to transparent areas in the layer.

Next: Masks

See Also
Tutorial: Working with layers
How layers are merged

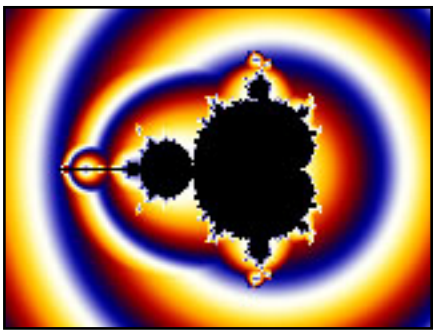
Masks

If you create transparent areas in a layer using a transparent gradient, the shape of the transparent areas is controlled by the selected coloring algorithms. Certain colors in the gradient are transparent, so those colors will become transparent in the layer, too. This means that you can not use this method to create arbitrarily shaped transparent areas.

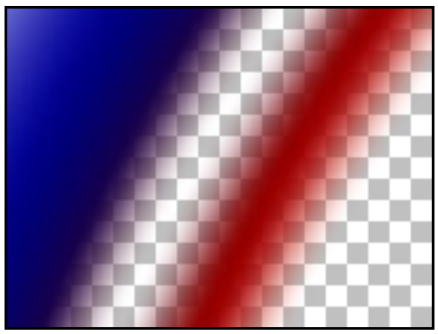
If you use transformations instead and set the opacity of the solid color to less than 255, you can create arbitrarily shaped transparent areas in the layer. You do need a transformation that will output the area you need, but you could write it yourself. Still, a limitation of this technique is that pixels are either set to the solid color (transparent), or they're colored according to the gradient and the selected coloring algorithms. You can only create sharp edges, not smooth transitions.

Masks overcome these problems. A mask is an invisible layer that is attached to the layer that needs transparent areas. The mask contains transparent areas, that are created with an ordinary transparent gradient. Since the mask is invisible, these transparent areas are invisible as well.

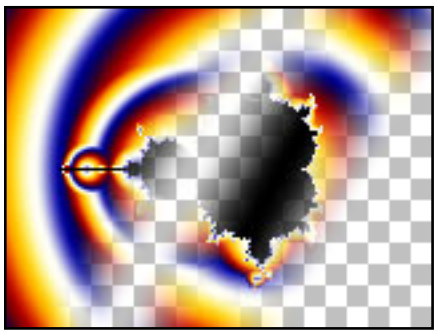
Instead, the layer owning the mask "borrows" the transparent areas of the mask. The shape of these areas is defined by the selected fractal formula, the selected coloring algorithms, and the gradient of the mask. The shape is independent from the layer owning the mask.



The layer that needs transparent areas.



The mask, with transparent areas.



The layer with the mask applied.

As you can see, the layer uses the transparent areas of the mask. The rest of the mask layer is ignored.

Layers can have multiple masks to add differently shaped transparent areas. If the layer contains transparent areas itself (for example created with a transparent gradient), they're also taken into account.

Next: Working with masks

See Also
Tutorial: Masking
Layers

Working with masks

Masks are managed in the Layers tab of the Layer Properties tool window.

To duplicate the active layer as a mask, hold down the **Add** button and click Duplicate as Mask in the menu that appears.

To delete a mask, select it and click the **Delete** button.

To turn an existing layer into a mask, click the **Use as Mask** button. The layer will become a mask, attached to the layer directly above it.

Click the **Show Mask Only** button to disable the layer owning the mask. Instead, the transparent areas in the mask will be shown. White areas are opaque, black areas are transparent. This makes it easier to edit the mask.

Usually, the mask will be entirely white because its gradient is not yet transparent. The first thing to do is to open the gradient editor. Note that only the opacity view of the editor is enabled, since the colors in the gradient do not matter for a mask. Add a few extra control points to the gradient so it will start to show some transparency (darker regions).

By toggling the **Show Mask Only** button, you can alternatively work on the mask and judge the effects that it has on the layer that owns it. The mask can be edited like any layer. For example, you can zoom in on it, select another coloring algorithm, and so on.

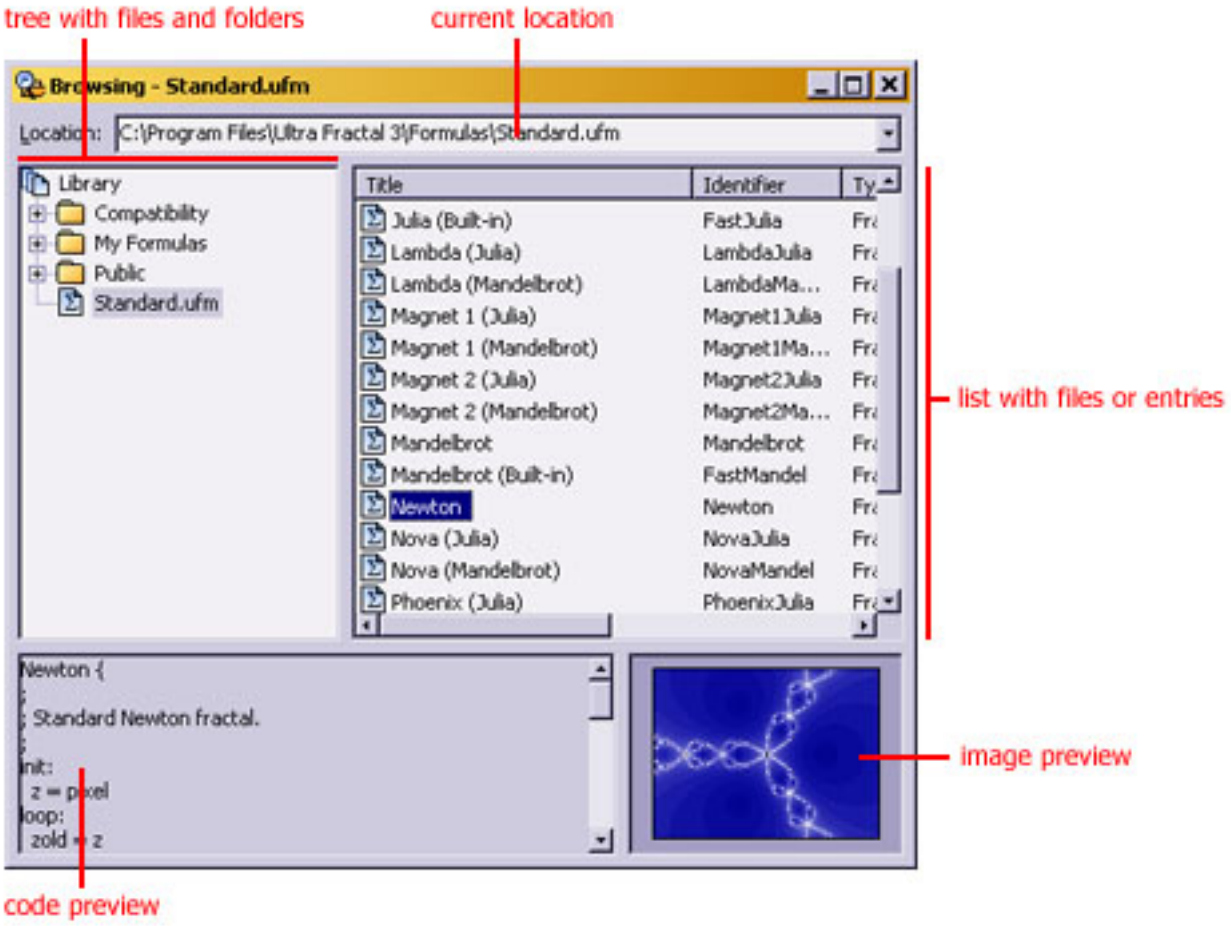
See Also
Tutorial: Masking
Masks
Layers

Browsers

To explore and organize the various types of fractal-related files on your computer, Ultra Fractal includes a flexible file browser. It works much like Windows Explorer, but it also works with files containing multiple entries, such as parameter files or formula files.

To open a browser, click Browse on the File menu.

The browser is divided into four panes:



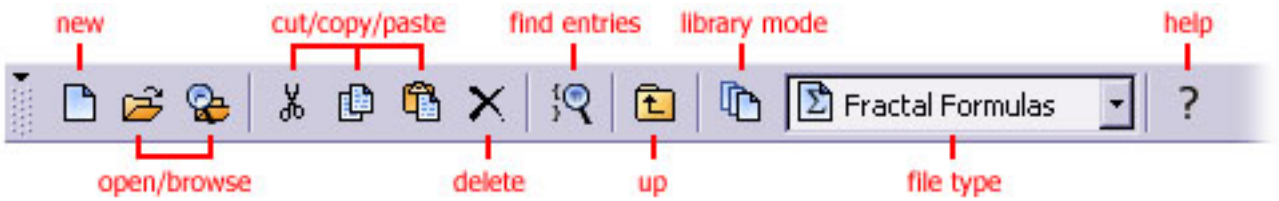
- The **location** input box at the top shows the file or folder that's currently selected. You can also type a new location here.
- The **tree** on the left shows an overview of all files and folders on your computer. If library mode is active, only the files and folders in the library of the current file type are shown. See Library mode.
- The **list** on the right shows the contents of the file or folder selected in the tree. The name of this file or folder is displayed by the location input box.
- The **code preview** shows the text corresponding to the entry selected in the list.
- The **image preview** shows a preview image for the entry selected in the list.

Next: Browser toolbar

See Also
Quick Start Tutorial

Browser toolbar

The toolbar for the browser contains commands to view and work with folders, files and entries:



- The **New** button creates a new fractal from scratch.
- The **Open** button opens a file from disk.
- The **Browse** button opens a new modeless browser. To duplicate the browser, click Duplicate on the File menu.
- The **Cut**, **Copy**, and **Paste** buttons are used to move and copy selected files, entries, and folders. See Organizing your work.
- The **Delete** button deletes selected files, entries, and folders.
- The **Find Entries** button opens a dialog where you can search for entries (such as parameter sets and fractal formulas) on your computer. See Finding files and entries.
- The **Up** button navigates to the folder containing the currently selected file or folder.
- The **Library Only** button toggles library mode on and off. See Library mode.
- The **File Type** drop-down box selects which files are currently visible. See File types.

The commands on the toolbar are duplicated on the File, Edit, and View pull-down menus. Frequently used commands are also on the menu that pops up when you right-click in the browser.

Next: Modal browsers

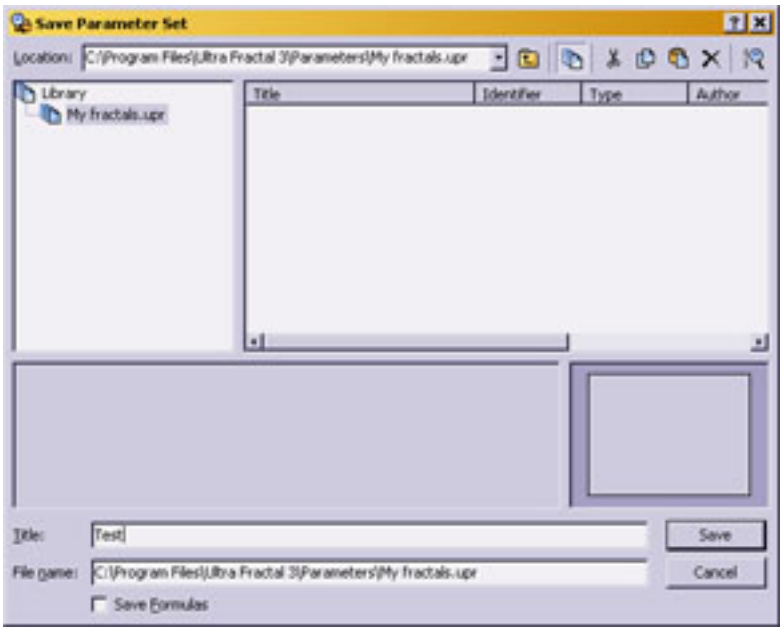
See Also
Keyboard shortcuts for browsers
Browsers
Workspace

Modal browsers

There are two types of browsers: modeless and modal browsers. A modeless browser is created when you click Browse on the File menu. Modeless browsers are typically used to organize files. They can stay open in the background while you work with other windows, such as fractal windows.

