The Guide to Drawing with FractaSketch 2.0 (draft)

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Introduction;

A fractal is a complex mathematical shape that can have infinite detail. A common kind of fractal consists of an infinite number of smaller copies of itself. Most natural shapes are fractals or approximately fractals: trees, stones, sponges, etc. *Linear* fractals have the special feature of self-generating from exact copies of themselves. Linear fractals are a stylized representation of nature, just as music can be, hence their decorative aspect.

Even though fractals have been known since more than a century, they are such complex figures that mathematicians were generally unable to draw them but could only mathematically describe them. M.C. Escher did draw some, but a computer is needed to realize most of them.

FractaSketch allows to create fractal images by growing them, much in the same way as plants do, by using a template that you design yourself. Your computer will take care of all calculations transparently, i.e. without you even noticing it. You can thus freely decide the degree of complexity that you want for your drawings.

Chapter 1. Creating a New Design;

Upon opening FractaSketch, two windows, A and B, appear side by side on the screen. You can modify the grid of the template window on the left in any way you want, for example by choosing the command Small in

the Grid menu. From now on, choosing a menu command will be written as "Grid + Small", where the first part "Grid" is the menu and the second part "Small" is the menu item.

You work from two drawings: first the *template*, in window A on the left, constituting the fractal's structure, and second the *drawing of the fractal* itself, in window B on the right (Fig. 1).

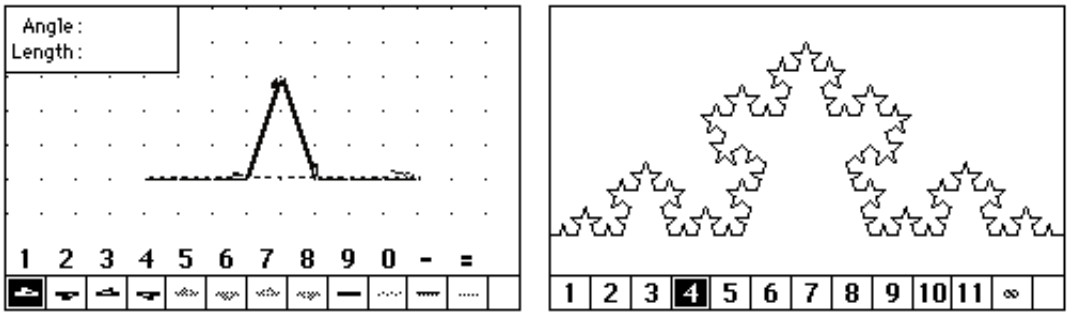


Fig. 1

As soon as the template is completed, it is used immediately to the draw the fractal. Whenever you modify this template, the fractal will modify simultaneously. This allows you to change the template as often as you want and immediately judge the result of the alterations.

A The Template ;

The *template* is the basic seed shape of a fractal design. A template consists of a number of line *segments*. Before you begin drawing the template, it will help to know two basic principles:

1) Between the first and the last point of your template, a dashed line with an arrowhead will appear: it is called the **base line** of the drawing. It is only intended to assist your construction and is not part of the final drawing. Using the base line as the reference, the template is copied to every segment when the fractal is drawn. Therefore, your last point should be distant enough from the first, so that the base line's length is proportional to the general size of the template. The combination of base line + template is also called an *element* (Fig. 2). The fractal is generated by multiplying copies of the element.

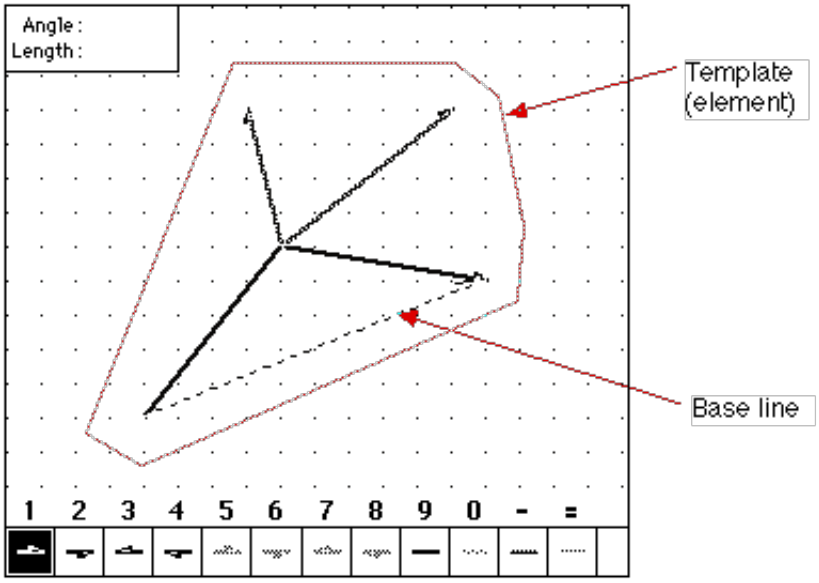


Fig. 2

2) No segment should be longer than the base line, or all you will get is an ugly doodle. This is because a segment longer than the base line would oblige the latter to stretch when the element duplicates on the segment in the fractal. The element would grow larger instead of reducing during the multiplication process. It is thus better to use small segments. Generally, the more segments that are used, the denser the fractal will be.

To prepare a template (Fig. 3):

* Click in the template window to start a segment and terminate the previous segment.

* Draw a segment by dragging the mouse.

* Double-click to finish your drawing (or choose Finish in the Edit menu). The fractal immediately shows up in the fractal window (initially, on the right of the screen).

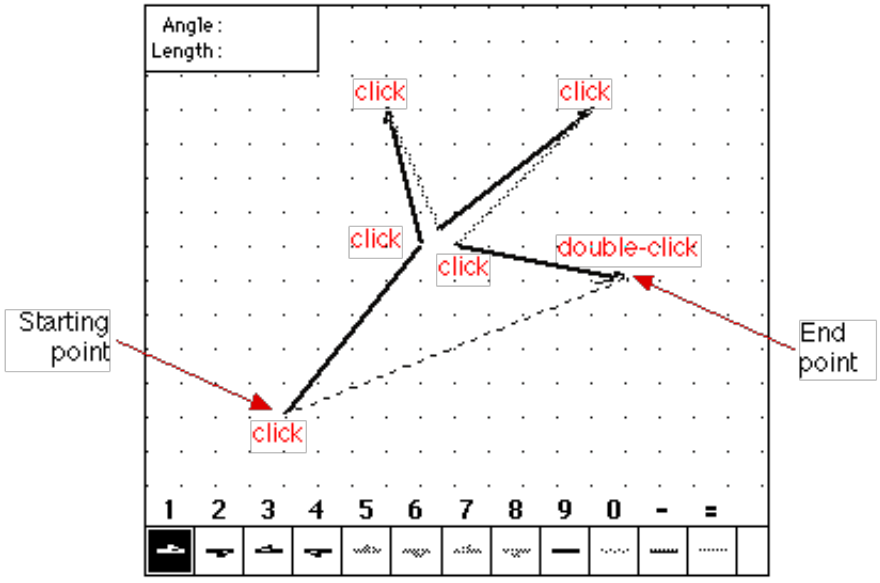
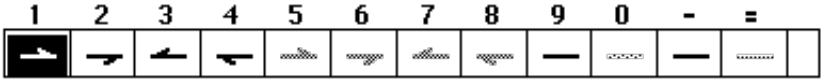


Fig. 3

The Palette of Line Types;

The palette of line types (Fig. 4) is used to change the orientations of the elements. Remember that even if your fractal contains curves, such as in a fern, the template consists only of straight segments. It is the large number of elements , whose directions and orientations are determined by the template, that produces curves.



The palette of line types

Fig. 4

The palette comprises the following line types:

* **1-2-3-4**: oriented lines. The segments of the fractal will multiply in the direction indicated by the arrow. That is, when an element is copied onto a segment, it will be oriented so that the arrow on its base line matches up with the arrow on the segment.

* **5-6-7-8**: alternating lines. These line types are used to modify the fractal's density. The segments work as with types **1** to **4**, but are visible or not according to the level of the drawing. When the fractal gets multiplied at Level 1, the affected segments all keep invisible, and the drawing is oriented as indicated by the arrows. At Level 2, the invisible segments become visible. At each higher level, the visibility reverses: those segments that were invisible on the template become visible and vice versa.

* **9**: solid line, unoriented. This segment is simple, i.e. it does not multiply. It stays unchanged whatever the drawing level of the fractal.

* **0**: invisible line, unoriented. This segment is used to create fractals with disconnected parts, and to come back from one point of the drawing to another, e.g. to place the end point. It is not drawn.

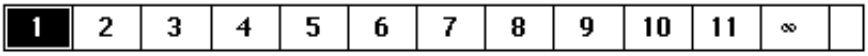
* **-** : solid line, unoriented. This has the same effect as type **9**, but the segment's length reduces as the drawing level is increased.

* **=** : invisible line, unoriented. This works as type **-**, i.e. the length reduces as a function of the level, but the segment is invisible so it does not show up on the fractal.

B Drawing the Fractal;

The drawing level can be selected from the drawing level palette (Fig. 5) or from the menu bar by choosing Draw + Level N (i.e., choose Level N in the Draw menu). Fig. 6 shows how the template of Fig. 3 gets multiplied when the level is raised.

You can have the fractal cover as much space as possible within its window with the command Scale + Scale to Fit. This command is a toggle, i.e. repeating it disables the scaling.



The drawing level palette

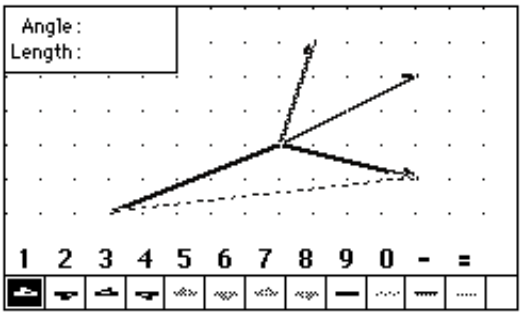
Fig. 5

The fractal is built as follows:

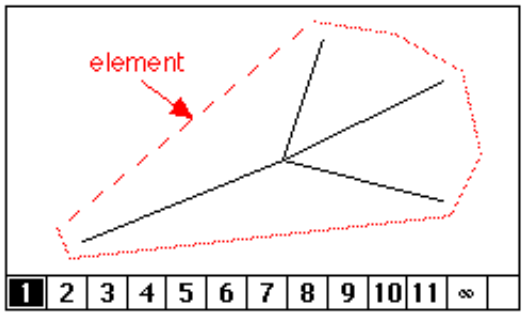
* At Level 1: the fractal consists of a single element.

