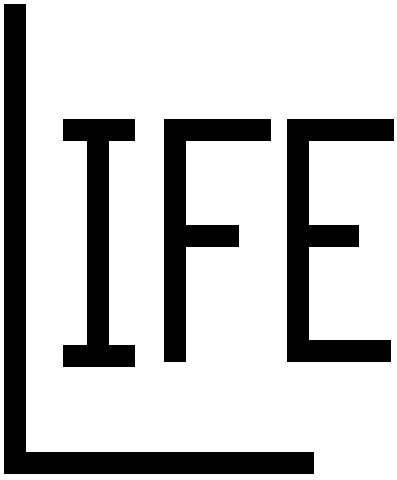
CSCI Presents

The Game of



Version 1.1
For the Apple Macintosh™

Computer **S**oftware **C**onsultants, **I**nc.
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The Game of Life was invented by John Horton Conway and brought to public attention by Martin Gardner in the Mathematical Games section of Scientific American, October, 1970, Volume 223, #4 and February, 1971, Volume 224, #2.

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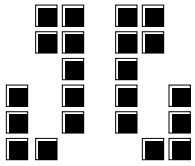
Introduction

The Game of Life is a fascinating game that was invented by John Horton Conway, an English mathematician, in the late 1960's. It was brought to public attention in the Mathematical Games section of the Scientific American (October, 1970), written by the esteemed Martin Gardner. In 90-dollar words, it is an example of the simulations used to investigate cellular automata theory. In practical applications, the game was predicted to be useful in the design of self-repairing circuits, or the wiring of any new circuit. Unfortunately, we haven't been able to determine if these predictions have come true. If you, the reader, have any pertinent information, please clue us in. Whether the game has any practical applications or not, we still like the pretty pictures.

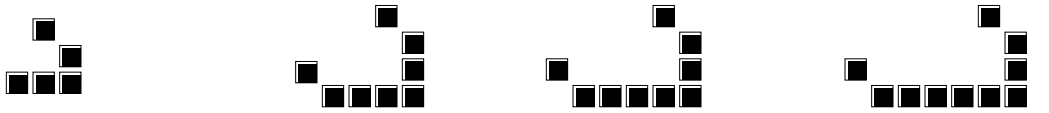
The game of Life uses a 2-dimensional grid as a representation of a universe where a colony of cells resides. Cells live and die according to strict rules of etiquette and crowding. An existing cell remains alive in the next generation if it has two or three neighbors to share tea. A cell with only one neighbor dies of loneliness in the next generation. A cell with more than three neighbors dies of crowding and lack of privacy. A new cell is born in the next generation in any space that has exactly three neighbors to look after it. Cells are born and die simultaneously.

There are certain types of patterns that have been discovered, including stable patterns, oscillators and travelers. Stable patterns remain unchanged forever. For instance, a 2 x 2 block of cells will not change. An oscillator returns to its original pattern after some number of generations. There are many different oscillating patterns, some of which are shown here. The tumbler (to use Conway's name for it) will turn upside down in 7 generations. The pentadecathalon will return to the original in 15 generations. The last pattern is an oscillator generator that will, in 32 generations, produce an oscillator that surprisingly returns to the original in only 3 generations.



Tumbler Pentadecathalon Oscillator Generator

There is another class of patterns that are interesting because they travel. These are patterns that will oscillate back to their original shapes, but will have shifted in some direction. There are at least four kinds of travelers: gliders (also called featherwieght spaceships), and three spaceships: lightweight, middleweight and heavyweight. These patterns are shown below. Gliders travel diagonally away from their corner. Spaceships travel along their long axis. Note that the heavier spaceships have an exhaust of one or two cells to their open corners, but the gliders travel cleanly. Some very interesting effects can be produced by colliding travelers. For instance, a glider can collide with a heavyweight spaceship so that is is reflected back parallel to its original path. Two heavyweights can be collided to form the same oscillator made by the oscillator generator shown on the previous page. Other possibilities we leave to you.