A modal browser is shown when you must select a parameter set or formula. The modal browser looks like a modeless browser, but it contains a small built-in toolbar, and Open and Cancel buttons. You must close the modal browser by clicking Open or Cancel before continuing.

Modal browsers are also used to save parameter sets and gradients. In this case, they contain input boxes to enter a file name and a title, and a Save button.



You can compare modal browsers to standard Windows Open and Save dialog boxes, except that they work with entries (such as parameter sets and formulas) instead of files. In the same way, a modeless browser can be compared to Windows Explorer.

Next: File types

See Also
Browsers
Browser toolbar

File types

The browser works with all Ultra Fractal file types. You can set it to display all fractal-related files, or only files of a selected type.

To select a file type, click File Types on the View menu, and then click the file type. You can also use the drop-down box on the toolbar. The following file types are available:

Fractal Files	Displays fractal files (*.ufr). Fractal files contain complete fractals. See Opening and saving fractals.
Parameter Files	Displays parameter files (*.upr). Parameter files contain multiple parameter sets that describe a fractal without storing the calculated pixels. Older Fractint parameter files (*.par) are also shown. See Parameter files.
Gradient Files	Displays gradient files (*.ugr). Gradient files contain multiple gradients that store coloring information for a fractal. Older gradient files (*.ual) and Fractint palette files (*.map) are also shown. See Opening and saving gradients.
Transformations	Displays transformation files (*.uxf). Transformation files contain multiple transformation formulas. See Transformations.
Fractal Formulas	Displays fractal formula files (*.ufm). Fractal formula files contain multiple fractal formulas. Older Fractint formula files (*.frm) are also shown. See Fractal formulas.
Coloring Algorithms	Displays coloring algorithm files (*.ucl). Coloring algorithm files contain multiple coloring algorithms (formulas). See Coloring algorithms.

Select **All Files** to display all these file types at the same time.

Notes

- If **All Files** is selected, Library mode is not available.
- Modal browsers cannot switch between file types, since their purpose is to open or save a file of a particular type.

Next: Library mode

See Also
Browsers
Browser toolbar

Library mode

The browser can be switched to library mode. In library mode, only the files and folders within the library of the visible file type are shown.

This prevents cluttering the tree on the left side of the browser with all folders on your computer (most of which will not contain any fractal-related files), and makes it easier to work with parameter files, gradient files, and formulas.

To activate library mode, click **Library Only** on the View menu. Click it again to turn library mode off.

The library for each file type is a folder (for example My Documents\Ultra Fractal 3\Parameters) that contains files for that file type by default.

Usually, you'll work in library mode, but if you want to open a file or entry that is not in the library, you have to turn library mode off in order to find it. In this case, you can view all files and folders on the local drives (including network drives) on your computer.

Notes

- Library mode does not work when all file types are visible, because files of different types do not share the same library folder.
- To customize the location of the library of a file type, click Options on the Options menu, and then click on the Folder tab.
- To open a file located on a different (networked) computer, you'll have to map a shared folder on that computer to a network drive with Windows Explorer first.

Next: Opening files and entries

See Also

Browsers
Browser toolbar

Opening files and entries

Browsers are used to organize your work, but they can also open all types of files and entries (only modeless browsers).

To open a file or entry, double-click in the list on the right of the browser. If you double-click a folder, its contents will be shown.

Fractal files and parameter sets will be opened in a new fractal window. You can also drag them from the browser to any open fractal window.

Right-click on a fractal file, parameter file, or parameter set and click **Render to Disk** to render it to disk. You can also drag them to the Render to Disk tool window.

Right-click a parameter set and click **Open as Text** to open the parameter set in the formula editor to edit it manually.

Gradients will be opened in a new gradient editor. You can also drag them from the browser to any open gradient editor.

Transformations, fractal formulas, and coloring algorithms will be opened in the formula editor.

You can also drag transformations to the list of transformations in the Mapping tab of the Layer Properties tool window. Fractal formulas can be dropped on the top of the Formula tab, and coloring algorithms can be dropped on the top of the Inside and Outside tabs to select them.

Next: Organizing your work

See Also

Browsers
Browser toolbar
Modal browsers

Organizing your work

To organize your fractal-related files, you can move, copy, delete, and rename files and entries in the browser. Again, the browser works similar to Windows Explorer, except that it also manipulates the entries in parameter files, gradient files, and formula files.

To move a file, folder, or entry, select it in the list view, and click **Cut** on the Edit menu. Select the new location, and then click **Paste** on the Edit menu.

To copy a file, folder, or entry, select it in the list view, and click **Copy** on the Edit menu. Select the new location, and then click **Paste** on the Edit menu.

Click **Paste** on the Edit menu to move or copy an item that was previously cut or copied to the Clipboard.

To delete a file, folder, or entry, select it in the list view, and click **Delete** on the Edit menu.

To rename a file, folder, or entry, select it in the list view and click it again, or click **Rename** on the Edit menu.

These commands are also on the menu that pops up when you right-click an item in the list view or in the tree view. In this way, you can also move, copy, delete, and rename files and folders using the tree view.

Alternatively, you can drag items from one location to another to move them. Hold down Ctrl while dropping to copy the items instead.

Notes

- Items that are cut or copied to the Clipboard are not actually moved or copied until you use the Paste command.
- Deleting a file, entry, or folder will delete it immediately. It will not be moved to the Recycle Bin.

Next: Finding files and entries

See Also

Browsers
Browser toolbar

Finding files and entries

The browser can search for files and entries that conform to selected criteria. This is useful when you're looking for certain formulas, parameter sets, or gradients, but you don't know their exact location.

To search for files and entries, click **Find Entries** on the Edit menu. This will open the Find Entries dialog box.

The Find Entries dialog box allows you to search for parameter sets, gradients, and formulas by title, comments, and identifier. You can also specify selected files and folders to search.

For parameter sets, you can also search for authors and formulas (identifiers and files) that are used.

Click **Find Now** to start the search. This will populate the list in the dialog box with results. Click a result to open it in the browser. The Find Entries dialog box will stay on top of the browser until you close it.

See Also
Browsers
Browser toolbar

Formula editors

Ultra Fractal contains a built-in formula editor. It's a simple text editor with a few extra features that are helpful when writing formulas.

The toolbar contains commands to edit and save the file you're working on:

- The **New** button creates a new fractal from scratch.
- The **Open** and **Browse** buttons open files from disk.
- The **Undo** button undoes the last change you made to the file.
- The **Cut**, **Copy**, and **Paste** buttons are used to move and copy blocks of text. See Editing formulas.
- The **Find** button opens a standard Find dialog where you can search for text.
- The **Find Entries** button opens a dialog where you can search for formulas in the file. See Finding text and formulas.
- The **Active Formula** drop-down box shows the formulas in the file and allows you to quickly jump to any formula.
- The **New Formula** button adds a new empty formula to the file.
- The **Complete Template** button completes the editor template at the cursor position. See Templates.

The commands on the toolbar are duplicated on the File, Edit, and Insert pull-down menus. Frequently used commands are also on the menu that pops up when you right-click inside the editor.

Next: Editing formulas

See Also

Keyboard shortcuts for formula editors
Fractal formulas
Coloring algorithms
Transformations

Editing formulas

To edit a formula, open it in the built-in formula editor:


Click the **Edit** button on the Mapping, Formula, Inside, or Outside tabs on the Layer Properties tool window to edit the selected transformation, fractal formula, or coloring algorithm.


Click **Browse** on the File menu to open a new browser, and double-click on a formula to edit it.


Click **Open** on the File menu and select a formula file to open it in the formula editor.

The editor works similar to Windows Notepad and supports common text editor features:


Click **Cut** on the Edit menu to move the selected text block to the Clipboard.


Click **Copy** on the Edit menu to copy the selected text block to the Clipboard.


Click **Paste** on the Edit menu to insert the text on the Clipboard into the file at the position of the cursor.


Click **Undo** on the Edit menu to undo your last change. Click Undo again to redo the change.

In the status bar, the status of the file and the current row and column are displayed while you type.

If you're editing a formula that's being used by an open fractal window, you can easily view your changes.


Click the **Reload** button on the Mapping, Formula, Inside, or Outside tabs on the Layer Properties tool window to save the formula file, recompile the formula, and recalculate the layer.

Click **Topic Search** on the Help menu to get help on the word at the cursor position. This works for reserved words, functions, predefined symbols, settings, compiler directives, and labels.

Next: Finding text and formulas

See Also
Formula editors
Writing formulas

Finding text and formulas

The formula editor provides various ways of finding text and formulas within formula files:

Click **Find** on the Edit menu to search for text using a standard Find dialog. Click on the Find Next button to start the search from the cursor position. The first occurrence of the text will be highlighted. Since the Find dialog will stay on top of the editor, you can keep it open while you edit the file.

Click **Replace** on the Edit menu to search for and replace text.

Click **Find Formulas** on the Edit menu to open the Find Formulas dialog. This dialog allows you to search for formulas within the file, based on various criteria. Click the Find Now button to start the search. Click a formula in the list of results to jump to it in the editor, where you can review and edit it. The Find Formulas dialog will stay on top of the editor until you close it.

Next: Indenting and commenting

See Also

Formula editors
Writing formulas

Indenting and commenting

The formula editor can indent and outdent blocks of code for you. Indentation is used to indicate the logical structure of code, to make formulas easier to read.

- Click **Indent Block** on the Edit menu to move the selected lines to the right. This will add a space at the start of each line.
- Click **Outdent Block** on the Edit menu to move the selected lines to the left. This will remove a space from each line (if there is one).

You can also easily comment and uncomment blocks of code. The compiler will ignore commented code, so this is an easy way to (temporarily) disable parts of a formula.

- Click **Comment Block** on the Edit menu to comment the selected lines. This will put a semicolon and a space at the start of each line.
- Click **Uncomment Block** on the Edit menu to uncomment the selected lines. This will remove a semicolon and a space from each line, if any.

Next: Templates

See Also
Formula editors
Writing formulas

Templates

To write formulas efficiently, you can use editor templates. An editor template is a commonly used piece of code that can be inserted easily.

Click **Complete Template** on the Insert menu (or press Ctrl+J) to expand the pattern at the cursor position to a template.

For example, to insert a parameter definition, enter "p" and press Ctrl+J. The pattern "p" will be expanded to a default parameter definition:

```
param |
  caption = ""
endparam
```

where | indicates the position of the cursor, so you're ready to type the name of the parameter.

If the pattern is not unique (for example when there are multiple patterns starting with "p"), a dialog box is shown where you can select the desired template.

To see the default patterns and templates and customize them, click Options on the Options menu, and then click the Editor tab.

See Also
Formula editors
Writing formulas

Exporting and rendering

To use the artwork that you create in Ultra Fractal for printing or on the web, you have to export it or render it to disk. This will create a bitmap image of the fractal, ready for further processing.

You can directly export the image from a fractal window to a bitmap image. Click **Export Image** on the File menu, enter a file name, and click Save. See File formats for a description of the image file formats that are supported.

Usually though, you'll want to render your artwork to disk. Rendering to disk provides the following benefits:

- Anti-aliasing for improved image quality. This is especially important if you're preparing images for the web. See Anti-aliasing.
- More accurate color blending and merging. When a fractal is rendered to disk, the colors are calculated more accurately than the fractal window does, producing smoother, higher quality images.
- Support for large images. You can render images up to 100,000 by 100,000 pixels. Because the images are rendered to disk, the size is not limited by available memory (RAM).
- Entire parameter files can be rendered to disk with one command, producing multiple images.

Note: If you're using an evaluation copy of Ultra Fractal, exported and rendered images will be marked with *Evaluation Copy* text. To fully enable exporting and rendering images, you must purchase your copy of Ultra Fractal. See Purchasing Ultra Fractal.

Next: Rendering images

See Also
Tutorial: Learning about transformations
Tutorial: Masking
Render jobs
Fractal windows

Rendering images

Rendering fractals to disk is the preferred way of exporting your artwork to bitmap images, ready for printing or publishing on the web.