* At Level 2: every segment is replaced by the (reduced) element.

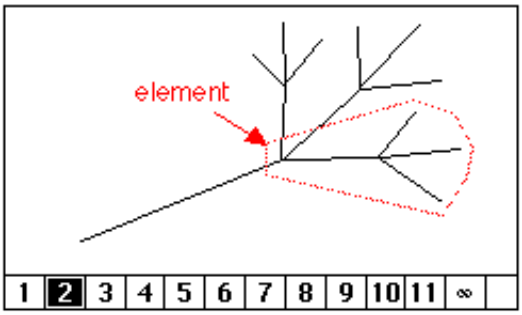
* At Level 3: the process repeats: every segment is replaced by the whole Level 2 drawing, and so on.



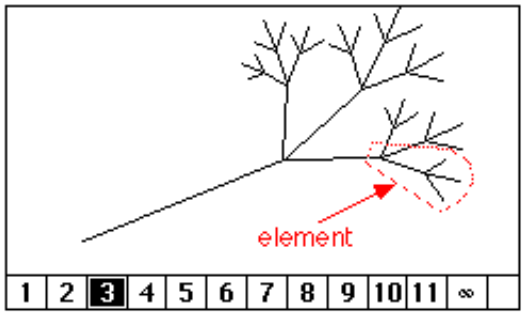
Template (element)



Level 1



Level 2



Level 3

Fig. 6

C Editing the Template ;

Every window has a template. To edit a window's template, click on the window and then choose Edit + Edit Fractal. If you are editing with two windows (a template on the left and the fractal on the right), just click on the template window to make it the current window. The following editing commands are possible:

* To erase the template completely, use the Edit + Clear command (i.e. choose Clear in the Edit menu).

* To erase a single segment or end point only: click on the segment or point to select it, then hit the Delete key.

* To move the template within its window: click and drag in the white space around the drawing.

* To split a segment: double-click it. It will be split into two segments that are each half the length of the original.

* To move a segment or change its direction within a template: select the segment or one of its end points and then drag to wherever you want.

* To change the line type of a segment: select it, then select the desired type in the line type palette.

To suppress the link between the fractal and the template windows, click the fractal window, then choose Edit + Clear. To create another fractal window, click the template window, then choose Edit + Edit with View.

If you inadvertently shifted from the template to the fractal in the template window (by typing a drawing command) and you want to come back to the template, choose Edit + Edit Fractal. To go back to the fractal, choose a drawing command such as Draw + Level N, where N is the desired drawing level.

Chapter 2. Basic Patterns;

This chapter shows some of the common species of patterns and how to grow them.

A Plant Patterns ;

* The Tree (Figs. 7 & 8);

Select line type **9** (see Fig. 8). Draw a horizontal segment from the left to the right, forming the tree's trunk. Next, draw branches from a dividing point on the trunk with two or three segments opening as a fan, with line type **1** or **2**. Each branch starts from the trunk, so that it should come back there with an invisible line type **0**. Place the end point at the end of another invisible line going to the top of the tree. After finishing the template, choose a drawing level. Finally, turn the drawing with the command Scale + Rotate to get the tree upright. How to add color is explained in Chapter 3.

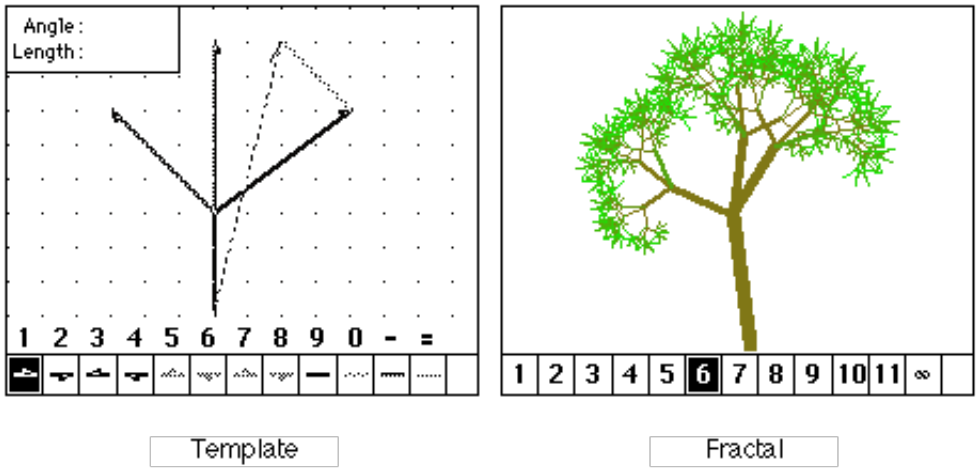
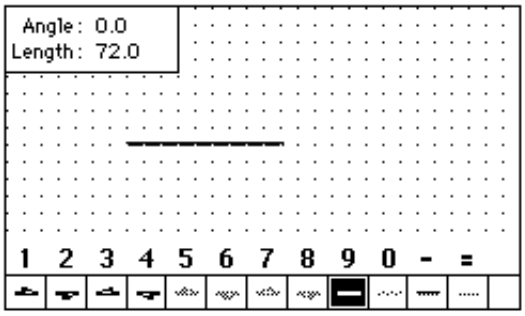
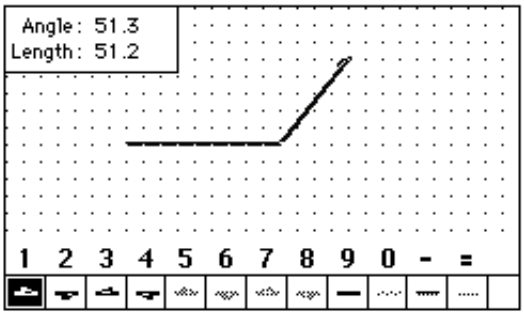


Fig. 7

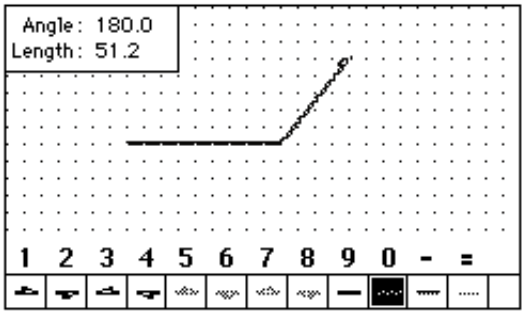
The following Fig. 8 shows how to create a tree in eight simple steps:



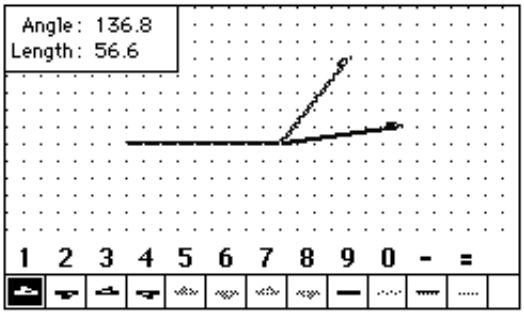
1. Line type 9, the trunk



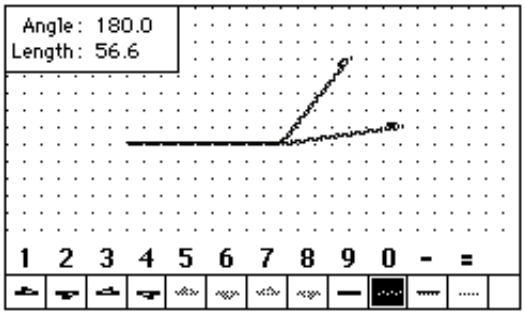
2. Line type 1, first branch



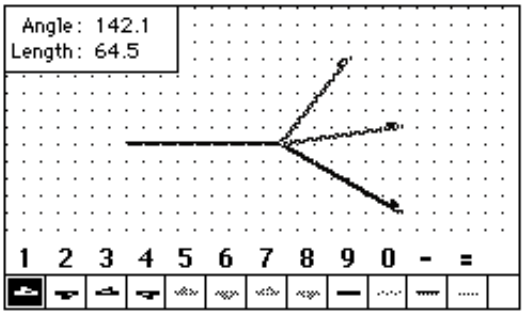
3. Line type 0, back to the trunk



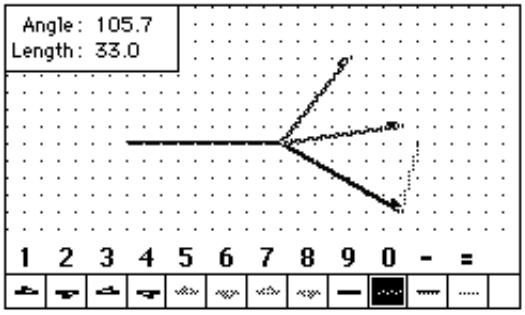
4. Line type 1, second branch



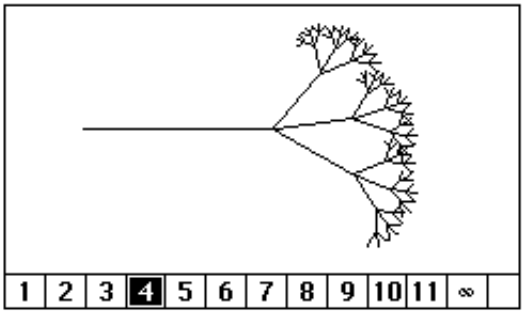
5. Line type 0, back to the trunk



6. Line type 1, third branch



7. Line type 0, end point



8. The level 4 fractal

* The Fern (Figs. 9 & 10);

Select line type **9** on the palette, draw a slanted segment (the fern's stem) from left to right, short enough: if the stem is too long, the fern will be scrawny. From the starting point of this first segment, draw two

segments, one on each side, with line types **1** and **2**, always coming back to the starting point invisibly with line type **0**. These two segments will produce the branches and leafs of the fern. Using line type **1**, draw the main stem as a prolongation of the basis stem, slightly turned, then double click to finish the drawing.