Glider Lightweight Middleweight Heavyweight

There are also configurations called glider guns that will oscillate and throw off a glider after a certain number of generations. By using multiple glider guns, you can cross streams of gliders to make different collisions. We have included three sample files that contain glider guns. One configuration fires gliders that travel diagonally down and to the left; it is called `Glider Gun - Left`. Another configuration fires gliders that travel down and to the right; it is called `Glider Gun - Right`. The last file contains both glider guns firing in streams that cross; it is called `Two Glider Guns`.

Hardware Requirements

The game of Life will run quite happily on a Macintosh Plus with 1 megabyte of memory. It will run even more happily (and much, much faster!) on a Macintosh II. We fervently believe that this program will also run on a Macintosh 512K Enhanced. Unfortunately, we have no access to one, so we can't test it. If that's what you've got, you're on your own, kimosabe.

About this Manual

This manual will show you how to set up and play with colonies of your own.

It is assumed that you are familiar with the Macintosh environment and that you understand concepts such as click and drag, opening applications and manipulating windows. If these ideas are foreign to you, you should consult the Macintosh tutorial for help.

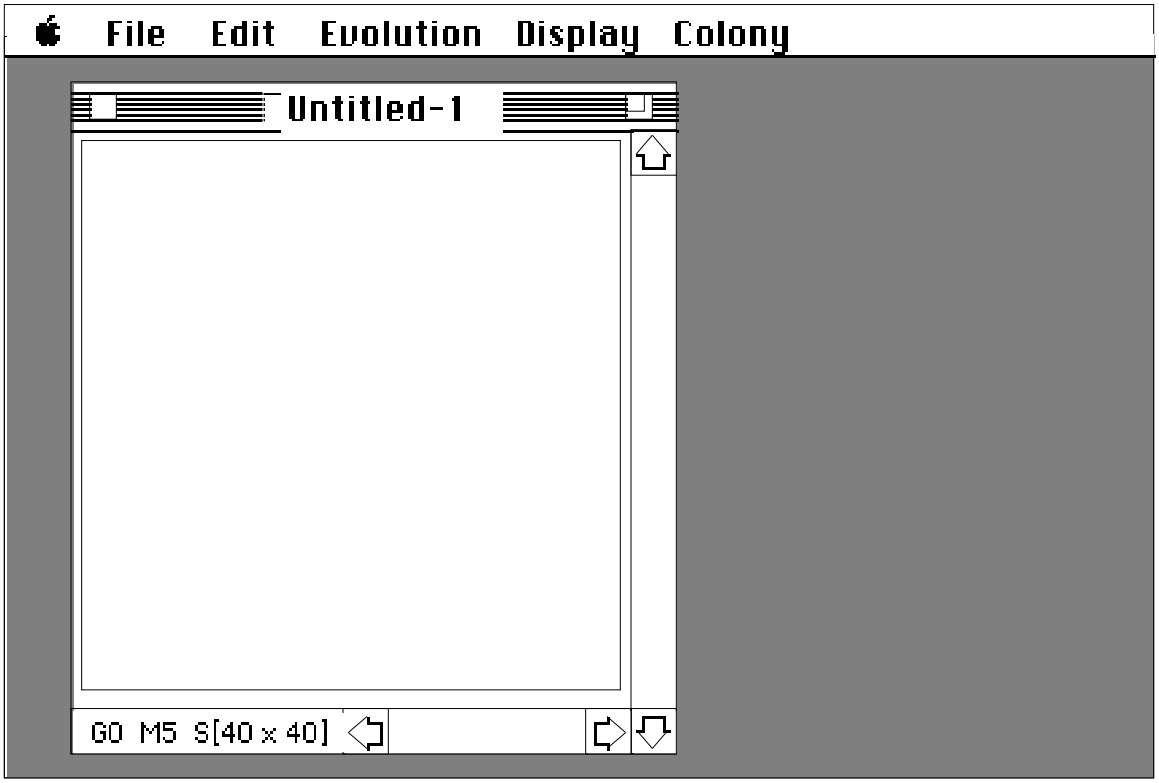
Installing the Game of Life

The game of Life is shipped on a double-sided floppy disk. To install the game on your hard drive, simply copy it. You can also copy the sample starting colonies included, if you want.

To run the application, double click on the game icon or on any saved colony.