To render the fractal in an open fractal window to disk, click **Render to Disk** on the Fractal menu.

Click the **Add** button on the Render to Disk tool window to render a parameter set to disk. Hold down the button and click **Add Fractal** to specify a fractal file to render.

This will open the Render to Disk dialog box. Here, you can specify a file name and file format for the image, the desired size and resolution, and the anti-aliasing settings. To get help on a control in the dialog box, click the **?** button in the title bar, and then click the control.

Click OK to start rendering the fractal. This will create a new render job that starts calculating the image in the background. Render jobs can be monitored and managed in the Render to Disk tool window. See Render jobs.

Notes

- You can also render fractals and parameter sets directly from the browser by right-clicking them and clicking **Render to Disk**, or by dragging them from the browser to the Render to Disk tool window. See Opening files and entries.
- The resolution specified when starting a render job is used to calculate the desired size in pixels if you enter the width and height of the image in cm or inches. Ultra Fractal attempts to store the resolution in the bitmap image, but you should verify (and correct) this before printing the image.

Next: Rendering parameter files

See Also
Exporting and rendering

Rendering parameter files

You may sometimes wish to render all images in a parameter file to disk. Instead of rendering each image separately, you can render the entire parameter file to disk with one command.

Hold down the **Add** button on the Render to Disk tool window, and click **Add Parameter File**. Select a parameter file to render in the dialog box that appears, and click Open.

This will open the Render Parameter File to Disk dialog box. Here, you can specify a folder that will contain the rendered bitmap images, the file format, the desired size and resolution, and the anti-aliasing settings.

You can choose to render all images in the parameter file, or only selected images, or only the images that do not yet exist in the destination folder (useful to update a folder that holds the images for a parameter file if you've added new parameter sets).

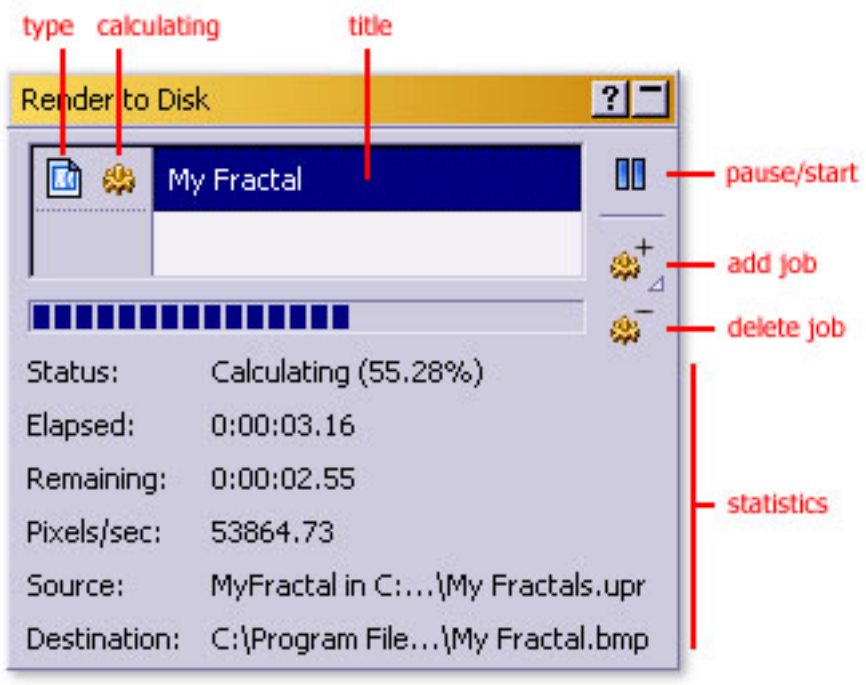
Click OK to start rendering the parameter file. This will create a new render job that starts calculating the images in the background. Render jobs can be monitored and managed in the Render to Disk tool window.

Next: Render jobs

See Also
Exporting and rendering
Rendering images

Render jobs

When you start rendering a fractal or a parameter file, a render job is created that performs the requested calculations in the background. Render jobs are monitored and managed in the Render to Disk tool window.



The tool window contains a list of render jobs. Below the list, the status of the selected job is shown, including various statistics.

- Click the **Pause/Start** button to pause the selected job. To resume it, click the button again.
- Click or hold down the **Add** button to add a new job. See Rendering images and Rendering parameter files.
- Click the **Delete** button to cancel and delete the selected job.

The icons before each job in the list show its type (single image or parameter file), and if it's currently calculating.

By default, only the job at the top is calculating. When it is finished, the next job in the queue is started. New jobs are added at the bottom, and therefore will be started automatically when all the other jobs have been completed.

To start another job, select a job in the list that's not calculating and click the **Pause/Start** button to start it. When this job is finished, it will start the next job in the queue, too.

You can reorder the jobs in the queue by dragging them up or down to adjust the order in which they will be calculated. For example, if you want a job to stay paused while the other jobs are calculated, drag it to the top of the list, so it won't be started automatically.

Notes

- To get help on a specific statistic, click the **?** button in the title bar of the tool window, and then click the statistic.

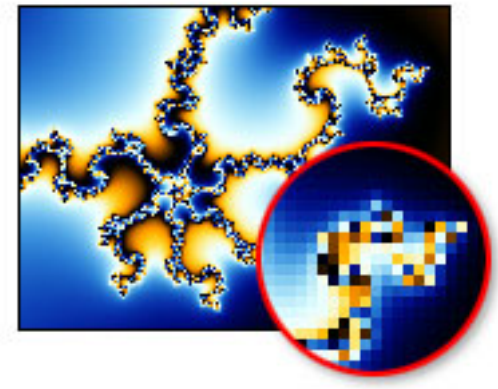
- When you hide or close the tool window, the jobs will continue to calculate in the background. When you close Ultra Fractal, the jobs will be paused. They'll be resumed automatically when you start Ultra Fractal again.
- Although Ultra Fractal is carefully designed to resume jobs correctly in case of a power failure or computer crash, you may want to back up time-consuming render jobs to be absolutely safe. To back up a render job, right-click it in the list and click **Backup Job**. This will save all calculated data to a single file (*.urj). To restore a job, hold down the **Add** button and click **Restore Job**.

Next: Anti-aliasing

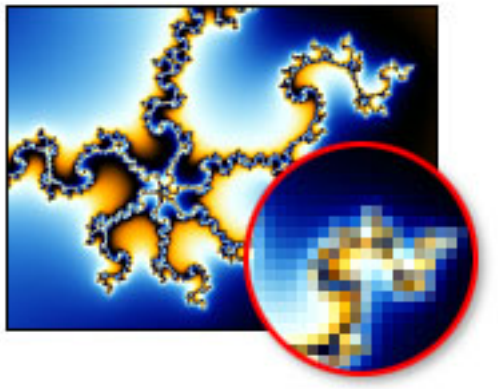
See Also
Exporting and rendering

Anti-aliasing

One of the reasons to render fractals to disk is to be able to use anti-aliasing. Anti-aliasing improves the quality of rendered images by sharpening and smoothening them, removing jagged edges.



No anti-aliasing



Normal anti-aliasing

Anti-aliasing increases the time it takes to render the image. The effect of anti-aliasing and the extra time required depends on the anti-aliasing settings you use when starting a render job (see Rendering images and Rendering parameter files).

The following settings are available:

Anti-aliasing Selects common anti-aliasing settings.

- **Off** turns anti-aliasing off completely.
- **Quick** selects minimal anti-aliasing settings that calculate relatively quickly.
- **Normal** selects normal anti-aliasing settings that provide good quality and reasonable calculation times.
- **Non-adaptive** turns off adaptive anti-aliasing. This gives better results for some images, but it requires (much) longer to calculate.
- **Custom** allows you to specify your own anti-aliasing settings.

Threshold Specifies the threshold to use for adaptive anti-aliasing. Ultra Fractal anti-aliases a pixel only when the difference between the pixel and its neighbors (red + green + blue) is larger than or equal to the threshold.

Use 0 to turn adaptive anti-aliasing off. This slows the calculation down, but is required if adaptive anti-aliasing does not work well (for example when the fractal contains many thin lines, such as with the Embossed fractal formulas).

Depth Specifies the anti-aliasing depth (1 or greater). Greater depths give better quality at the expense of calculation time. Increasing the depth by one can easily double or triple the calculation time. The default value of 1 is usually sufficient.

Subdivisions Selects how pixels are subdivided for anti-aliasing. The default value 9 (3x3) gives better quality and is recommended. Use 4 (2x2) only for quick renders, or when the depth is greater than 1.

The **Normal** setting is recommended, and will usually give the best results. If you're preparing images for printing, it may not be necessary to use anti-aliasing. This is because on prints, individual

pixels are rarely visible due to the much higher resolution.

Next: File formats

See Also
Exporting and rendering

File formats

Ultra Fractal supports various image file formats for exporting and rendering images. You can select the file format when selecting the file name of the exported image and when starting a new render job (see Rendering images and Rendering parameter files).

The following file formats are supported:

Bitmap image	Saves the image as a Windows bitmap image (*.bmp). This format is supported by almost all Windows graphics programs.
Photoshop image	Saves the image as an Adobe Photoshop image (*.psd). This allows you to save layers individually, so they can be post-processed. This file format also supports transparent images.
PNG image	Saves the image as a Portable Network Graphics image (*.png). This file format is readable by many graphics programs and supports lossless compression and transparent images.
JPEG image	Saves the image as a JPEG image (*.jpg). This format offers very good compression. You can set the quality of the saved image to adjust the file size. A value of 95% will usually give good results. Don't use this format if you want the best possible image quality.
Targa image	Saves the image as a Targa image (*.tga). This is a common format for high-end graphics programs, such as raytracers and 3D packages. It supports transparent images.
TIFF image	Saves the image as a TIFF image (*.tif). This format is often used by print shops and graphics designers working with Apple computers. It also supports transparent images.

See Also
Exporting and rendering
File types

Network calculations

Ultra Fractal allows you to distribute calculations over multiple computers connected with a network. This can greatly increase the speed at which complex fractals are calculated, especially in combination with deep zooming.

It works by running a separate program called **Ultra Fractal Server** on remote computers, and creating connections to those computers with the Network tool window in Ultra Fractal. One server can accept multiple connections from different computers running Ultra Fractal, and one computer running Ultra Fractal can create connections to multiple servers.

When you've successfully created one or more connections, calculations will immediately be divided among all available computers. You can add or remove connections at any time. Both calculations performed by fractal windows and calculations performed by render jobs can be distributed.

Ultra Fractal uses the TCP/IP protocol for network calculations, so you can connect to computers both on a local network and on the Internet.

Next: Network servers

See Also
Connections
Fractal windows
Exporting and rendering

Network servers

To be able to connect to a remote computer, it must be running the Ultra Fractal Server program. The server accepts connections from other computers running Ultra Fractal and performs requested calculations.

To start the server, click Programs on the Start menu, click Ultra Fractal 3, and then click **Ultra Fractal Server**.

To run the server on another computer, you can install Ultra Fractal on that computer. Alternatively, share the drive that Ultra Fractal is installed on (with Windows Explorer) so you can access it from other computers, and then start the Server.exe program located on your own computer in the Ultra Fractal folder from a remote computer.

The server shows a list with the current connections and a log that displays all activity. In the status bar, the number of connections and the current IP address are shown.

By default, the server listens on port 8691 for connections, but you can change this if it causes conflicts with other programs. If there's a firewall on the server computer, you need to configure it to allow incoming connections on this port.

Click **Options** on the File menu of the server to set connection and security options for the server. See Security.