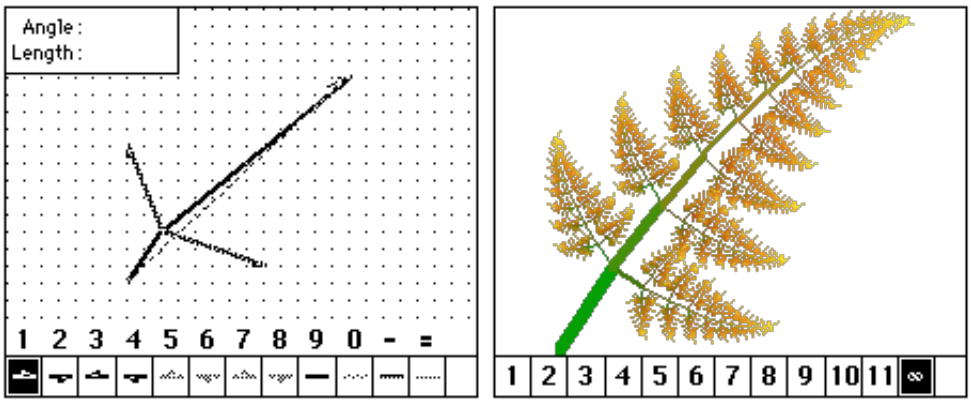
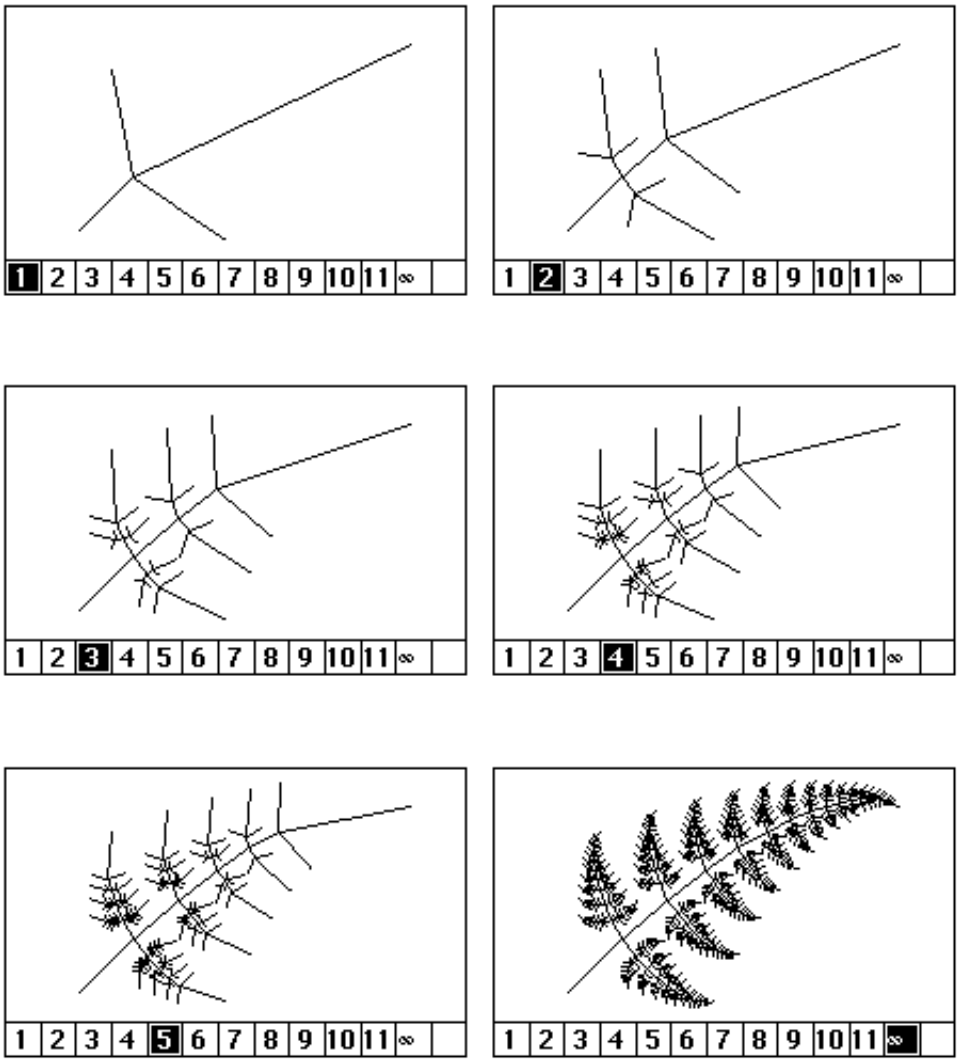


Fig. 9



Growth of the fern

Fig. 10

B Geometrical Patterns ;

* The Spiral (Fig. 11);

Selecting line type **9**, draw a short segment oriented downwards and from left to right. From its end point, using line type **1**, draw a perpendicular segment pointing upwards and longer than the first. The thick line of the spiral comes from selecting the command Line + Proportional, and then increasing the line thickness with Line + Thicker.

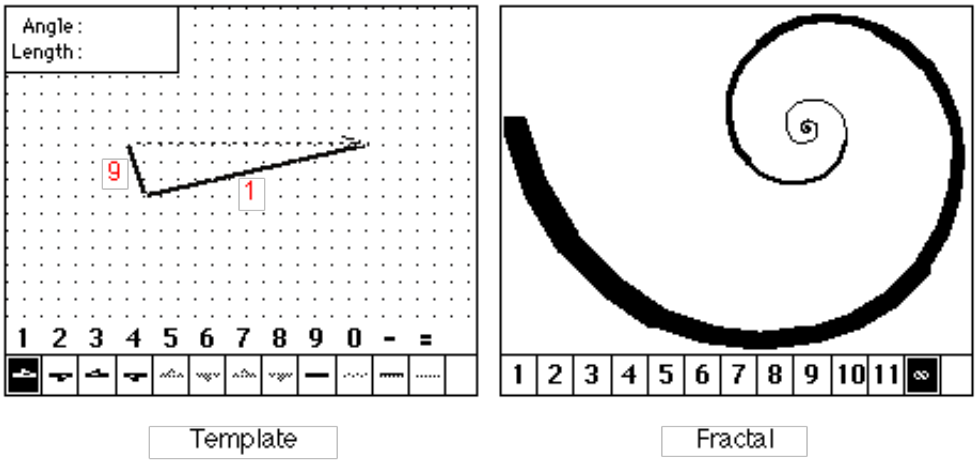


Fig. 11

* The Square Tiling (Fig. 12);

Draw a cross whose branches meet in the center. Invisible segments (line type **0**) allow to go from one branch to the other when drawing the cross.

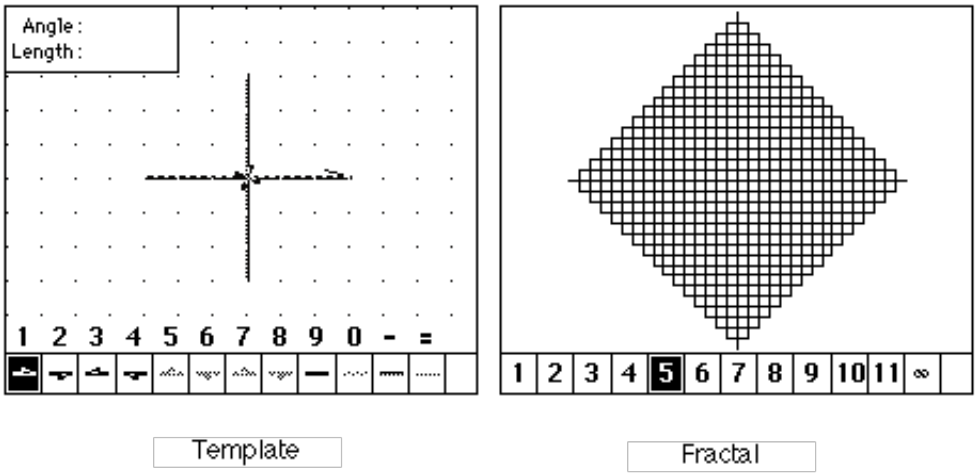


Fig. 12

* The Hexagonal Tiling (Fig. 13);

First choose a hexagonal grid (Grid + Hexagonal). Draw a six-sided polygon using line type **1**. To finish the drawing, draw a diagonal using the invisible line type.

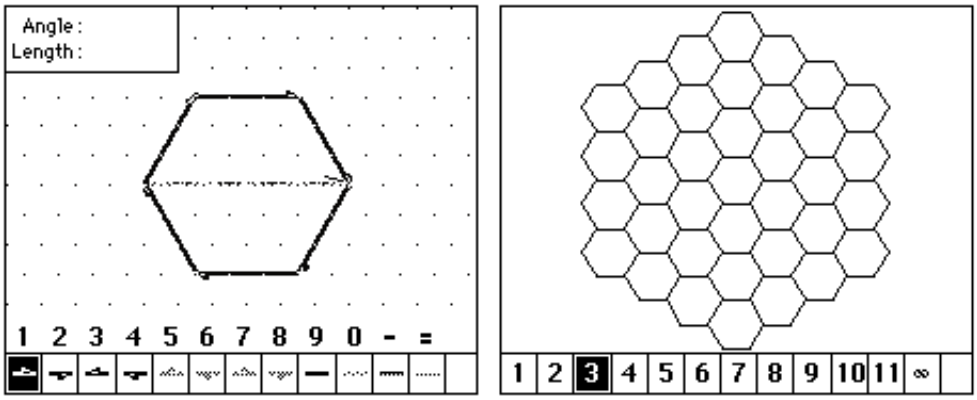


Fig. 13

* The Square (Fig. 14);

Draw a square and finish your drawing with an invisible diagonal. Take care if you modify the position of the end point, as this also changes the orientation of the square.