Playing the Game of Life

When you start the game of Life, your screen will look like the one shown below. You can click on any cell within the frame of the universe to bring it to life. Live cells are colored squares. If you do not have color capabilities, the cells will be black, but we'll talk about colors later. You can also click and drag to bring to life every new cell that you touch. If you have ever used



a drawing program like MacPaint, you can think that clicking and dragging works like the pencil tool. If you haven't used MacPaint or something similar, then the reference is obviously lost on you, and you'll have to figure it out for yourself. If a cell is already

alive, clicking on it will kill it. If you click on a live cell and then drag, you can kill lots of cells at once. Note that if you click and drag to create cells and happen to touch a living cell, that cell will remain living.

After you have created a beginning colony, you can evolve it. Evolutions are performed by the options on the Evolution menu. You can choose to evolve a colony for up to ten generations directly from the menu or through keyboard equivalents, or you can evolve for any number of generations by choosing Evolve... You can evolve up to 9,999 generations this way.

You can stop a series of evolutions at any point by using Command-period (hold down the Command key and press the period). The evolutions will be stopped at that point and you can select any other option in the application. If you want to pause the evolution, use Command-comma. This will hold the current pattern on the screen until you move the mouse. You can also turn off the display by using Command-slash. Command-slash halts the display of each generation on your screen without interfering in the actual evolutions. Evolution is much faster this way, so if you want to get to, say, generation 100 in a hurry, hold down the Command-slash.

These are the basics of the game of Life. There are other facets to the game that make it more interesting and more pleasant to play. You can resize the universe, magnify the size of each cell, even change the rules of evolution.

The Window

You may have noticed the small box on the left side of the bottom scroll bar that reads something like this: G0 M5 S[40 x 40]. This is the status box, and it tells you the generation number, the magnification and the size of the universe.

The first item is the generation number. The generation number is the number of evolutions so far for this colony. It is displayed as “G” followed by a number. You can set the generation to be any number using the Set Generation Number option on the Colony menu. Subsequent generations will increment from the number you enter.

Next to the generation number is the magnification. The magnification is the number of pixels along one side of a cell. New colonies always start with magnification 5. You can go down to 1 pixel cells or up to 75-pixel cells. Remember that changing the magnification does not change the size of the universe; it only changes the displayed size of the cells. You can set the magnification to a particular pixel value using the Magnification… option on the Display menu, or you can increment or decrement the magnification by one pixel using Zoom In and Zoom Out, which are also located on the Display menu.

The last information in the status box is the size of universe. The universe is a grid, and its size is always shown as a number of rows (the height or vertical distance) followed by a number of columns (the width or horizontal distance). New universes start as a 40 by 40 grid, but you can set the size of either side to be between 5 and 300. Remember that making a universe larger increases the number of cells by an awful lot, and the program will run visibly slower. Also, you may not have enough memory to handle the additional cells. The Resize option is on the Colony menu.

The status box performs another important function. Whenever you click on a cell, or click and drag, the status box will display the coordinates of the cell that is being set. If you hold down the Shift and Option keys when you click or click and drag, the coordinates will be displayed similarly, but the cell will not be changed. Knowing coordinates is important when you resize a

colony.

The File Menu

The file menu follows all Macintosh standards. It is expected that you already know and understand how to use the options on this menu. For details, see the Macintosh tutorial that came with your system.

The New option allows you to create a brand new universe. New universe will be 40 rows by 40 columns in size, have magnification set to 5 and will start at generation 0. The evolution rules will be set so that loneliness is fatal with less than two neighbors, overcrowding occurs with more than three neighbors and birth takes place with exactly three neighbors.

The Open command allows you to open previously saved game files. We have included several sample files for you to examine at your leisure.

The Close command closes the currently active universe. If there are changes to be saved, you will get a dialogue box asking if you want to save them.

The Save command allows you to save the current universe. Saving Life files follows all Macintosh conventions for file names, locations in folders, etc.

The Save As... command allows you to save the current universe without disturbing the previously saved version. Suddenly, you have two files instead of just one.

The Revert To Saved... option will recall the universe as it was last saved to disk.

The Page Setup... lets you set the characteristics you want for your printer and printouts. The page setup commands available to you are dependent on the capabilities of your printer.