Notes

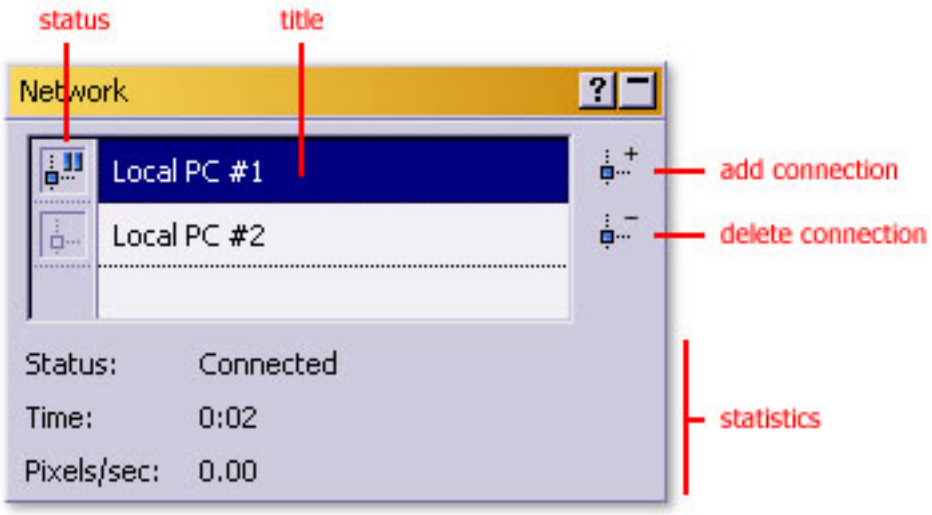
- If you want to keep the server running continously on a remote computer, create a shortcut to it in the Startup folder in the Start menu. By minimizing the server window, it will run unobtrusively in the taskbar tray area.
- You don't need an extra license to run Ultra Fractal Server on other computers.
- The computers that run Ultra Fractal Server do not require any fractal formulas, so you don't need to have an updated collection of formulas on those computers.

Next: Connections

See Also
Network calculations

Connections

In the Network tool window, you can create and manage connections to other computers running Ultra Fractal Server.



- The **Add Connection** button creates a new connection. This will open a dialog box where you can enter the address of the computer to connect to. To get help on a control in this dialog box, click the **?** button in the title bar, and then click the control.
- The **Delete Connection** button deletes the selected connection.
- The **status** icon before each connection shows its current status. Click on the icon to disable and enable the connection.
- In the list, the **titles** of the connections are displayed. Click on the title of the selected connection to rename it. Double-click a connection to edit its properties. You can drag connections up or down to organize them.
- Below the list, various **statistics** on the selected connection are displayed.

Right-click inside the list to open a pop-up menu with frequently used commands.

Next: Tips

See Also
Network calculations

Tips

The following tips will help you to use network calculations effectively.

- Network calculations work best with images that are slow to calculate. Especially deep-zoomed fractals will benefit. If the fractal calculates relatively quickly, the network communication overhead can sometimes outweigh the extra calculation speed.
- Large images do not necessarily benefit more from network calculations than small images.
- Connect to local computers rather than to computers on the Internet if you can help it, because the communication overhead is likely to be much smaller on a local network (LAN).
- If you can, avoid using a personal firewall because it might make the network calculations less efficient.
- Try to connect to remote computers that are roughly as fast as your own computer. It doesn't help much to connect to slower computers.

Next: Security

See Also
Network calculations
Network servers

Security

By default, a computer that runs Ultra Fractal Server accepts connections from any user on any computer. However, you have several options to restrict access to the server.

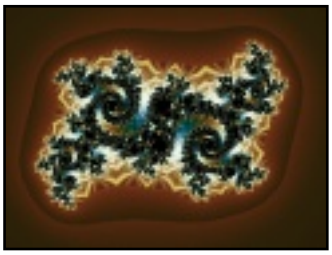
Click **Options** on the File menu of the server, and then click the Security tab to adjust the security options.

- You can restrict access to selected IP addresses or ranges of IP addresses. Using this feature, you can for example only allow users on your local network to connect to the server.
- You can require users to supply a password when creating a connection to the server. Users without a valid password will not be able to create a connection.

In the log at the bottom of the server window, you can see all connection activity. The log also shows incoming connections that were not accepted because of a blocked IP address or an invalid password. The log can also be written to a file so you can analyze it later.

See Also
Network calculations
Network servers

Writing formulas



In Ultra Fractal, every part of the fractal calculation process is controlled by formulas. There are three types of formulas: fractal formulas, coloring algorithms, and transformations. A formula can be seen as a small, specialized computer program that is compiled and executed by Ultra Fractal.

By writing your own formulas, you can completely customize how a fractal is calculated. It is recommended to first learn how to use Ultra Fractal and get comfortable with it before you start writing formulas.

This chapter explains how to write your own formulas. It is divided into four sections:

- The **Language** section introduces the syntax and elements of the formula language. You should study this first.
- The **Formulas** section shows how to use the formula language in practice to write fractal formulas, coloring algorithms, and transformations.
- The **Reference** section describes all operators, functions, predefined symbols, etc. that are available.
- The **Tips** section contains additional information on debugging and publishing your formulas.

Use the Contents tab to navigate to topics in these sections.

Next: Creating a new formula

See Also
Fractal formulas
Coloring algorithms
Transformations

Creating a new formula

This topic shows step by step how to create your first fractal formula, a basic Mandelbrot set.

1. Create a new fractal. It doesn't matter which formula is selected, since it will be replaced by your own.
2. Click **New** on the **File** menu, and then click **Fractal Formula File**. The formula editor appears with an empty file.
3. Click **New Formula** on the **Insert** menu. Enter "My Mandelbrot" as the title and click OK. The new entry should now appear in the formula editor.
4. After the init: label, insert the following line:
   ```
   z = 0
   ```
   This initializes the complex variable z to (0,0).
5. After the loop: label, insert the following line:
   ```
   z = z * z + #pixel
   ```
   This is the main equation for the Mandelbrot set. #pixel refers to the coordinates of the pixel being computed and will be different for every pixel. The statements in the loop section will be executed repeatedly.
6. After the bailout: label, insert the following line:
   ```
   |z| < 4
   ```
   This defines when Ultra Fractal should stop repeating (or iterating) the statements in the loop section. With this condition, the loop section will be iterated as long as |z| (equal to sqr(real(z)) + sqr(imag(z))) remains smaller than (4,0).
7. The formula should now look like this:

   ```
   MyMandelbrot {
   init:
     z = 0
   loop:
     z = z * z + #pixel
   bailout:
     |z| < 4
   default:
     title = "My Mandelbrot"
   }
   ```

8. Save the new formula by clicking **Save As** on the **File** menu. Enter "My Formulas.ufm" as the filename and click Save.
9. Now, click the **Browse** button in the Formula tab of the Layer Properties tool window. Select "My Mandelbrot" from the file "My Formulas" and click OK.
10. Congratulations! You've just created your first fractal formula.

Notes

- If compiling the formula results in compiler errors, make sure you've entered the formula correctly. Highlight the error in the Compiler Messages tool window and click the **Trace** button to see where the first error occurred. Correct the error and click the **Reload** button in the Formula tab to try again (changes in the formula will be saved automatically).
- Try to experiment with the loop section. For example, change z * z into z * z * z and see what happens. Click the **Reload** button in the Formula tab to reload the formula after you have changed it.

Next: Formula files and entries

See Also

Fractal formulas

Formula editors

Formula files and entries

Formula files are plain text files with the extensions .ufm (fractal formula files), .ucl (coloring algorithm files), or .uxf (transformation files). A formula file can contain any number of formulas (called entries).

Each entry starts with an entry identifier, followed by the contents of the entry between curly brackets { and }. After the entry identifier, an optional value between parentheses can be added. Examples:

```
My-Formula {
; entry contents
}

Mandelbrot(XAXIS) {
; this formula uses an optional setting
}
```

The entry identifier may consist of almost all characters, except spaces and tabs, of course. Since you can specify an additional descriptive title for the formula, the identifier can be cryptic as the user never notices it (but it is shown by the browser). The identifier is used to distinguish between formulas in the same file, so no two formulas in the same file can have the same identifier.

The semicolon ; is used to add comments to a formula. After a semicolon, the rest of the line is ignored by the compiler. You can also add global comments like copyright information to a file by placing them inside a special comments { } entry, which is also ignored (but the browser shows it when the file is selected).

To facilitate working with entries, the built-in formula editor can automatically create new entries and search for existing entries. See Formula editors.

Next: Sections

See Also
Creating a new formula
Fractal formulas

Sections

Each entry in a formula file is divided into one or more sections. It depends on the formula type which sections are supported and what they can contain. This topic describes sections in general. For specific information about a formula type, see Transformations, Fractal formulas, and Coloring algorithms.

Here's an example of a fractal formula:

```
Mandelbrot {
init:
  z = 0
loop:
  z = sqr(z) + #pixel
bailout:
  |z| < 4
default:
  title = "Mandelbrot set"
}
```

This formula contains four sections. There are three types of sections:

- Sections containing statements. These statements can be executed by Ultra Fractal; how and when this happens depends on the particular section. Each statement must be on a separate line, or they must be separated by commas. Examples of these sections are **init** and **loop**.
- Sections containing a boolean expression. There's only one section of this type, the **bailout** section.
- Sections containing settings related to the formula. Settings always have the form "setting = value". An example is the **default** section.

As you can see, sections are divided by labels. A label is just the name of the section followed by a colon.

For compatibility reasons, it is sometimes allowed to omit the label in some sections. For more information, see the formula-type specific documentation.

You can break long statements and settings across several lines using the backslash \ character. The backslash character must be the last character on the line for this to work. Any spaces or tab characters on the next line are removed, so if you want to add one or more spaces, you must put them on the previous line (the line containing the backslash). Example:

```
default:
  title = "A very long title \
          for my \
          favorite formula"
```

This is equal to:

```
default:
  title = "A very long title for my favorite formula"
```

Next: Expressions

See Also

Formula files and entries
Global sections

Expressions

To recap briefly, a formula is divided into multiple sections, separated by labels. Some sections (for example **init** and **loop**) can contain statements. Most statements are just expressions, and this topic explains what expressions really are.

Almost everything is an expression. Variables, parameters and constants are all expressions. By using operators or functions, expressions can be composed of one or two subexpressions. Examples:

```
a
3
3 + 2
sin(a)
(3 + sin(a)) / 2
```

These are all valid expressions (note that "a" is a variable). The important property of an expression is that you can always calculate its value, no matter how complicated the expression is. Moreover, you can do something with this value, for example assigning it to a variable by using the = (assignment) operator:

```
b = 3 + 2
b = (3 + sin(a)) / 2
```

These expressions are called assignments. It's important to realize that assignments are expressions themselves, so this is also a valid expression:

```
c = b = 3 + 2
```

This gives both c and b the value 5.

Now, remember that statements can be expressions, so that means any expression is a valid statement. Of course, it doesn't make sense to use expressions like "3" or "(3 + sin(a)) / 2" as statements, since nothing is done with the value of the expression, so the statement is ignored by the compiler (and results in a warning message). Only assignments actually use the value of the expression, therefore statements usually are assignments.

Note: don't confuse the = (assignment) operator with the == (equality) operator. The == operator is used to test if two expressions are equal, and returns a boolean value (**true** or **false**).

Next: Types

See Also
Sections
Operators
Functions

Types

To write formulas, you need to be aware of the concept of types. Expressions (constants, variables, parameters, etc.) in formulas can have different types. Ultra Fractal supports five types. The following table shows each type and explains it use.

bool — Boolean expressions can only have two values: **true** or **false**. This type is returned when expressions are compared:

```
3 < 4 ; true

false == true ; false
```

int — Integers are useful for counting. They can have values from -2147483648 to 2147483647. Most arithmetic operations can be performed on integers. Example:

```
3
-2
```

float — Floating-point numbers are the most familiar type of numbers. They can be very small or large, and have virtually unlimited precision (see Arbitrary precision). Their greatest benefit is that they can represent fractional values. Examples:

```
3.1
-2.9
1.3e7
```

complex — Complex expressions represent complex numbers. They consist of two floating-point numbers and are used to perform complex arithmetic, which is very useful for fractal calculations. Examples:

```
(2.8, 4)
2.8 + 4i
```

color — Color expressions represent a color. You can perform operations on colors and store them in color variables. Internally, a color is stored as four floating-point values, corresponding to red, green, blue, and alpha (opacity) components. Each value ranges from 0 to 1. Colors are intended only for direct coloring algorithms.