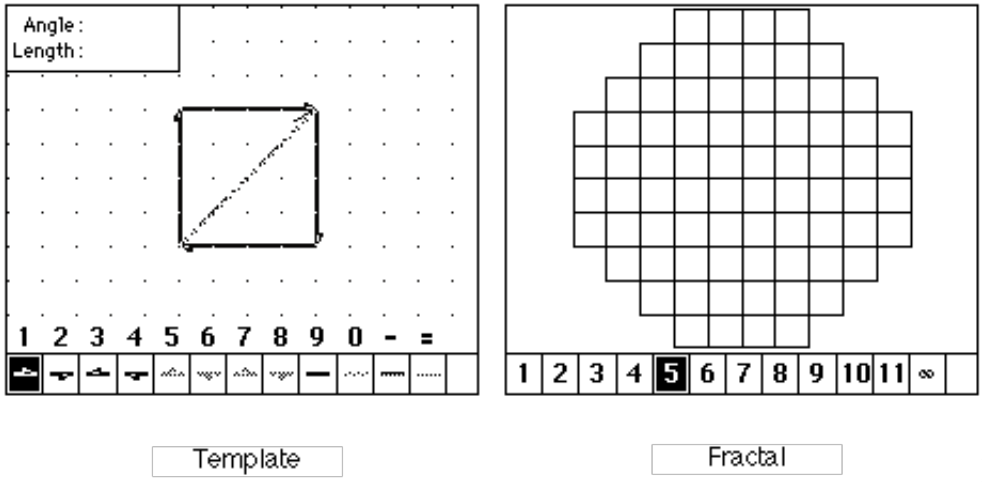


Fig. 14

C Decorative Patterns ;

* The Dragon (Fig. 15);

Draw a slanted segment oriented downwards and from left to right using line type **1**. From its end point, draw another slanted segment pointing upwards, using line type **4**, and of the same length as the first one.

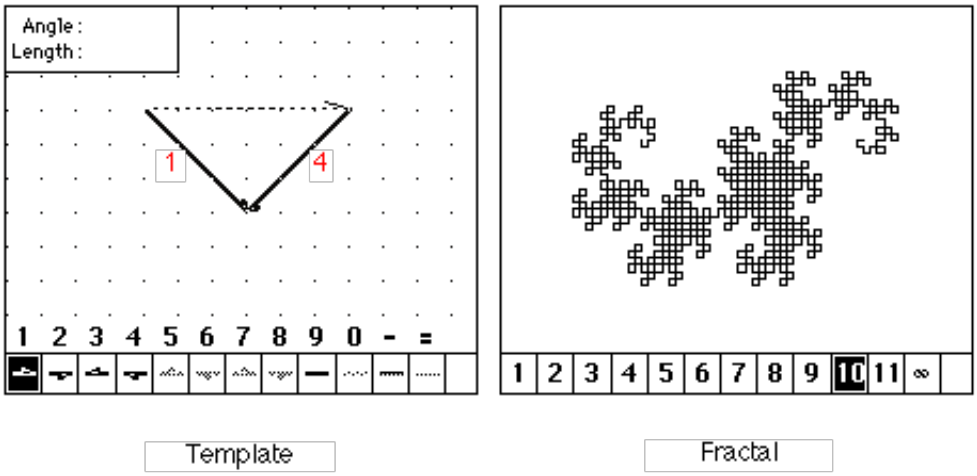


Fig. 15

* The Filled Snowflake (Fig. 16);

Using line types **2, 3, 4,** and a hexagonal grid, draw the template given in Fig. 16. Pay due attention to the orientations of the segments. When multiplied, this element covers the whole interior area of a snowflake in one stroke.

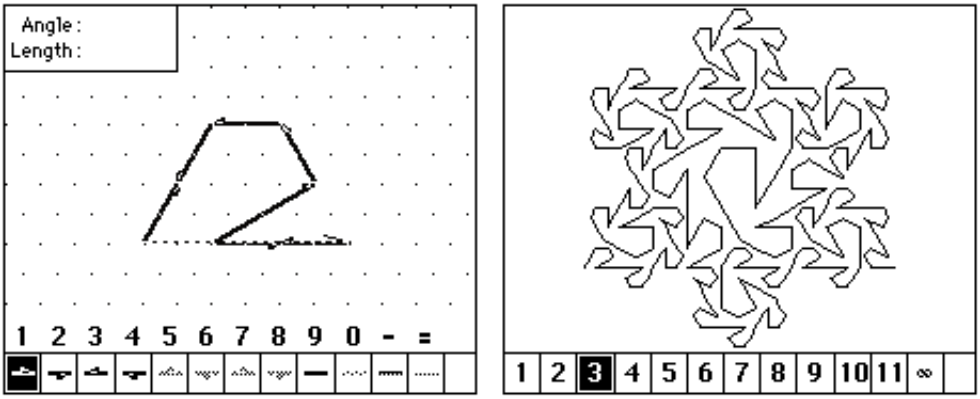


Fig. 16

Chapter 3. Color;

With FractaSketch, fractals are colored one segment at a time. The program allows for an infinite number of colors, depending on the characteristics of your screen. The main tool for coloring is the color triangle.

A The Color Triangle;

The color triangle (Fig. 17) contains the whole color spectrum. The triangle is used to color fractals using a coloring principle that respects the originality of fractals, i.e., that each part is a reduced copy of the whole. There is continuous gradation of colors and no part of the fractal has to be uniform.

To pop up the color triangle, choose Color + Color Triangle (or Cmd + `). In the triangle, the template is represented by a color template (also called "color path"). As long as the drawing is black and white, all

points are situated in the center of the triangle, at the white spot. The points are joined by lines, which becomes apparent when you drag them away from the center.

Each fractal window has its own color triangle. The color triangle contains the color path for each template that the fractal window contains or is linked to. Changing a template's color path will immediately update all fractals that use that template.

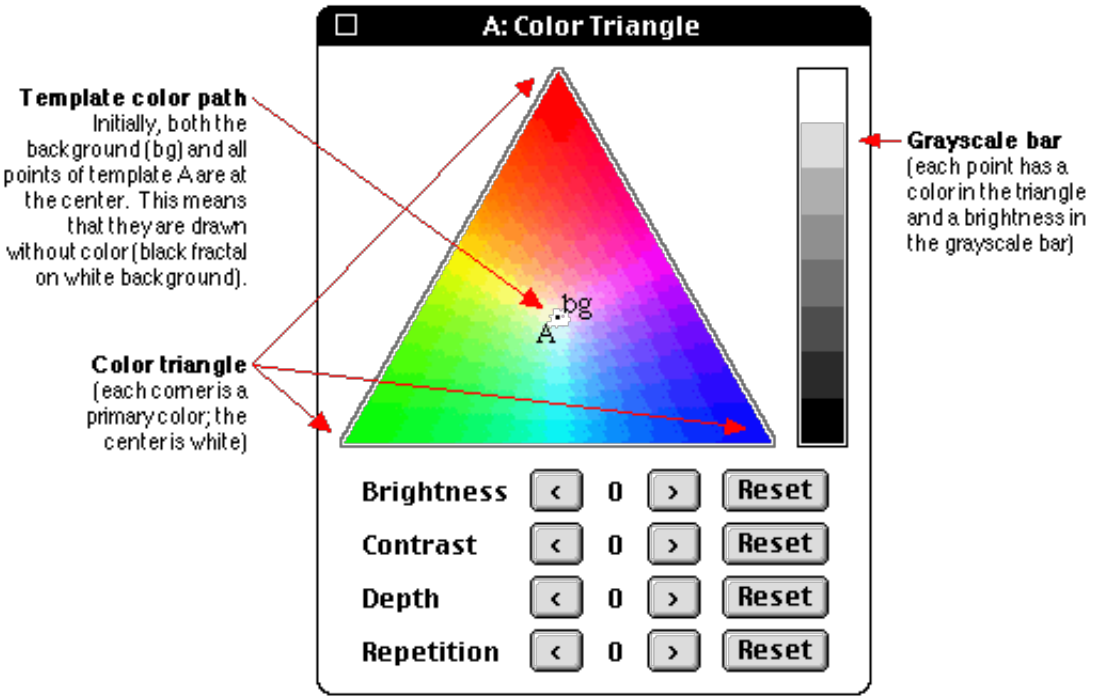


Fig. 17

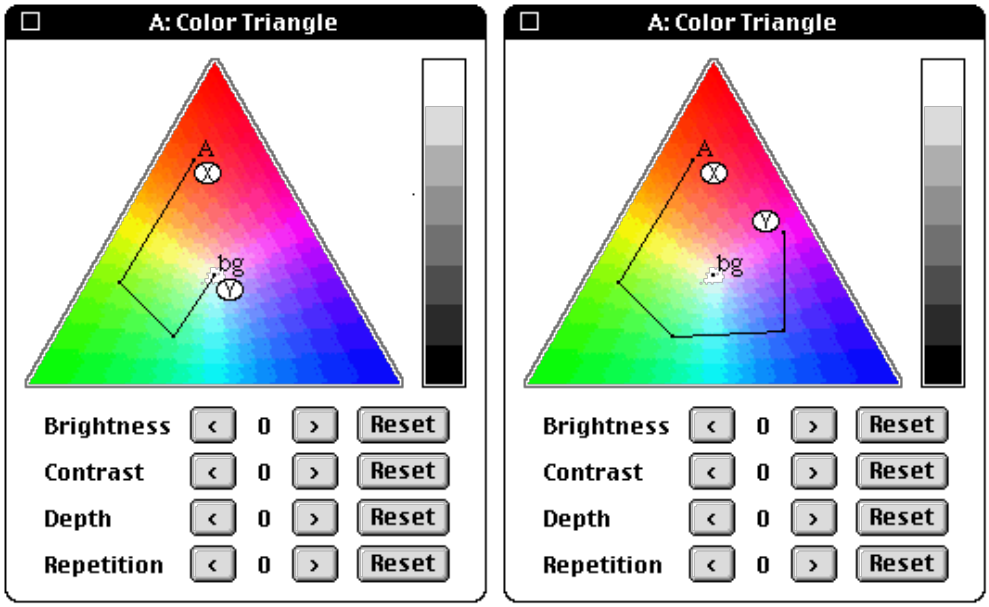
To color according your taste, you only have to select each point of the template in the center of the triangle and drag it to the color you want it to take. Fig. 17 shows how the coloring process starts with a template that has five points (i.e., four segments).

By choosing the position of the points in the triangle, you define both the basic colors of the fractal, and the path that each segment will follow in the color spectrum, from X to Y (Fig. 18 and 19):

* The whole fractal goes along the color path from X to Y, through all shades of the spectrum in between.

* Each smaller element also goes through colors from X to Y, superimposing itself and thus mixing with the colors of the next lower layer.

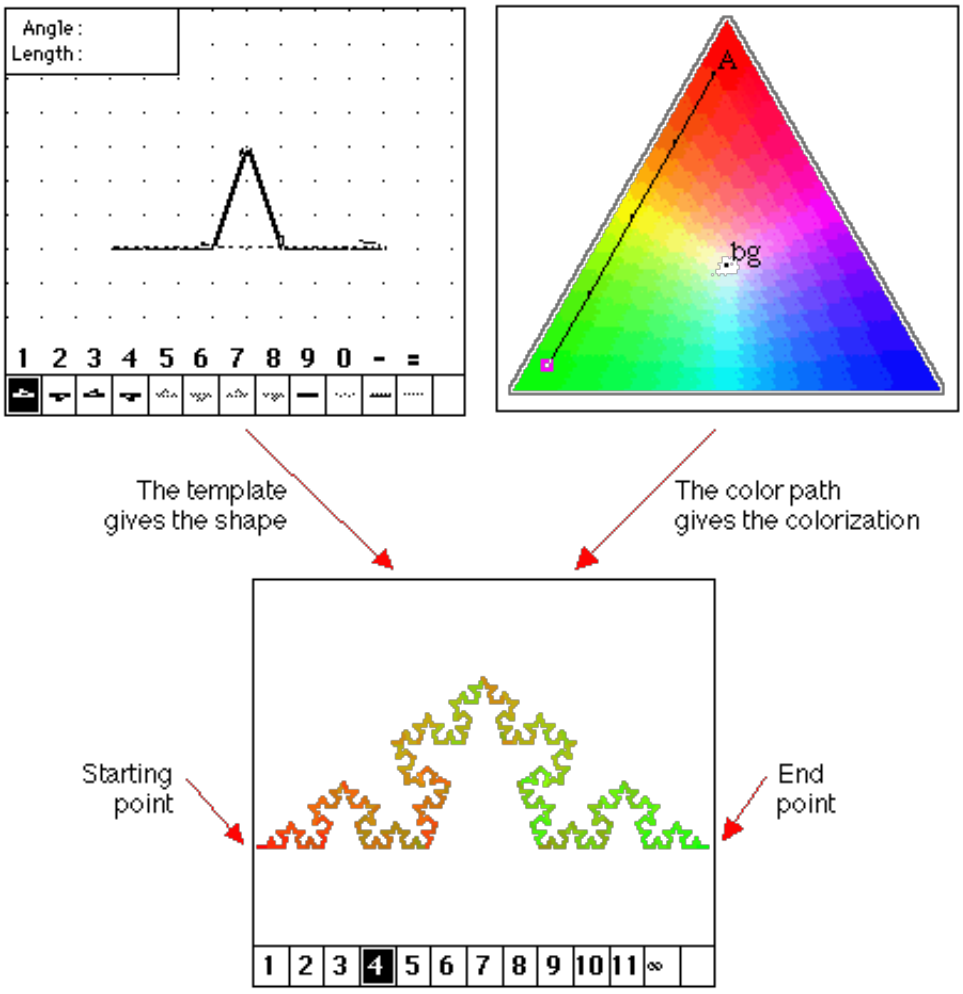
This process is instantaneous and therefore you don't notice it on the screen: only the final mixing result is visible. Fig. 19 shows an example of the resulting colorization. In order to conform with the fractal nature of the drawing, the influence of each element depends on its size: the smaller the element, the smaller the effect of its color path.



Three points (starting with X) are colored; the other two are still black (in the center with Y)

All five points are colored (from X to Y)

Fig. 18



Colorization with the color triangle

Fig. 19

The Grayscale Bar ;

The grayscale bar is on the right side of the color triangle. It allows to adjust the intensity of any color. First select a color point in the triangle, then adjust the corresponding intensity by moving the slider.

Tuning the Colorization;

The buttons underneath the color triangle directly affect the colorization of the fractal drawing. Four characteristics can be modified:

* **Brightness**, to adjust the intensity, as on a video screen.

* **Contrast**, to modify the contrast, again as on your screen.

* **Depth:** this increases or decreases the influence of the smaller elements on the bigger ones.

* **Repetition**: this determines the number of times the color path is completely traversed when

drawing the fractal.

If you increase the depth, then small color variations become more apparent, giving more texture to the colorization. If you decrease the depth, then the color changes more uniformly. At the minimum depth, a completely uniform gradation from the first color to the last is obtained. At the maximum depth, the color variations are at such a small scale that the fractal appears to have only one color.

Repetition 0: the fractal travels the defined color path from X to Y directly, without passing through the intermediate points. Repetition 1: the fractal travels the color path just once, passing through all intermediate points. The bigger the value of Repetition, the more times the color path is repeated.

If you want the basic colors of the color path not to mix together in the fractal, select 1 for Repetition and decrease the Depth to -5 or -6. If you are not satisfied with your modifications and you want to go back to the black and white fractal, choose Color + Reset Color.

B Monochrome and Bichrome Coloring ;

To get a monochrome fractal (one color only), choose the Color + Monochrome... command and select a color. It is also possible to select one color for the beginning and another for the end of the fractal with the commands Color + Begin... and Color + End.... In this case, the color path follows a straight line from the beginning to the ending color.

C Background Color;

To show the subtle color gradations of a fractal to advantage, a white background is seldom the best solution. To change the background color, drag the dot labeled "bg" in the color triangle, or use the command Color + Color Background.... To obtain a white background, choose Color + White Background. For a black background, choose Color + Black Background. (When printing the fractal, take note that many color printers, e.g., ink-jet printers, will give pleasing results only for light background colors. Furthermore, dark colors tend to quickly use up ink supplies.)

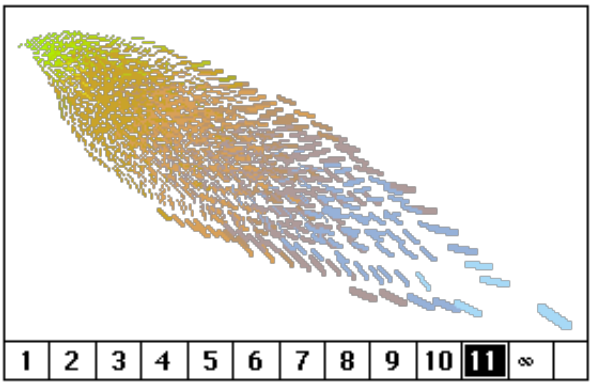
D Spill ;

After the fractal is colored in the normal way with the color triangle (Fig. 20, first bird), the "Spill" function offers two further possibilities:

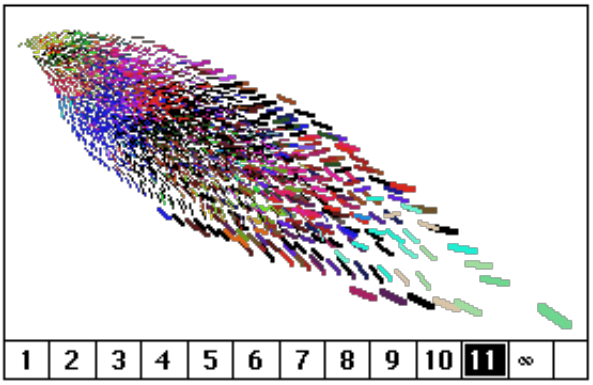
1) Spill a color into its complementary color, along the spectrum sequence. Choose the command: Spill + Complementary (Fig. 20, second bird).

2) Spill a color into the same color. The colors do not change but become more pastel. Choose the command: Spill + Pastel (Fig. 20, third bird).

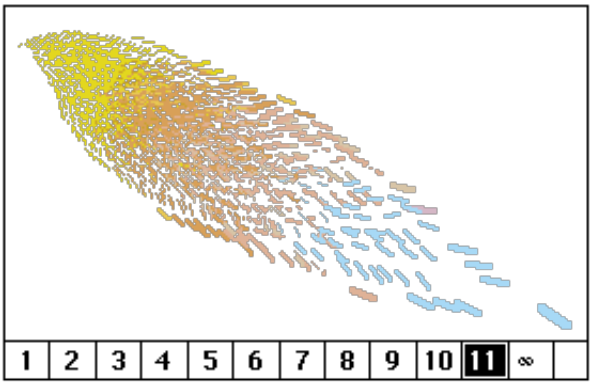
The strength of the spill can be changed by changing the spill factor (Spill menu). In contrast to the standard coloring process, spilling is haphazard and cannot really be controlled much. In particular, a major disadvantage is that the color effects change when the drawing level changes, which is not the case if only the color triangle is used to color a fractal.



The bird colored using the color triangle



The bird spilled in complementary



The bird spilled in pastel

Fig. 20

Chapter 4. Associations;

Any fractal can be used by itself or combined with others. The possibility of merging several patterns together allows for an infinite variety of constructions. In particular, it allows you to impose a desired special contour shape to any fractal. The basic mechanism is to make a *link* between two templates. When a fractal is stored on disk, FractaSketch automatically gathers together all templates that it needs and remembers all links between them, so that your work is completely saved.

A The Process ;

In order to associate two or more fractals, a link between them must be created to obtain a single combined fractal. Starting with a template already displayed on screen, for example the template of the dragon, choose Edit + Edit with Association. You now have three windows:

* Window A: the template of the dragon (giving the fractal in Fig. 21, second drawing).

* Window B: still empty. You can create another template there, or insert an existing fractal from an external file, taking care to show the template of the inserted fractal (using Edit + Edit Fractal, if necessary). For example, you can put here the spiral (Fig. 21, first drawing).

* Window C: will eventually show the fractal resulting from the association (Fig. 21, third drawing).

Select, in the template of window A, one of the segments that you want to associate, then hit Option + click on a segment of the template of window B (while holding Option down, click on the segment). Small letters appear on the segments, indicating that they are linked. Your pattern is now associated, and the resulting fractal is immediately displayed in window C.