Next: Constants

See Also

Expressions
Type compatibility
Operators
Functions

Constants

Constants are used in formulas to specify fixed values. Example:

```
x = 3 * x + 4
```

Here, 3 and 4 are constants. This topic explains how constants are used in Ultra Fractal formulas, and how Ultra Fractal determines the type of a constant (you should be aware of this).

Boolean constants are of type bool. There are only two boolean constants: **true** and **false**.

Integer constants are of type int. Integer constants are signed numbers within the range -2147483648 .. 2147483647. Examples:

```
5
-23
```

Floating-point constants are of type float. They consist of a signed mantissa, optionally followed by the character E and a signed integer exponent to denote a power of ten. The exponent may range from -4931 to 4931. Examples:

```
3.0
-1.23482
98.283E-3  (= 0.098283)
-1e5       (= -100000)
```

Complex constants are of type complex. They consist of two floating-point numbers, separated by a comma and surrounded by parentheses. Alternatively, you can specify an imaginary number by typing the letter **i** right behind a normal floating-point number. Examples:

```
(2, 3)
(3e2, 3.239)  (= (300, 3.239))
2.3i          (= (0, 2.3))
2 + 1.63i     (= (2, 1.63))
```

Color constants are of type color. They are created by supplying the rgb, rgba, hsl, and hsla functions with constant arguments. Examples:

```
rgb(0.5, 1, 0)        (= orange)
hsla(0, 0, 0.5, 0.5)  (= transparent red)
```

Next: Variables

See Also
Expressions
Types

Variables

Formulas are often composed of several separate calculations. Therefore, it is necessary to store intermediate results in memory. To do this, you must use variables.

Identifiers are used to refer to variables. An identifier must start with a letter, followed by one or more letters, digits or the underscore character "_". Here are some examples of valid identifiers:

```
x
MyOwnVariable
var_32
```

It doesn't matter if the letters are lower- or uppercase, so "myvar" and "MyVar" represent the same variable. Some identifiers (called keywords) are reserved by the compiler for other purposes: you can't use them as variables.

Before you can read from a variable, you must first write to it. To do this, use the = (assignment) operator:

```
x = 3
y = 3 + 28 / 7
```

The variable is created when it is first written to. By default, the type of the variable is complex, but you can change that by placing a type keyword (bool, int, float or complex) in front of the assignment. Alternatively, you can declare the variable before using it.

```
int i
i = 2
int x = 3
bool MyBooleanVariable = x > 3
```

Assignments are expressions themselves, so their result can be assigned again. This example gives both x and y the value 1:

```
x = y = 1
```

To read from a variable, use the identifier in an expression. This example reads the value in x and stores it in y:

```
y = x
```

Of course, you can also perform calculations when doing this:

```
y = x * 3 + 7
```

Next: Parameters

See Also

Parameters

Parameters are used to allow users to customize formulas without needing to rewrite them. Parameters are used just like variables, with two exceptions: you can't write to them, and you must prefix them with the @ character (so the compiler can determine they are parameters instead of variables). Here's an example of parameters:

```
Mandelbrot {
init:
  z = 0
loop:
  z = z^@power + #pixel
bailout:
  |z| < 4
}
```

The parameter used here is @power. In the Formula tab, the user can now enter a value for this parameter and view the Mandelbrot set of any power using just one formula.

By default, the type of a parameter is complex. You can change that by adding a param block to the **default** section of your formula and providing the necessary settings. Using the param block, you can also specify enumerated parameters. With enumerated parameters, the user doesn't have to enter a numerical value, but rather chooses an item from a drop-down list.

It's also possible to use user functions. These can be used just like normal functions, with the exception that the user can choose the actual function from a list of all available functions. Here's an example of user functions:

```
Mandelbrot {
init:
  z = 0
loop:
  z = @myfunc(z) + #pixel
bailout:
  |z| < 4
}
```

Now, the user can use **sqr**, but also **sin** and **cos** and many other functions with this formula. You can customize the behavior of the user function using the func block in the **default** section.

Notes

- It is possible to write to parameters, although this is not recommended and can make your formulas run slower. It is provided for compatibility with old Fractint formulas.
- There are six predefined parameters: p1..p6, and four predefined functions: fn1..fn4. You don't need to use the @ prefix with these parameters and user functions. However, it's recommended to use your own names instead of these (with the @ prefix) to make your formulas easier to understand.
- The param and func blocks also provide settings for changing the caption, default, minimum and maximum values of parameters and user functions, as well as adding a small help text.
- Parameters are sorted alphabetically in the user interface, unless you provide a param block

for each parameter. In this case, the parameters appear in the order of the param blocks in the formula file.

- In the user interface, you can also group parameters together by adding headings.

Next: Arrays

See Also

Providing help and hints

Writing direct coloring algorithms

Arrays

Arrays are used to store multiple variables in an organized way. Before you can use an array, you must declare it. Example:

```
int myArray[8]
```

This declares an array called myArray with 8 elements. You can use the elements in the array like normal variables:

```
myArray[0] = 1
myArray[myArray[0]] = 2 * myArray[0] + 1
```

You access an element in an array by specifying the index of the element between square brackets [ ]. The index must be an integer expression, ranging from 0 to the number of elements - 1 (the value 0 corresponds to the first element in the array).

You can also declare and use multi-dimensional arrays by specifying multiple values between the brackets. When declaring an array, the size of each dimension must be a constant integer expression. Parameters and most predefined symbols also qualify as constants. Example:

```
float a[10, 2 * 6 - 2]
bool flags[#width, #height]
a[3, 5 - 3] = 1.5
flags[0, 0] = a[1 + 2, 2] > 0
```

You can directly assign arrays with the same size to one another:

```
color x[10]
color y[10]
x = y
```

Notes

- You will often use loops to iterate through the elements of an array.
- Arrays are often filled with pre-calculated values in the global section to speed up calculations.
- If you use constant array indices outside the supported bounds, the compiler will produce an error message. If you use expressions that evaluate to an invalid index value while the formula is executed, a run-time message is written to the Compiler Messages tool window if the **debug** compiler directive is defined. See Compiler directives.
- If you assign arrays to one another that are incompatible and the size of the arrays is unknown at compile time, a run-time message occurs, too.

Next: Type compatibility

See Also
Types
Variables

Type compatibility

As explained in Types, every expression has a type. If an expression is a variable, a constant or a parameter, its type is equal to the type of the variable, constant or parameter, of course. This topic explains what happens if an expression is composed of two subexpressions with different types.

Consider this example:

```
3 + 2.1
```

The type of "3" is int, and the type of "2.1" is float. The type of the resulting expression is always the "highest" type of the subexpressions. High means "most descriptive" here. For example, **complex** is higher than **float**, which is in turn higher than **int** (boolean expressions are treated differently). So, this means the type of the expression above must be float. Since its result should be 5.1, this behaves as you would expect.

This means, however, that "3", a constant of type int, must be converted to "3.0", a constant of type float. This conversion is performed automatically by the compiler. You should be aware of the fact that the compiler can only convert types to higher types. For example, it cannot convert a float to an int. So this statement is illegal and results in an error message:

```
int i = 3.1
```

Functions like round and real are available to perform these conversions manually, if this is necessary.

Be aware of the fact that some operators and most functions always return float or complex values. For example, this statement is illegal, since the division operator / cannot return an integer result (it returns 1.5):

```
int i = 3/2
```

You can look up the behavior of all operators and functions in the Reference section.

The compiler can convert booleans to other types and vice versa, but it does generate a warning for each conversion. The value **true** is converted to 1, and the **value** false to 0. An expression of another type (int, float or complex) is converted to **false** if it is equal to 0, otherwise it is converted to **true**. Please note that this is only supported for compatibility with old Fractint formulas. It is not recommended to use this in new formulas.

Colors cannot be converted automatically. Use the rgb, rgba, hsl, and hsla functions to convert floating-point values to colors. Use red, green, blue, hue, sat, lum, and alpha to convert colors to floating-point values.

Next: Conditionals

See Also
Expressions
Variables

Conditionals

This topic describes the **if** statement. The **if** statement is used to write pieces of code that should only be executed under certain circumstances (conditions). Here's an example:

```
if a > 3
  b = 2
else
  b = 1
  a = 2
endif
```

In this code snippet, b is given the value 2 when a is greater than 3, otherwise b is given the value 1, and a is given the value 2.

Here is the complete syntax of the **if** statement:

```
if <boolean-expression>
  <statements>
[elseif <boolean-expression>
  <statements>]
[else
  <statements>]
endif
```

The parts between brackets [ ] are optional. There can be as many **elseif** blocks as you find useful. Here is an example which finds the largest of three variables a, b and c and places it in x:

```
if a > b && a > c
  x = a
elseif b > c
  x = b
else
  x = c
endif
```

The usage of **elseif** is not really necessary. The following example does exactly the same thing:

```
if a > b && a > c
  x = a
else
  if b > c
    x = b
  else
    x = c
  endif
endif
```

This example uses a nested **if** statement (an **if** statement within another **if** statement). **If** statements may be nested as much as you want.

Notes

- In Fractint, it is necessary to surround the boolean expressions after if and elseif with parentheses. Ultra Fractal doesn't require this, but it isn't harmful.
- For more information on boolean operators like &&, see Operators in the Reference section.

Next: Loops

See Also
Expressions
Types

Loops

Sometimes you may want to repeat a sequence of statements. Ultra Fractal provides two constructs to do this: the **while** loop and the **repeat** loop. Here is the syntax:

```
while <boolean-expression>
  <statements>
endwhile

repeat
  <statements>
until <boolean-expression>
```

The **while** loop repeats the statements as long as the boolean expression is **true**. If the boolean expression is or becomes **false**, the statements are never or no longer executed. The **repeat** loop, however, repeats the statements until the boolean expression becomes **true**. This means that the statements are always executed at least once.

If you want the statements to be executed at least once, use the **repeat** loop. Otherwise, use the **while** loop.

Here's an example that calculates x = n! (defined as x = 1*2*3*...*(n-2)*(n-1)*n), first using a **while** loop, and then using a **repeat** loop:

```
int n = 23 ; or another value
float x = 1 ; float because 23! is very large
while (n > 1)
  x = x * n
  n = n - 1
endwhile

int n = 23
float x = 1
if n > 1
  repeat
    x = x * n
    n = n - 1
  until n == 1
endif
```

Obviously, the **while** loop is better suited to calculate the factorial of a number, but in other cases the **repeat** loop may be better.

As with **if** statements, loops may be nested as much as you want.

Next: Transformations

See Also

Writing transformations

Transformations are put in transformation files with the .uxf extension. They can have the following sections, in this order:

- **global**
- **transform**
- **default**

If a transformation doesn't start with a label, it's assumed to start with the **transform** section. The optional setting within parentheses after the entry identifier is ignored.

The **global** section is executed only once per image and can be used to fill look-up tables and initialize read-only variables. See Global sections.

The **transform** section contains one or more statements. The purpose of these statements is to take the predefined symbol #pixel, which contains the coordinates of the pixel currently being calculated, transform it and put the result back in #pixel. They can also set the predefined boolean symbol #solid to **true** to give the pixel a solid color instead of calculating it. This solid color is adjustable on the Mapping tab of the Layer Properties tool window.

The **default** section can contain the following settings:

- helpfile
- helptopic
- precision
- render
- title

It can also contain one or more parameter blocks.

Next: Writing fractal formulas

See Also
Writing formulas
Transformations

Writing fractal formulas

Fractal formulas are put in fractal formula files with the .ufm extension. They can have the following sections, in this order:

- **global**
- **builtin**
- **init**
- **loop**
- **bailout**
- **default**
- **switch**

If a fractal formula doesn't start with a label, it's assumed to start with the **init** section. If a fractal formula contains an empty label (a single colon), it's assumed to start the **loop** section, and in this case, the last statement in the **loop** section is assumed to be the boolean expression from the **bailout** section (so the formula should not contain a separate **bailout** section). This ensures compatibility with old Fractint formula. It's not recommended to use this when writing new formulas, though.

The optional setting within parentheses after the entry identifier specifies the symmetry of the fractal formula. See Symmetry.

The **global** section is executed only once per image and can be used to fill look-up tables and initialize read-only variables. See Global sections.

The **builtin** section is used for accessing built-in fractal formulas. If this section is used, the **global**, **init**, **loop**, and **bailout** sections are not allowed. The **builtin** section can contain the following settings:

- type

The **init** section is executed only once per pixel, and is useful for initializing variables.

The **loop** section is executed once per iteration. It should update the value of the predefined complex variable z (you can also write #z) using the old value of z.

The **bailout** section contains a single boolean expression. The **loop** section is repeated as long as this expression evaluates to **true** (but it is always executed at least once).

The **default** section can contain the following settings:

- angle
- center
- helpfile
- helptopic
- magn
- maxiter
- method
- periodicity
- precision
- render

- skew
- stretch
- title

It can also contain one or more parameter blocks.

The **switch** section is used to implement switching from one formula type to another (for example from Mandelbrot to Julia). See Switch feature.

Next: Writing coloring algorithms

See Also
Writing formulas
Fractal formulas

Writing coloring algorithms

Coloring algorithms are put in coloring algorithm files with the .ucl extension. They can have the following sections, in this order:

- **global**
- **init**
- **loop**
- **final**
- **default**

If a coloring algorithm doesn't start with a label, it's assumed to start with the **final** section (in that case, the **init** and **loop** sections are not allowed).

The optional setting within parentheses after the entry identifier specifies whether the coloring algorithm can be used for inside coloring, outside coloring, or both. The possible values are:

INSIDE	The coloring algorithm is only intended for coloring the inside of a fractal.
OUTSIDE	The coloring algorithm is only intended for coloring the outside of a fractal.

If the setting is omitted, or has another value, the coloring algorithm is supposed to be useful for both inside and outside coloring. See also Inside and outside.

The **global** section is executed only once per image and can be used to fill look-up tables and initialize read-only variables. See Global sections.

The **init** section is executed only once per pixel, and is useful for initializing variables.

The **loop** section is executed once per iteration, right after the **loop** section of the fractal formula has been executed. It can read the current value of #z and perform some calculations on it.

The **final** section is executed afterwards to determine the actual index into the gradient (this index is further transformed by the various settings on the Inside or Outside tabs). The index is a float value and should be written to the predefined symbol #index. If the settings on the Inside or Outside tab are set to their default values (Density = 1, Transfer = Normal and Offset = 0), the entire gradient range corresponds to the range 0..1 of the index value.

To create a direct coloring algorithm, use the predefined symbol #color instead of #index.

It's also possible to set the predefined symbol #solid to **true**: this gives the pixel the solid color set in the Inside or Outside tab.

The **default** section can contain the following settings:

- helpfile
- helptopic
- precision
- render
- title

It can also contain one or more parameter blocks.

Next: Writing direct coloring algorithms

See Also
Writing formulas
Coloring algorithms

Writing direct coloring algorithms

Direct coloring algorithms directly output a color instead of an index value. So, they assign a value to the #color predefined symbol instead of to #index.

To compute this color, you can use color expressions, color variables, and color arithmetic. The following arithmetic operations are available:

c1 + c2	Returns a color where each component is the sum of the respective components from c1 and c2. So, red(c1 + c2) is equal to red(c1) + red(c2).
c1 - c2	Subtracts the color components in c2 from the respective color components in c1. So, red(c1 - c2) is equal to red(c1) - red(c2).
c * f	Multiplies each component of c with a float value. So, red(c * f) is equal to red(c) * f. **Note**: the float value must be at the righthand side of the * operator.
c / f	Divides each component of c by a float value. So, red(c / f) is equal to red(c) / f.

For example, to calculate the average of two colors, use (c1 + c2) / 2. Be aware of the fact that the alpha value is treated just like the other components. So, c / 2 will not only darken a color, it will also make it more transparent.

The following conversion functions are available:

- rgb
- rgba
- hsl
- hsla
- red
- green
- blue
- hue
- sat
- lum
- alpha

There are some functions for blending and retrieving gradient colors:

- gradient
- blend
- compose

There are also functions to reproduce all layer merge modes. They're called **mergeX**, where **X** stands for the name of the merge mode. See Merging functions.

You can use color parameters to let user specify a color. You can also use special user functions that allow a user to select a merge mode. See Parameter blocks.

Next: Global sections

See Also
Writing coloring algorithms

Direct coloring algorithms

Global sections

Sometimes, initializing variables of a formula can require a large amount of calculations. Since you would normally initialize variables in the **init** section of a fractal formula or a coloring algorithm (or the **transform** section of a transformation), these calculations are performed again and again for every pixel.

Often, they only depend on parameter settings, and therefore the results are the same for every pixel. To avoid doing many repeated calculations, you can move them to the **global** section. This is a special section at the start of a formula that is executed once per image.

Use the global section to perform per-image calculations and store the results in variables that can be read in other sections. Variables declared here are treated as read-only in other sections, so you cannot use this to share variables across pixels (that would be unreliable).

In the following example, the global section is used to pre-calculate an array of random values that is the same for every pixel. These random values are subsequently used to disturb a standard Mandelbrot set.

```
MandelbrotModified {
global:
  float values[#maxiter]
  int i = 0
  int seed = 12345678
  while i < 100
    seed = random(seed)
    values[i] = seed / #randomrange
    i = i + 1
  endwhile
init:
  z = (0,0)
  int iter = 0 ; "i" is already taken
loop:
  z = sqr(z) + #pixel + values[iter]
  iter = iter + 1
bailout:
  |z| <= 4
}
```

Notes

- Global sections are often combined with arrays to compute look-up tables that can speed up the formula tremendously.
- You can even declare an array equal to the size of the image (with the #width and #height predefined symbols) and calculate the entire fractal in the global section of a coloring algorithm. The **final** section is then used only to return colors or index values from this array. This enables you to implement fractal types like IFS that are not natively supported by Ultra Fractal. This technique does have some limitations: it can require a fair amount of memory and the progress of the calculation is not reported. It is very slow and memory-intensive with rendering to disk, especially with anti-aliasing, and it doesn't work well with

network calculations either. See also render setting.

Next: Random values

See Also
Arrays
Sections

Random values

Some formulas need to calculate random values. Ultra Fractal offers two ways of obtaining pseudo-random values.

The predefined symbol #random returns a new complex random number for every pixel. This exists primarily for compatibility with old Fractint formulas.

The preferred way of obtaining a random value is the random function. This function accepts an integer seed and returns a new random seed. To generate a series of random numbers, you should call the function repeatedly, each time supplying the seed returned by the previous call. Example:

```
int seed = 123456789 ; initial value
seed = random(seed)
; seed is now the first random number
seed = random(seed)
; seed is now the second random number
```

To obtain a random floating-point number between 0 and 1, divide abs(seed) by the predefined symbol #randomrange. To obtain a random integer between 0 and n - 1, use abs(seed) % n.

You can generate multiple independent, reproducible series of random numbers just by declaring and using multiple seeds. The random function will always return the same result for the same seed value.

Next: Symmetry

See Also
Global sections

Symmetry

Some fractal formulas always create images that are symmetric. Ultra Fractal can take advantage of the symmetry to speed up the calculation. To enable this, you must specify the symmetry of the formula as the optional setting between parentheses right after the entry identifier. Example:

```
Mandelbrot(XAXIS) {
  ...
}
```

This formula is symmetric around the horizontal x-axis, therefore it uses the XAXIS setting. This table lists all possible values for the symmetry setting:

XAXIS	Forces symmetry around the horizontal x-axis, or the real axis.
YAXIS	Forces symmetry around the vertical y-axis, or the imaginary axis.
XYAXIS	Forces symmetry around both the horizontal and the vertical axes.
ORIGIN	Forces rotational symmetry around the origin. This is useful for Julia sets.
PI	Not implemented.

You can append **_NOPARM** to all values (thus obtaining **XAXIS_NOPARM**, etc) to make sure symmetry is only applied when all complex parameters are set to (0, 0). The XAXIS setting also allows the suffixes **_NOREAL** and **_NOIMAG** to disable symmetry for non-zero real and imaginary parts of all complex parameters.

Notes

- Symmetry is always disabled if the rotation angle set in the Location tab is not zero, or if a coloring algorithm that reads the value of #z is selected.
- It is not recommended and not reliable to use this to enforce symmetry that doesn't exist in the formula. It is only intended as a speed-up for formulas that naturally exhibit symmetry.

Next: Switch feature

See Also

Writing fractal formulas
Formula files and entries

Switch feature

The switch feature allows you to switch easily between related fractal types. One fractal type can be used as a map for another. This is very useful, since Mandelbrot sets, for example, are in fact maps of the corresponding Julia sets.

To use the switch feature with your own formulas, you must include the **switch** section as the last section in your fractal formula. Here is an example of a typical Mandelbrot formula using the **switch** section:

```
Mandelbrot {
init:
  z = 0
loop:
  z = sqr(z) + #pixel
bailout:
  |z| < @bailout
switch:
  type = "Julia"
  seed = #pixel
  bailout = bailout
}
```

The type setting specifies the identifier of the formula (in the same file) to switch to. The other settings can copy parameters and the pixel value from the source formula to the destination formula (the formula Ultra Fractal is switching to). The #pixel symbol returns the coordinates of the point in the fractal window where the user clicked to initiate the switch.

When switching, Ultra Fractal now loads the Julia formula, and tries to find the parameters **seed** and **bailout** in the Julia formula. If these parameters can be found, they are set to the pixel value and the bailout of the Mandelbrot formula. Otherwise, the settings are ignored.

So, you need to take the following steps to use the switch feature:

1. Append the **switch** section to the end of your formula.
2. Insert the type setting and use the entry identifier of the formula you want to switch to as the setting value, enclosed in double quotes (like all string values).
3. Insert the setting "destination-parameter = #pixel" to let the switch feature be dependent on the point where the user clicked inside the fractal window. If you want, you can use this setting more than once, or just leave it out. The parameter in the destination formula must be complex, otherwise this setting is ignored.
4. Optionally, insert additional settings "destination-parameter = source-parameter" to copy other parameters from the source formula to the destination formula. Be sure that the types of the source and destination parameters are the same; otherwise, the setting is ignored. Parameters not explicitly copied here are set to the default values.

Here's an example of a Julia formula that could be used with the Mandelbrot formula shown above. Note that the Julia formula allows you to switch back to the Mandelbrot formula (of course without using the pixel value).

```
Julia {
init:
```

```
  z = #pixel
loop:
  z = sqr(z) + @seed
bailout:
  |z| < @bailout
switch:
  type = "Mandelbrot"
  bailout = bailout
}
```

Next: Providing help and hints

See Also
Writing fractal formulas
Switch mode

Providing help and hints

To make your formulas easier to use, you might want to add help. There are two ways to provide help for formulas.

The easiest way to add help to your formula is to provide hints for all parameters. A hint is a small explanatory message that is shown when the user clicks the **?** button in the title bar of the Layer Properties tool window, and then clicks the parameter.

- To add a hint to a parameter, use the hint setting in the parameter block.

Although parameter hints are certainly helpful, they cannot provide an overview of the purpose and intended use of the formula. To overcome this, you can create a separate help file and specify its name and location in the formula file so Ultra Fractal can open it.

Ultra Fractal supports help in HTML files, in Windows Help files (*.hlp), and in Windows HTML Help files (*.chm). These help files are usually installed in the **Help on Formulas** folder. By default, its location is "My Documents\Ultra Fractal 3\Help on Formulas", but you can change this in the Folders tab of the Options dialog.

- To link a formula to an external help file, use the helpfile and helptopic settings in the **default** section.

Ultra Fractal launches the help file when the user clicks the **More** button in the Layer Properties tool window, and then clicks **Help**.

Next: Debugging

See Also
Publishing your formulas
Parameter blocks

Debugging

When you're writing complex formulas, it is likely that they will not immediately function as intended. Although the compiler tries to catch most of the common mistakes and reports them as errors or warnings, some mistakes will go unnoticed until you try the formula.