A letter on a segment means that the drawing process will use that template instead of the segment's own template when drawing. For example, a segment in template A that has a letter "B" means that the segment will be replaced by an element of template B, not template A, when drawing. FractaSketch allows links to be made between any segment and any template, including mutually recursive ones (for example, where template A is linked to template B and vice versa).

Each of the templates A and B keeps its own color triangle settings, so that you can color precisely each segment of the resulting fractal.

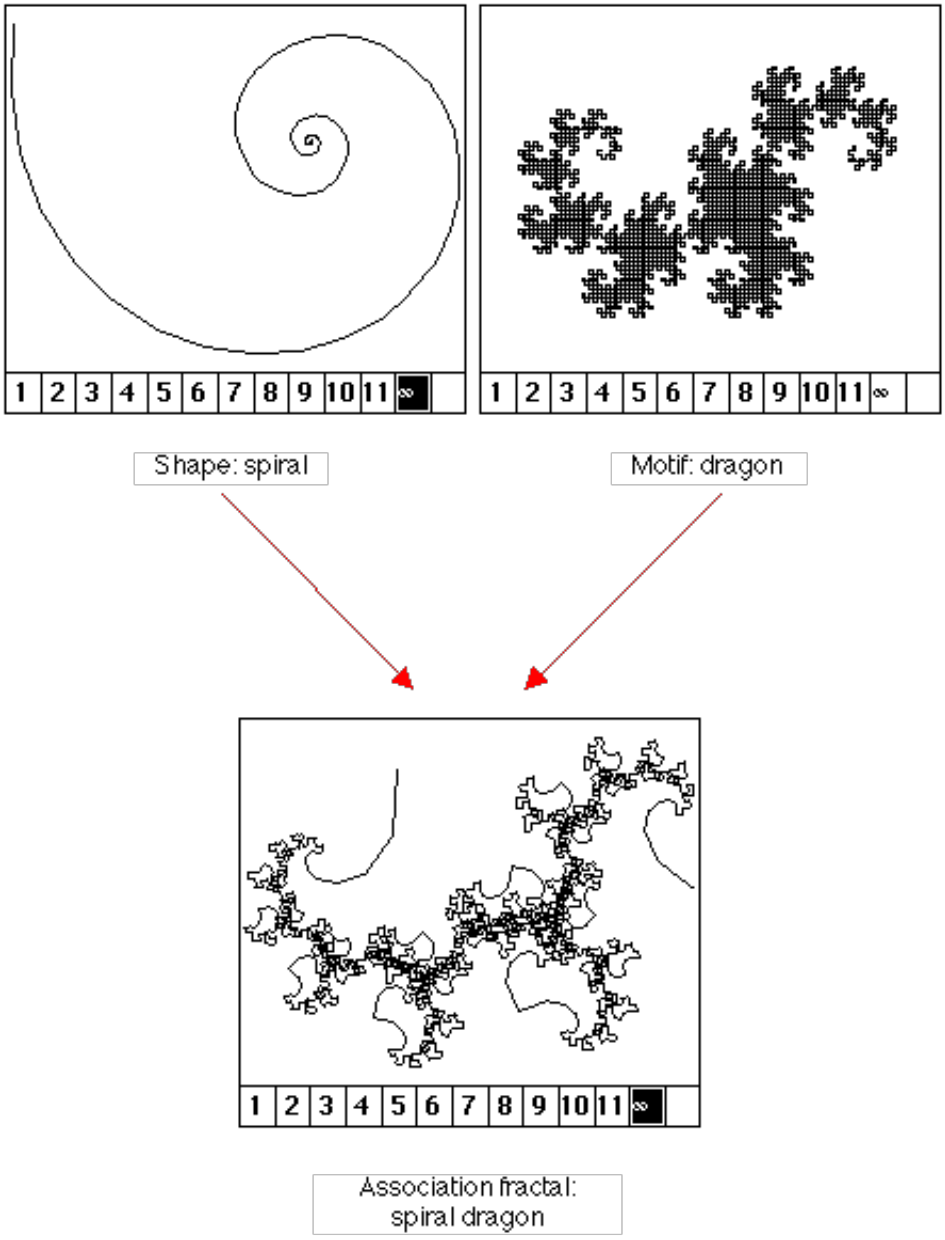
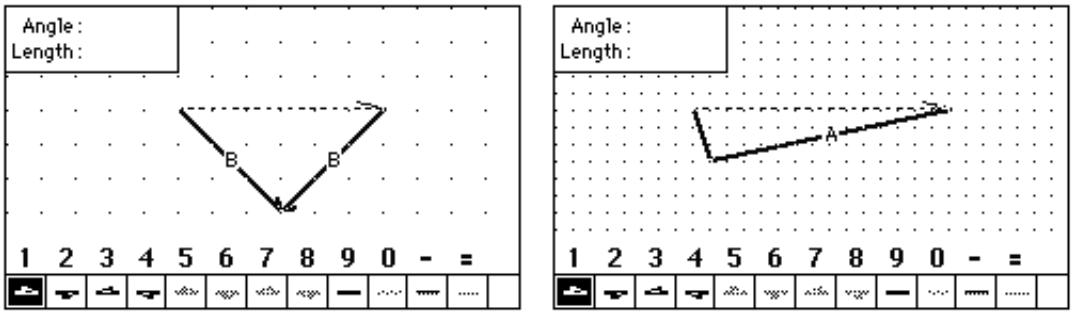


Fig. 21

The spiral dragon has two templates (Fig. 22):



Template A: the dragon

Template B: the spiral

The two templates of the spiral dragon

Fig. 22

Figs. 23 and 24 give another example of an association, of a triangle and a Koch snowflake.

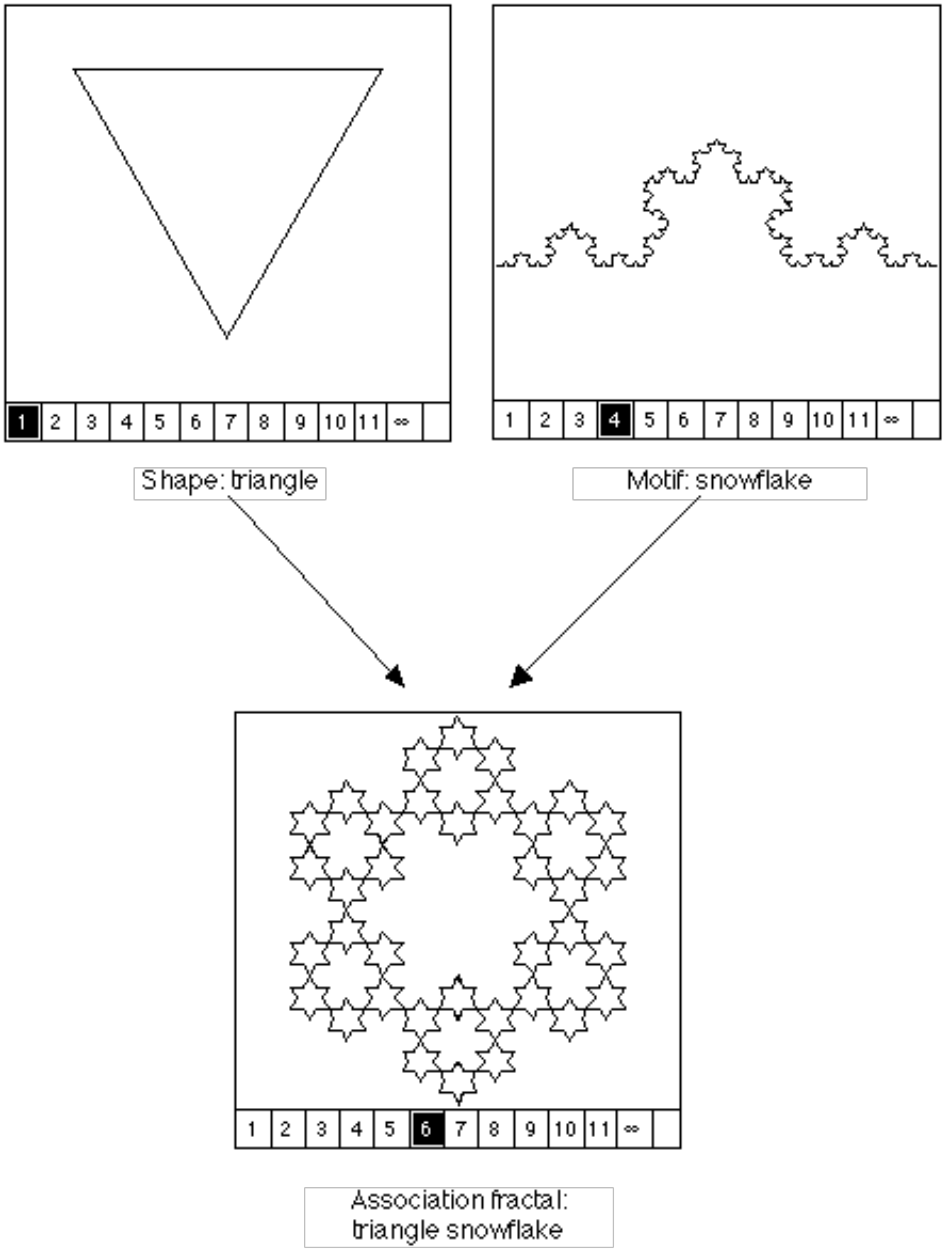
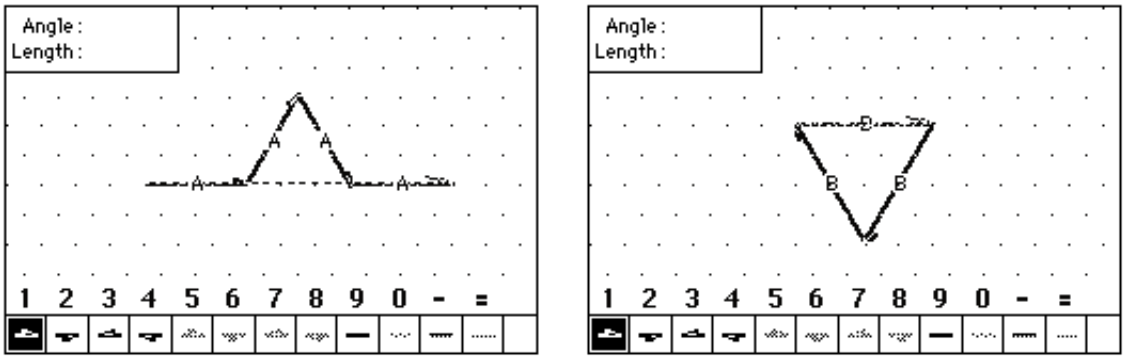


Fig. 23

The triangle snowflake has the following two templates:



The two templates for the triangle snowflake

Fig. 24

Note that each segment of each template is linked to the other one. This gives a maximum of mixing between the two fractals. If less mixing is desired, it is up to the fractal designer to make fewer links. Which links are needed to get a pleasing result is a secret known only to the true artist.