The process of trying a formula and correcting it until it works is called **debugging**, because you're essentially removing bugs (programming mistakes). To debug a formula, you use run-time messages.

Run-time messages can be generated by a formula while it is executed. They appear in the Compiler Messages tool window, where you can examine them.

To enable run-time messages, define the **DEBUG** symbol. Run-time messages are caused by an array index that is out of bounds, an assignment of incompatible arrays, or by the print function. Here's an example:

```
int a[4]
int i = 5
a[i] = 4                ; out of bounds, no run-time message
print("Hello?")         ; ignored
$define DEBUG
a[i] = 3                ; out of bounds, causes run-time message
print("Hello, world")   ; causes run-time message
```

Use the print function to examine the values of variables while the formula is executed, so you can understand why it's not working properly.

By not defining the **DEBUG** symbol, run-time messages are not generated. When you're publishing a formula, you should make sure the **DEBUG** symbol is not defined, since the users of your formula will probably not appreciate the run-time messages.

Next: Optimizations

See Also
print function
Compiler directives

Optimizations

The compiler performs optimizations to make sure that all formulas run as fast as possible. It is helpful to know something about these optimizations when writing formulas.

The optimizations can be divided into two categories:

- Evaluation of constant expressions. Constant expressions are expressions whose value can be evaluated by the compiler. Constant expressions can contain operators, functions, constants and parameters. This is possible because the formula is re-compiled each time a parameter changes, so parameters can be treated as constants by the compiler.
- Replacement of slow operations by faster ones, such as replacing 2*x by x+x (adding is faster than multiplying).

When writing formulas, this has the following consequences:

- Writing to parameters is not recommended. This can make the formula run slower, because parameters cannot be treated as constants anymore.
- You can write constant expressions wherever you want. You don't have to precalculate them, because the compiler can do that for you. So, using 2 + 1/3 is just as fast as using 2.3333. Just use whatever you find most convenient.
- **If** statements with constant expressions (like **if** 3 < 2) are completely eliminated by the compiler. This is very helpful when you use lots of **if** statements depending on the values of enumerated parameters. Therefore making your formula versatile by providing many options doesn't make it run any slower.
- You can use descriptive operators like z^4 instead of z*z*z*z or sqr(sqr(z)), since Ultra Fractal automatically chooses the most efficient operation independent of the operators or functions used.

Next: Compatibility

See Also
Conditionals

Compatibility

Ultra Fractal 3 accepts almost all formulas written for Ultra Fractal 2. There are some minor differences:

- There are a three new keywords: **color**, **heading**, and **endheading**. Variables with these names will have to be renamed. Parameters with these names should not be renamed to avoid breaking backwards compatibility. Instead, add a @ character to the parameter name in the parameter block that describes it, so the compiler will recognize it as a parameter, not as a keyword. For example, "param color" should be changed to "param @color".
- Some formulas might not run well with double precision (Ultra Fractal 2 always uses extended precision). In this case, either correct the formula, or adjust the **Additional Precision** value in the Formula tab of the Layer Properties tool window so extended precision is used. You can verify this in the Statistics tool window. Also see Arbitrary precision.
- Functions that can return complex values with float arguments are treated differently. If the return value is assigned to a complex variable, the float argument is converted to complex and the complex version of the function is called instead of the float version. This fixes a number of bugs like:

  ```
  complex c = sqrt(-1) ; should be (0, 1)
  ```

  Unfortunately, sometimes it breaks backwards compatibility because Ultra Fractal 2 would assign an invalid value to c in this case. To work around this, use:

  ```
  float f = sqrt(-1)

      complex c = f
  ```

The formula compiler is largely compatible with Fractint's parser and most Fractint formulas can be used right away. There are a few exceptions, however:

- Writing to parameters is not recommended, since Ultra Fractal can perform special optimizations when parameters are read-only. Formulas writing to parameters will be accepted, though.
- Writing to predefined symbols that are read-only, such as #pixel, is not allowed. Formulas writing to these predefined symbols will not be accepted.
- Formulas using the predefined symbol LastSqr will not be accepted. The usage of LastSqr serves no purpose; it is intended as a speed-up but it only makes formulas run slower (even in Fractint). Furthermore it makes formulas very hard to write and to understand.
- Formulas using the function cosxx will not be accepted either. This function results from an early version of Fractint which contained a bug in the cos function. The cosxx function allows you to reproduce this bug in later versions of Fractint. If you still want to use the cosxx function, you can write conj(cos(a)) instead of cosxx(a).
- In Fractint, functions with invalid arguments often return other values than in Ultra Fractal. For example. log(0) returns 0 in Fractint, but it returns -infinity in Ultra Fractal. This can cause problems. In general, if a Fractint formula gives a blank screen instead of a fractal, you should check the formula for this kind of errors (log(0), division by zero, recip(0), etc).
- Fractint iterates fractal formulas not the number of times given by the maximum iterations value, but one time less. Ultra Fractal does iterate fractal formulas the number of times given by the maximum iterations value. The Fractint PAR import feature in Ultra Fractal takes this into account and subtracts one from the maximum iterations value used by Fractint.

Generally, formulas that depend on the forgiving behaviour of Fractint's parser will not be accepted.

Often Fractint accepts formulas that contain syntax errors and it will still produce a picture. Ultra Fractal will refuse to load such formulas. This is useful, because it helps you to write clear and understandable formulas, and it might point you in the direction of possible errors.

Next: Execution sequence

See Also
Invalid operations

Execution sequence

To help you understand the way Ultra Fractal executes the various sections in all formula types, here is an overview of the execution sequence per pixel, written in pseudo-code similar to the formula language.

Before calculating the image, the global sections are executed:

```
for each transformation
  execute global section of transformation
execute global section of fractal formula
execute global section of inside coloring algorithm
execute global section of outside coloring algorithm
```

Then, for each pixel, the following calculations are performed:

```
for each transformation
  #solid = false
  execute transform section of transformation
  if #solid == true
    stop and give pixel the solid mapping color
endfor
execute init section of fractal formula
execute init section of inside coloring algorithm (if it exists)
execute init section of outside coloring algorithm (if it exists)
int iter = 0
repeat
  execute loop section of fractal formula
  bool b = the expression in the bailout section of the fractal formula
  if b == true
    ; not yet bailed out
    execute loop section of inside coloring algorithm (if it exists)
    execute loop section of outside coloring algorithm (if it exists)
  endif
  iter = iter + 1
until (b == false) || (iter == #maxiter)
#numiter = iter
if #numiter == #maxiter
  ; pixel is inside
  execute final section of the inside coloring algorithm
else
  ; pixel is outside
  execute final section of the outside coloring algorithm
color the pixel
```

Next: Invalid operations

See Also

Writing transformations
Writing fractal formulas
Writing coloring algorithms
Global sections

Invalid operations

Formulas can easily perform invalid operations, such as dividing by zero. Rather than showing an error message when an invalid operation occurs, Ultra Fractal just ignores the error and calculates further. This means that the resulting image can be unpredictable if you don't pay proper attention to these special cases.

Invalid operations include dividing by zero (also with the % operator), and using functions with invalid arguments. The range of valid arguments for a function is always discussed (if there are invalid values) in the description of the function. It doesn't hurt to use arguments outside the valid range, as long as you remember that the results may be unpredictable.

If you are using loops, you should avoid writing infinite loops at all times. An infinite loop is a loop which repeats forever, without stopping. Here is are two examples:

```
while true
  ...
endwhile
repeat
  ...
until false
```

You must make sure that the loop is exited at some time. This means that the condition in a while loop should eventually become false, and that the condition in a repeat loop should eventually become true.

If, for some reason, the formula still enters an infinite loop, the fractal window will remain black and no pixels will be calculated at all because the formula is still busy to calculate the first pixel (which will never be finished). Ultra Fractal is still able to terminate an infinite loop. Just close the fractal window, or select another formula.

Next: Publishing your formulas

See Also
Debugging

Publishing your formulas

When you've written a new formula, you might want to publish it, so other people can use it as well. You can publish it using the online formula database at formulas.ultrafractal.com.

Before publishing your formula, take a step back and ask yourself the following questions:

- Does your new formula add something that is not already available in the formula database? In other words, is it worth trying for other people?
- Have you carefully considered all parameters and the effect that they have? Usually, formulas with fewer parameters are more effective and easier to use. Don't add extra parameters just because they look interesting.
- Have you added help and hints to make your formula easier to use?

In general, you should take responsibility for the formulas that you publish. For complex formulas, you might want to have them beta-tested by a small group of people first. Consider that it might not be possible to fix problems later without breaking compatibility with parameter sets produced by earlier versions.

When you are revising and improving your formula files, make sure that you don't break backwards compatibility either. Here are some guidelines to help you:

- Don't give the formula a different entry identifier, unless you know what you're doing. Parameter files reference the formula by its identifier, so they cannot be restored anymore if the identifier has been changed. You can always change the title of the formula, of course.
- Don't change the identifiers of existing parameters in your formula, since parameter sets reference parameters in a formula by their identifiers. Instead, change their captions.
- When using enumerated parameters, don't change the names of the existing items. It's possible though to change their order and add new items without breaking existing parameter sets.

See Also
Public formulas
Compatibility

General keyboard shortcuts

The following general keyboard shortcuts apply to any document window in Ultra Fractal, and some can also be used when no document window is open at all.

Shortcut	Menu command	Description
Ctrl+N	File|New|Fractal	Creates a new fractal window.
Ctrl+O	File|Open	Opens an existing document file.
Ctrl+B	File|Browse	Opens a new browser window to open and organize your documents.
Ctrl+D	File|Duplicate	Duplicates the active document window.
Ctrl+S	File|Save	Saves the active document.
F11	-	Toggles keyboard focus between the active document window and the tool windows.
Ctrl+F11 Shift+Ctrl+F11	-	Moves keyboard focus between the tool windows.
Shift+F2..F9	Window|Tool Windows	Shows and hides a tool window.
F12	Options|Tool Windows	Shows and hides all tool windows.
F1	Help|Help	Shows context-sensitive help.
Shift+F1	Help|Contents	Shows the help table of contents.
Ctrl+F1	Help|Index	Shows the help index.

Next: Keyboard shortcuts for fractal windows

See Also
Workspace

Keyboard shortcuts for fractal windows

The following keyboard shortcuts apply to fractal windows:

Shortcut	Menu command	Description
Ctrl+A	File|Save Parameters	Saves a parameter set describing the fractal. See Parameter files.
Ctrl+E	File|Export Image	Exports the fractal as an image. See Exporting and rendering.
Ctrl+Z	Edit|Undo	Undoes the last action. See Fractal history.
Ctrl+Y	Edit|Redo	Cancels the last Undo command.
Ctrl+C	Edit|Copy	Copies the parameters of the fractal to the Clipboard. See Copying and pasting.
Ctrl+V	Edit|Paste	Pastes the contents of the Clipboard into the fractal.
F4	Fractal|Gradient	Shows the gradient editor to edit the colors of the fractal.
F9	Fractal|Zoom In	Zooms in to the center.
F10	Fractal|Zoom Out	Zooms out of the center.
Ctrl+F	Fractal|Full Screen	Shows the fractal in full-screen mode.
F5	Fractal|Normal Mode	Selects Normal mode for zooming, panning, and rotating by dragging the mouse.
F6	Fractal|Select Mode	Selects Select mode for zooming using a zoom box.
F7	Fractal|Switch Mode	Selects Switch mode for switching to a related fractal type.
Ctrl+R	Fractal|Render to Disk	Adds the fractal to the queue of render jobs. See Rendering images.
Ctrl+1..4	Right-click, Gradient|Randomize	Randomizes the gradient of the active layer.
Ctrl+Q	Right-click, Gradient|Adjust Colors	Adjusts the colors of the active layer.
Ctrl+] Ctrl+[	Right-click, Gradient|Cycle Colors	Cycles the colors in the active layer.

Next: Keyboard shortcuts in Select mode

See Also

General keyboard shortcuts
Fractal windows

Keyboard shortcuts in Select mode

The following keyboard shortcuts can be used in a fractal window when Select mode is active:

Shortcut	Description
Cursor left/right/up/down	Moves the selection box.
Shift+cursor up/down Delete/Insert	Stretches the selection box.
Page Up	Shrinks the selection box.
Page Down	Enlarges the selection box.
Numeric keypad -/+	Rotates the selection box.
Home/End	Skews the selection box.
Enter	Zooms in.
Ctrl+Enter	Zooms out.
Esc	Cancels Select mode.

Hold down the Ctrl key for fine adjustments.

Next: Keyboard shortcuts for gradient editors

See Also
Keyboard shortcuts for fractal windows
Fractal windows

Keyboard shortcuts for gradient editors

The following keyboard shortcuts apply to gradient editors:

Shortcut	Menu command	Description
Ctrl+R	File|Replace	Opens an existing gradient, replacing the current gradient.
Ctrl+Z	Edit|Undo	Undoes the last action.
Ctrl+Y	Edit|Redo	Cancels the last Undo command.
Ctrl+C	Edit|Copy	Copies the gradient to the Clipboard.
Ctrl+V	Edit|Paste	Pastes the contents of the Clipboard into the gradient.
Ins	Edit|Insert	Inserts a new control point.
Ctrl+Del	Edit|Delete	Deletes the selected control points.
Ctrl+A	Edit|Select All	Selects all control points.
F3	Gradient|Fractal	Shows the fractal window that owns the gradient editor.
F2	Gradient|Color	Activates the color bars.
Ctrl+F2	Gradient|Opacity	Activates the opacity bar.
Ctrl+L	Gradient|Link Color and Opacity	Links or unlinks the color and opacity bars. See Transparent gradients.
F5..F8	Gradient|Randomize	Randomizes the gradient.
Ctrl+J	Gradient|Adjust Colors	Adjusts the color balance and brightness of the gradient. See Adjusting gradients.
Ctrl+Enter	Right-click, Select Color	Selects the color of the selected control points.
Ctrl+Left	-	Selects the previous control point.
Ctrl+Right	-	Selects the next control point.

Hold down Ctrl while clicking in the gradient editor to add a new control point. When dragging control points, hold down Shift to constrain the movement to horizontal or vertical only.

Next: Keyboard shortcuts for the Layer Properties tool window

See Also
General keyboard shortcuts
Gradients

Keyboard shortcuts for the Layer Properties tool window

The following keyboard shortcuts apply to the Layer Properties tool window. Most shortcuts work on the active tab. Use Ctrl+Tab and Ctrl+Shift+Tab to activate other tabs.

	Shortcut	Description
	Ctrl+Alt+Enter	Opens the browser to select another fractal formula or coloring algorithm.
	Ctrl+Alt+R	Reloads the fractal formula, coloring algorithm, or selected transformation.
	Ctrl+Alt+E	Edits the fractal formula, coloring algorithm, or selected transformation.
	Ctrl+Alt+C	Copies the fractal formula, coloring algorithm, or selected transformation (including parameter settings) to the Clipboard. If the Location tab is active, the location is copied.
	Ctrl+Alt+V	Pastes the contents of the Clipboard into the active tab.
	Ctrl+Alt+Z	Resets the parameters of the fractal formula, coloring algorithm, or selected transformation. If the Location tab is active, the location of the active layer is reset.
	Ctrl+Alt+F1	Shows help (if available) on the fractal formula, coloring algorithm, or selected transformation.
	Ctrl+Alt+A	Adds a new transformation.
	Ctrl+Alt+D	Deletes the selected transformation.
	Ctrl+Alt+T	Enables or disables the selected transformation.
	F2	Renames the selected transformation.

Next: Keyboard shortcuts for the Fractal Properties tool window

See Also

General keyboard shortcuts
Formulas
Coloring algorithms
Transformations

Keyboard shortcuts for the Fractal Properties tool window

The following keyboard shortcuts apply to the Fractal Properties tool window:

	Shortcut	Description
	Shift+Alt+A	Duplicates the active layer and inserts the new copy in the layers list.
	Shift+Alt+D	Deletes the active layer.
	Alt+Up	Activates the next layer.
	Alt+Down	Activates the previous layer.
	Shift+Alt+K	Turns the active layer into a mask for the layer above it, or turns it into a normal layer again. See Masks.
	Shift+Alt+O	Shows the transparency of the mask in grayscale, making it easier to edit.
	Shift+Alt+M	Selects the merge mode of the active layer.
	Shift+Alt+1..9, 0, Left, Right	Changes the opacity of the active layer.
	Shift+Alt+F	Shows or hides the active layer.
	Shift+Alt+E	Makes the active layer editable or not editable.
	Shift+Alt+T	Turns layer transparency on and off. See Transparent layers.
	F2	Renames the active layer.
	Shift+Alt+Up	Moves the active layer one place up.
	Shift+Alt+Down	Moves the active layer one place down.
	Shift+Alt+C	Copies the active layer to the clipboard.
	Shift+Alt+V	Pastes the contents of the Clipboard into the layers list.

When clicking on the **Visible**, **Editable**, or **Transparent** icons, hold down Shift to toggle all other layers on and off.

Next: Keyboard shortcuts for formula editors

See Also
General keyboard shortcuts
Layers

Keyboard shortcuts for formula editors

The following keyboard shortcuts apply to formula editors:

Shortcut	Menu command	Description
Ctrl+P	File|Print	Prints the active document.
Ctrl+Z	Edit|Undo	Undoes the last action.
Ctrl+X	Edit|Cut	Moves the selected text to the Clipboard.
Ctrl+C	Edit|Copy	Copies the selected text to the Clipboard.
Ctrl+V	Edit|Paste	Pastes the contents of the Clipboard into the editor.
Ctrl+A	Edit|Select All	Selects all text.
Ctrl+F	Edit|Find	Finds text in the active document. See Finding text and formulas.
Ctrl+H	Edit|Replace	Finds and replaces text in the active document.
Ctrl+E	Edit|Find Formulas	Finds formulas in the active document.
Ctrl+I	Edit|Indent Block	Moves the selected text to the right. See Indenting and commenting.
Ctrl+U	Edit|Outdent Block	Moves the selected text to the left.
Ctrl+L	Edit|Comment Block	Turns the selected text into a comment.
Ctrl+K	Edit|Uncomment Block	Turns the selected comment into normal text.
Ctrl+M	Insert|New Formula	Inserts a new formula.
Ctrl+J	Insert|Complete Template	Replaces text just before the cursor with the corresponding code template. See Templates.
Ctrl+Q	-	Quickly jumps to another formula.
Alt+F1	Help|Topic Search	Searches for help on the word at the cursor position. This works for reserved words, functions, predefined symbols, settings, compiler directives, and labels.

Next: Keyboard shortcuts for browsers

See Also

General keyboard shortcuts
Formula editors

Keyboard shortcuts for browsers

The following keyboard shortcuts apply to modeless browsers. Most shortcuts also work in modal browsers.

Shortcut	Menu command	Description
Ctrl+X	Edit|Cut	Removes the selected items and copies them to the Clipboard. The items are not actually removed until you use the Paste command. See Organizing your work.
Ctrl+C	Edit|Copy	Copies the selected items to the Clipboard.
Ctrl+V	Edit|Paste	Inserts the items you have copied or cut into the selected location.
Ctrl+Del	Edit|Delete	Deletes the selected items.
F2	Edit|Rename	Renames the selected item.
Ctrl+A	Edit|Select All	Selects all items in the window.
Ctrl+I	Edit|Invert Selection	Reverses which items are selected and which are not.
Ctrl+F	Edit|Find Entries	Finds entries in files. See Finding files and entries.
Ctrl+L	View|Library Only	Shows the library folders only, or shows all folders. See Library mode.
F5	View|Refresh	Refreshes the contents of the browser.
Ctrl+R	Right-click, Render to Disk	Renders the selected fractal file, parameter file, or parameter set to disk. See Exporting and rendering.

See Also
General keyboard shortcuts
Browsers

Purchasing Ultra Fractal

If you want to continue to use Ultra Fractal after the 30-day trial period, you must purchase it. You will then receive a personal license key that turns your evaluation copy into a full registered version.

The full version does not mark exported and rendered images, and it does not show any evaluation reminder dialog boxes. In addition, you are entitled to free support via email and upgrades for a reduced price.

Ultra Fractal 3 costs US $59 for new users, or US $39 for an upgrade (existing Ultra Fractal users only).

You can place your order online via a secure server. All major credit cards are supported. You can also send a check via postal mail. To proceed, go to the Ultra Fractal web site:

- Purchase Ultra Fractal

If you order online, your personal license key will be sent to you by email in a few minutes. Please contact info@ultrafractal.com if you have any questions!

Next: Entering your license key

See Also

License information
Support

Entering your license key

After you've purchased Ultra Fractal, your personal license key will be sent to you via email in a few minutes. This license key turns your evaluation copy of Ultra Fractal into a full version.

1. Start Ultra Fractal, and click **Enter License** in the Evaluation Reminder dialog that appears. (Alternatively, click **Enter License** on the Purchase menu if Ultra Fractal is already opened.)
2. Enter your full name and license key, exactly as they appear in the email you have received. Please pay attention to spaces and capital letters.
3. If you're upgrading from Ultra Fractal 2, make sure that **I'm upgrading from version 2** is checked. If you still have Ultra Fractal 2 installed, your old registration code will be picked up automatically. Otherwise, you'll have to enter it yourself. (Contact info@ultrafractal.com if you have lost your old registration code.)
4. Click OK and restart Ultra Fractal to complete registration.

Please contact info@ultrafractal.com if you have any questions. Thank you for purchasing Ultra Fractal 3!

Next: License information

See Also
Purchasing Ultra Fractal
Support

License information

If you purchase Ultra Fractal 3, you will receive a personal license. This personal license entitles you to install and use the full version of Ultra Fractal 3 on any computer, as long as you're the only one using the installed copies.

The license key that you receive upon purchasing Ultra Fractal 3 is personal and confidential. You may not publish it, give it away, or sell it in any way. If you would like to introduce Ultra Fractal to someone else, please point him or her to the Ultra Fractal web site at www.ultrafractal.com so he or she can download a fresh evaluation copy.

In case you would like to purchase multiple copies of Ultra Fractal, for example for classroom use, you can purchase a site license for a reduced price. Contact info@ultrafractal.com for details and pricing.

See Also
Purchasing Ultra Fractal
Support

Support

If you need help using Ultra Fractal, refer to the other topics in this help file first. You'll usually find the information you need here. Try to do some of the included tutorials if you're new to Ultra Fractal. The help file is also available as a printable PDF manual on www.ultrafractal.com.

In case the online help doesn't solve your problem, ask a question on the public Ultra Fractal mailing list. This is also a great place for sharing tips and parameter sets. See Mailing list.

To find links to tips, articles, and more tutorials, visit the **Resources** section on the Ultra Fractal web site at www.ultrafractal.com. Also take a look at the **Answers** page for answers to frequently asked questions.

For technical support, you can also contact the author of Ultra Fractal via email at info@ultrafractal.com.

Next: Mailing list

See Also
Purchasing Ultra Fractal
Tutorials

Mailing list

The Ultra Fractal mailing list is a great place to ask questions and to share tips or fractal images with other Ultra Fractal users. See www.ultrafractal.com/mailinglist.html for more information and instructions for signing up.

Warning: the mailing list generates about 20 to 50 messages per day. To make it easier to handle this amount of messages, you can set up your e-mail software to automatically place messages from the Ultra Fractal mailing list in a separate folder.

In Outlook Express, you can do this with Tools|Message Rules|Mail. In Netscape Messenger, use Edit|Message Filters. Messages from the Ultra Fractal list always contain [ultrafractal] in the subject line, so that is a good way to identify them.

Next: Acknowledgements

See Also
Copying and pasting fractals
Support

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Ultra Fractal 3 was developed with Borland Delphi 4. The source code is now about 116,000 lines long and occupies about 4 MB. It uses the following free libraries:

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- The JPEG library, written by Jacques Nomssi Nzali.
- Indy internet components for Delphi by Nevrona.

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See Also
Support