B Using Arbitrary Shapes;

You can associate any shape with your template. Draw the shape using the simple unoriented line type **9**, then link the shape with a segment of the template with which you want it associated.

C Several Designs side by side ;

You can place two or more designs side by side instead of associating them as a single fractal (Fig. 25). The designs are not mixed, but simply juxtaposed.

1) Open or create the first design.

2) Open or create the second design, then place both fractal windows side by side.

3) Create a third window, using the command File + New.

4) In this third window, draw a template for the composition: two segments with oriented lines, separated by a segment of invisible line type **0**. This template won't serve as the source for a new fractal, but you'll link its segments to the templates of the two original designs, in order to define their positions in the composition.

5) Now, link the patterns to the composition template: click on a segment, then Option + click in the window of the design you want on that segment. A letter appears on the segment, showing which pattern comes there. Repeat the procedure for the next segment and design.

The links being created, now choose the drawing level of your composition, using the command Draw + Level N.

Sometimes, you may have to modify the length or orientation of segments of the composition template . Use the command Edit + Edit with View.

If you find that one pattern looks too dense with respect to another, you can decrease its density by clicking on the linked segment and then hitting the K key once. To increase its density instead, you would hit the L key. This causes the drawing level on that segment to be decremented or incremented relative to the other segments. The template letter shown on the segment shows by how much the level is changed. For example, a segment with "B" may become "B+2" or "B-3" if the level is increased by 2 or decreased by 3.

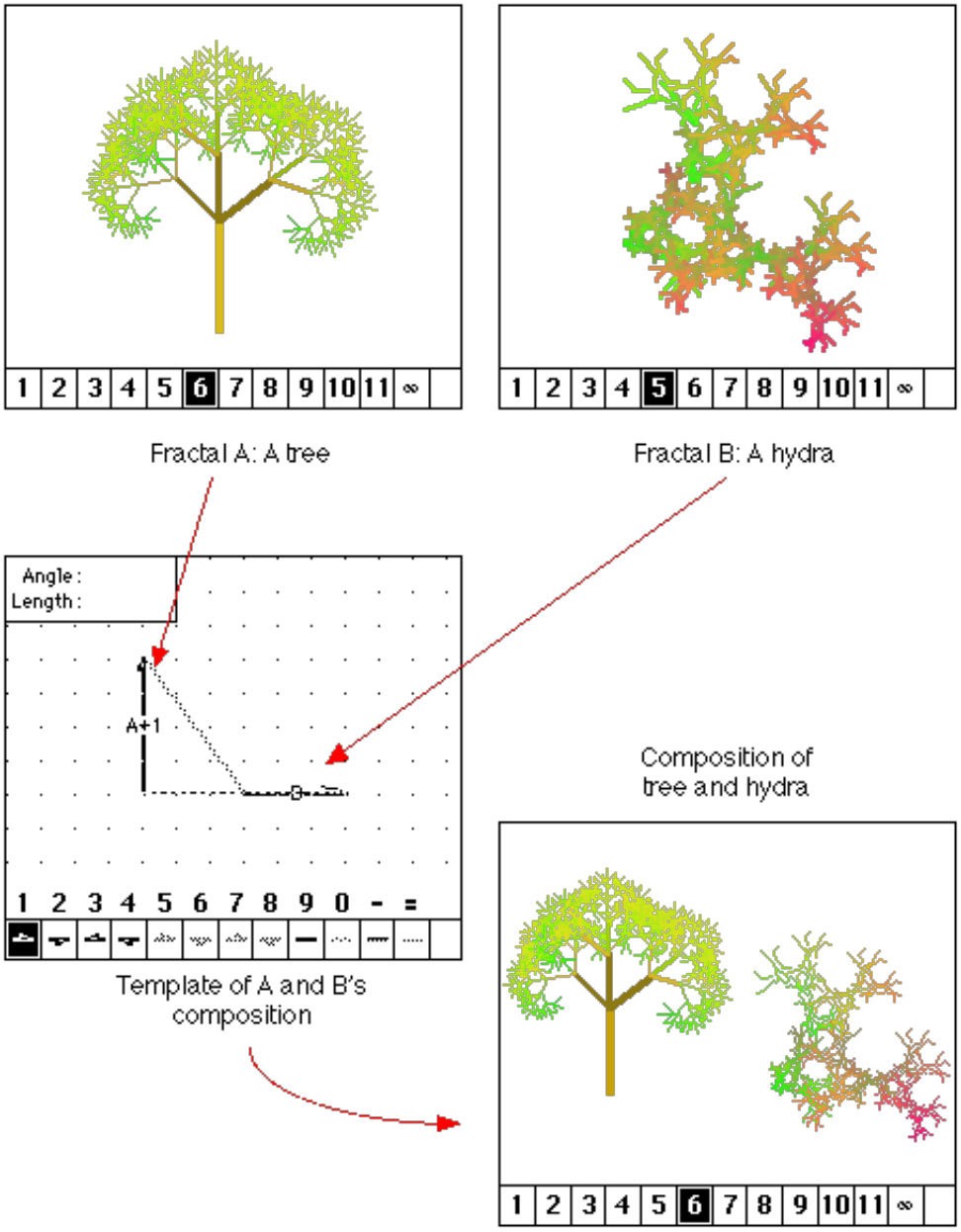


Fig. 25

Chapter 5. Additional Commands;

A Simple Commands ;

* The left and right arrows (¨ Æ) decrease or increase the drawing level.

* The down and up arrows (Ç Ø) reduce or expand the window's size. There are limits, however!

* The numeric keys (1 to 9, 0) set the drawing levels 1 to 10, as from the palette. The "-" and "=" keys set the drawing levels 11 and infinity.

* Option + N where N is a number key sets a so-called "infinite" drawing level. The level is marked "L=É(N)" in the menu bar. The program chooses the drawing level while it is drawing to ensure that all elements have a base line of at most N pixels long (the 0 key means 10). This threshold can be decreased or increased with the left and right arrow keys (¨ Æ). The left arrow can decrease the threshold to below one pixel, namely to 0.1 pixel. The right arrow can increase the threshold to above 10 pixels. A few examples of infinite levels:

Option + 1: the drawing is very dense. The size of the smallest elements is maximum 1 pixel.

Option + 4: the drawing is somewhat dense, the strokes appear light. The size of the smallest elements is set to 4. This density is the default used by the É drawing level in the palette.

Option + 0: the maximum element size set to 10, so the drawing is light.

* Option + Cmd + R: reduces the fractal's size by one pixel.

* Option + Cmd + E: enlarges the fractal's size by one pixel.

B Complex Commands ;

Precision Display;

The upper left corner of the template window displays two numbers related to the selected segment or point in the template drawing:

Angle: indicates the angle in decimal degrees between a selected segment (or the segment whose end point is selected) and the preceding segment.

Length: indicates the length of the selected segment (or the segment whose end point is selected) in decimal pixels.

Special menus on the right side of the menu bar give additional indications for the current fractal:

* D gives the mathematical dimension of the fractal to four decimal places, ignoring links to other fractals. This number is always between 0 and 2, inclusive.

* L is the drawing level. An infinite level is indicated by *(n), where n is a number giving the maximum size of the smallest element's base line in the drawn fractal.

* S is the degree of spill. A prime (S') indicates pastel spill. Otherwise, a complementary spill is meant. The S menu is not shown if color spilling is not used.

These indications are useful to get high precision in the creation of fractals, e.g., when generating fractals to

be used in an animation.

Multiple Windows with Automatic Links;

A fractal is always prepared in two steps: first the template is designed, and then the fractal itself is drawn. Both of these steps can be done with a single window. First prepare a template, then multiply it into a fractal and color it using the color triangle. The window's mode can be switched between editing the template (with Edit Fractal) and drawing the fractal (by entering a drawing command).

Using two windows instead of one for these two modes is more user-friendly. With two windows it is possible to edit the template while simultaneously monitoring the result on the final drawing. Two windows are created side by side with the Edit with View command. You get a window A for the first mode (editing the template) and a window B for the second mode (drawing the fractal). Actually, there is nothing new going on here. Window B has a template too, as for a composition. This template is very simply a single horizontal segment. It is automatically linked to the template of window A by the Edit with View command.

This principle is taken one step further for associations. The Edit with Association command creates three windows: a second window for the drawing mode and a third window in which the user can put a fractal to be associated. The three windows A, B, and C which are simultaneously displayed on screen for associations (Edit with Association) are linked along the same principle: A and B are automatically linked to segments of C's template.

Double Linking;

This process creates two links in one step, i.e., it simultaneously links a segment of fractal A with fractal B and a segment of fractal B with fractal A. This saves a lot of time and mouse clicks when creating associations with many links. First show two templates on the screen (say A and B), then:

* Select a segment of A.

* Option + click on a segment of B.

This links A's segment to B and B's segment to A in a single operation. The new fractal can be displayed by entering a drawing command on template A or B, or by using Edit + Edit with View. The latter is recommended, since the two windows with the templates are not disturbed.

Chapter 6. Command Reference;

This chapter gives brief summaries of all the menu commands in FractaSketch 2.0.

File ;

New: Opens a new window, allowing to create a new fractal. The New command allows both ways of designing a template:

(1) You can have two windows simultaneously on screen, as when you first open the program. In

this case the template is on the left, while the resulting fractal is on the right. After creating a new window with New, immediately choose the command Edit + Edit with View to create the second window.

(2) If you prefer to work on single windows, you can open them with the command New. Then, to modify the template after having switched to the fractal, choose Edit Fractal. If you want to go back to the two windows configuration, choose Edit + Edit with View.

Open...: Opens an existing file.

Insert...: Inserts a file in an existing window.

Close: Closes the active window. Holding Option down while closing a window does not ask whether to save the window's contents to a file.

Close All: Closes all open windows. Holding Option down while closing all windows does not ask whether to save the windows' contents to files.

Save: Saves the current fractal, i.e., the active window and all windows that it is linked to, directly or indirectly.

Save As PICT: Saves the current fractal as a drawing in standard Macintosh format.

Save As TEXT: Saves the current fractal as a text. This allows to inspect FractaSketch's internal encoding of a fractal. This command is not recommended for casual use.

Revert: Reverts to the previous version.

Duplicate: Duplicates the selected window.

Page Setup: Defines the printing setup.

Print: Prints the contents of the active window on a single page at the maximum possible size.

Print Poster: Prints the fractal in the active window on four pages that fit together as a 2x2 poster. Holding Option down while choosing Print Poster will print a larger poster (3x3). Print Poster may take large amounts of time and disk space.

Quit: Exits the program.

Edit ;

Cut: Cuts the selected template to the clipboard.

Copy: Copies the selected template to the clipboard.

Paste: Pastes the copied template in the active window.

Clear: Deletes the content of the active window.

Finish: Terminates the template and draws the resulting fractal.

Edit Fractal: Shows the fractal's template in the active window. The template can be edited.

Edit With View: Shows the fractal's template in the active window, and opens a new fractal window to the right of the active window.

Edit With Association: Opens two windows to the right and below the existing one to realize an association or a composition.

Reset Links: Cancels all links within the activated template window.

Expand Window: Doubles the surface area of the active window, up to full screen. The proportions of the fractal are not affected. This command is identical to the Æ command (right arrow).

Reduce Window: Divides the surface area of the active window by two, down to a minimum size. The proportions of the fractal are not affected. This command is identical to the ¨ command (left arrow).

Grid ;

The whole surface of the template window is covered with a grid. The end points of a segment always stick to grid points. The grid serves only as a guide for constructing the template. It is not printed. Both the arrangement and density of the grid can be adjusted. The commands are:

Square: the grid points are arranged in a square matrix (default).

Hexagonal: The grid points are arranged in a hexagonal matrix.

None: The grid is suppressed. This allows to draw the segments with the end points anywhere.

Very Small: 1 grid point every 4 pixels.

Small: 1 grid point every 8 pixels.

Medium: 1 grid point every 16 pixels (default).

Large: 1 grid point every 32 pixels.

Very Large: 1 grid point every 64 pixels.

Color ;

. **Color Triangle**: Shows or hides the color triangle. The color triangle is the principal tool used to color a fractal. Colorization with the color triangle has the property that it is independent of the drawing level, that is, it becomes more detailed at higher levels but the colors to not changed. This is a powerful feature that allows the shape and color of a fractal to be designed separately.

Begin...: Alows to choose the precise color at the beginning of the template.

End...: Allows to choose the precise color at the end of the template.

Monochrome...: Allows to choose a single precise color for the whole fractal.

Reset Color: Reverts to the standard colors, i.e., a black fractal on a white background.

White Background: The background becomes white.

Black Background: The background becomes black.

Color Background...: Allows to choose the precise background color.

Mixed Colors: The colors of the segments are mixed taking their intensity into account (default).

Pure Colors: Instead of mixing, the colors of segments stay basic colors when they meet or superpose. Basic colors are colors that are always at maximum intensity. All colors as shown in the color triangle are basic colors.

Interpolate by Length: The longer a segment, the bigger the part of the color path that it traverses (default).

Interpolate by Number: Every segment travels the same proportional part of the color path independently of its length.

Spill ;

None: Cancels the spill (default).

Complementary: The colors spill into their complementary colors. This command is a toggle, that is, when repeated, the complementary spill is alternatively turned on and off.

Pastel: The colors spill into pastel colors. This command is a toggle.

The other commands are used to adjust the degree of spill:

Less Spill: Decreases the spill by 1.189, i.e., nearly 20%. If this command is repeated 4 times, the spill is divided by a factor of exactly two.

More Spill: Increases the spill by 1.189. If this command is repeated 4 times, the spill is multiplied by a factor of exactly two.

Nudge Less Spill: Decreases the spill 10 times less than with the Less Spill command.

Nudge More Spill: Increases the spill 10 times less than with the More Spill command.

Reset Spill Factor: Sets the spill factor to its default value.

Draw ;

Same Level: Redraws the fractal with the same drawing level.

Higher Level: Increases the drawing level by 1 step.

Lower Level: Decreases the drawing level by 1 step.

Level 1: Sets the drawing level to 1 (same as from palette).

Level 2: Sets the drawing level to 2 (same as from palette).

...

Level 10: Sets the drawing level to 10 (same as from palette).

Level *: The drawing level is chosen dynamically during the drawing such that the maximum size of any element is 4 pixels. The commands Higher Level and Lower Level can be used to modify this threshold. The infinite level can be used to give a drawing a uniform, adjustable density.

Top Down: The elements are drawn at a size that is determined by the length of each segment, and typically decreases with increasing drawing level (default). This command disables the Bottom Up command.

Bottom Up: The elements are drawn at a constant size. This command disables the Top Down command.

Scale ;

Expand: Enlarges the surface area of the fractal by a factor of two.

Reduce: Reduces the surface area of the fractal by a factor of two.

Expand One Pixel: Enlarges the fractal by one pixel.

Reduce One Pixel: Reduces the fractal by one pixel.

Scale To Fit: The fractal is drawn at the maximum size to fit in the visible part of the window.

Reset Scale: Cancels the above commands: the fractal is centered in the window at its default size (default).

Rotate: Allows to rotate the drawing. After choosing this command, click and drag in the fractal window: the drawing rotates around the center of the window. When Rotate is enabled, the mouse pointer changes to a curved arrow.

Line ;

Thinner: Decreases the thickness of the lines.

Thicker: Increases the thickness of the lines.

Proportional: This command is a toggle. When enabled, the line thickness varies as a function of the length of the segments: the longer they are, the thicker. This allows for pseudo-three-dimensional effects.

Centered: Thick lines are centered on the segment (default). When disabled, thick lines are offset so that their top edge coincides with the segment. The latter mode is kept for upward compatibility with older versions of FractaSketch.

Reset Line: Resets the line thickness to the default 1 pixel.

Normal: The lines are drawn as with a pen, that is, newer lines paint over older ones.

Invert: Whenever two segments cross each other, the intersection becomes invisible. Similarly, a segment superposing onto another makes the latter invisible. This is useful for black and white drawings. For color drawings, the fractal's color is always the complementary of the background color.

Glossary ;

Association: An association combines two fractals, a pattern and a shape, or two patterns into a single fractal. This is realized by creating links between segments from one and from the other in their templates.

Base line: The line joining the starting point to the end point of the template and serving as the basis for the multiplication of the element in the fractal. It is displayed as a dashed line.

Basic colors of the fractal: Chosen by positioning points in the color triangle. The connected set of line segments passing through them is called the color path. They determine the prevailing colors of the fractal.

Color triangle: A triangle containing all pure colors of the spectrum, used to color the fractal. The colorization determined by the color triangle is independent of the drawing level. That is, higher-level drawings will be more detailed than lower-level drawings but will have the same colorization.

Color path: Path traveled by a segment or the whole fractal through the color spectrum in the color triangle. The color path is a connected series of line segments that has the same number of segments as there are active segments in the template.

Combined fractal: A fractal produced as the result of an association.

Complex association: A complex association combines two fractals by interlinking very precisely specific segments in their templates. The result is a function of the chosen segments.

Drawing level: To draw a fractal, each segment is replaced by an element. The number of times this is done to the whole fractal is called the drawing level. The higher the drawing level, the more complex and dense the fractal will be, and the longer it will take to draw.

Drawing level palette: Allows to set the drawing level of the fractal directly, without accessing the Draw menu.

Composition with several patterns: In contrast to an association, a composition combines patterns without changing them: they are just placed side by side as desired.

Density of the fractal: How "filled" the drawing is. The drawing contains more or less filled areas: if it is too dense the shades appear indistinct, whereas if it is insufficiently dense the lines are too thin and the colors appear faded out. Typically, the density is changed by changing the drawing level.

Element: The set of segments and the base line in a template. Such an element is progressively reduced while being multiplied in the fractal, according to the drawing level. Modifying the element thus changes the resulting fractal.

End point: The last point of the template. The distance between the starting point and the end point should be about the same size as the template. If the end point is too close to the starting point, a last invisible segment should be created. This last invisible segment can also be used to adjust the orientation of the fractal.

Fractal: A fractal is a mathematical object that has a large complexity when viewed in a particular way. It can represent natural objects (sponges, ferns, trees, snow flakes, etc.). The parts of a fractal exhibit similar patterns at increasingly fine scales. A drawing of a template at a given drawing level is also referred to as a fractal, although to be precise it is only an approximation to a fractal.

Grayscale bar: Situated to the right of the color triangle, it is used to adjust the intensity of a selected color.

Line type palette: Allows to select the orientation of a segment in the template, which will affect the orientation of the element when it gets multiplied in the fractal.

Link: A link is a connection between a segment and another template. When the fractal is drawn, the element on that segment will have the shape of the template it is linked to.

Pattern: A fractal of which the decorative aspect is more important than the shape.

Pixel: The smallest uniformly colored element of a computer image.

Position template: A special template, the segments of which are linked to the patterns of a composition to set their respective positions.

Segment: A single stroke in the template, used to construct an element, which is then itself repeated to draw a fractal.

Shape: A fractal which is not only useful by its own decorative character but is used to shape another fractal in an association: it can be a square, an hexagon, a spiral or whatever.

Spill: A process allowing to shade away the colors of a fractal towards complementary colors or towards pastel colors. Spilling is hard to control because the effects depend on the drawing level.

Starting point: The first point of a template. See `end point'.

Template: A sequence of line segments, which is the basic seed from which a fractal is generated.

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