The Print command will print the current universe. If you are using colors, the printout will be in color. If your printer does not use colors, the cells will print in shades of gray. If you do not have Display colors selected, the cells will print as black on a white

background.

Finally, the Quit command ends the session with the game. Any open files will be closed; any files with changes to be saved will bring up a dialogue box for you.

The Edit Menu

The edit menu has only one item of any value to this application: the Undo command. However, we have graciously left the Edit menu in place, little as we need it, so that it would be available to your desk accessories.

The Undo command will undo the last command if that command was an evolution of whatever length, a kill colony or a click or click and drag that created or destroyed cells. Undo will not undo magnification changes, changes in generation numbers or any resizing.

The Evolution Menu

The options on the Evolution menu are used to bring the colony to life. You can evolve for up to 10 generations directly from the menu or through keyboard equivalents, or you can use the Evolve... dialogue box to select any number of generations up to 9,999.

If you don't know about keyboard equivalents, then pay attention and keep reading. Keyboard equivalents, if there are any, are listed next to each option like this: ⌘1. This combination is the Command key and the number one. It would be used by holding down the Command key and pressing the number one key. It is listed next to the Evolve One command, so that pressing this key combination would evolve the colony for one generation. Other combinations are listed next to the appropriate menu choice. From the Evolution menu, you can see that holding the Command key and pressing 8 would activate the Evolve Eight command. There are command key equivalents on each of the menus in the game of Life.

The Display Menu

The Display menu is used to change the view on your screen. It controls the size of a cell as well as whether or not color will be used. Options on the Display menu cannot be undone.

Magnification

The size of a cell can be changed in two ways. You can select a particular size by using the magnification dialogue box or you can change the cell size by one pixel using either Zoom In or Zoom Out. Cells can be any size between one pixel and 75 pixels on a side.

If you select Zoom In from the Display menu, the size of a cell will be increased by one pixel, as if you were getting closer to it. If you select Zoom Out, the cells will get smaller.

If you select Magnification... from the Display menu, you will get a dialogue box. Type in the magnification you want and click OK. The default is 5 pixels.

Color

The game of Life can be played in living color. If your Macintosh has ColorQuickDraw, then the game will automatically be played in color. If you do not have a color monitor, the colors will be shades of gray. If you have color capabilities but prefer black and white, make sure the Display Colors option on the Display menu is not checked. If it is checked, select the option to turn off color display.

The color of a cell indicates its age. As a cell remains living from one generation to the next, its color will change until finally it becomes black. A first-generation cell is emerald green. If it lives for a second generation, it turns desert tan. The colors for each generation are:

Generation	Color
1	Emerald Green
2	Desert Tan
3	Crimson
4	Lilac
5	Sapphire Blue
6	Sky Blue
7+	Black

Once a cell turns black, it remains black until it dies. Note that if you click on a cell of any color, it will die; however, if you click and drag across a living (colored) cell, it will be turned emerald green.

The Colony Menu

The options on the Colony menu affect the basic make-up of the colony. You can kill a colony or reset the generation number. You can change the size of the universe, and you can also change the rules of evolution.

Kill Colony

This option resets the current universe to generation 0 with no living cells. The size of the universe and the rules of evolution are unaffected.

Set Generation Number

This option is used to set the generation number as you wish. A dialogue box will be displayed on your screen. You can set the generation number up to 9,999.

Resize Colony

The Resize Colony option copies a specified section of the old universe into a different universe with dimensions that you specify. Using this option, you can shrink or expand the size of the universe, selecting all or part of the current colony. To resize a colony, you must give the new vertical and horizontal sizes, indicate a rectangle that includes all the cells you wish to keep, and indicate where that rectangle should be placed in the new universe. The rectangle selected must fit in the new universe at the place you specify. All of this information is on the resize dialogue box.

The current V size is the number of rows in the universe; the current H size is the number of columns. For a new universe, these values are both 40. The new V size will be highlighted. If you want to change the number of rows, you can enter it that number now. If you want to change the number of columns, select the new H size box.

Below the new size boxes is the From Rectangle information. This is the section of the old universe that you want copied to the new. You must specify the row and column numbers of the corners of the rectangle to be copied. If you select resize from the menu, the corners of the rectangle will be the corners of the universe.

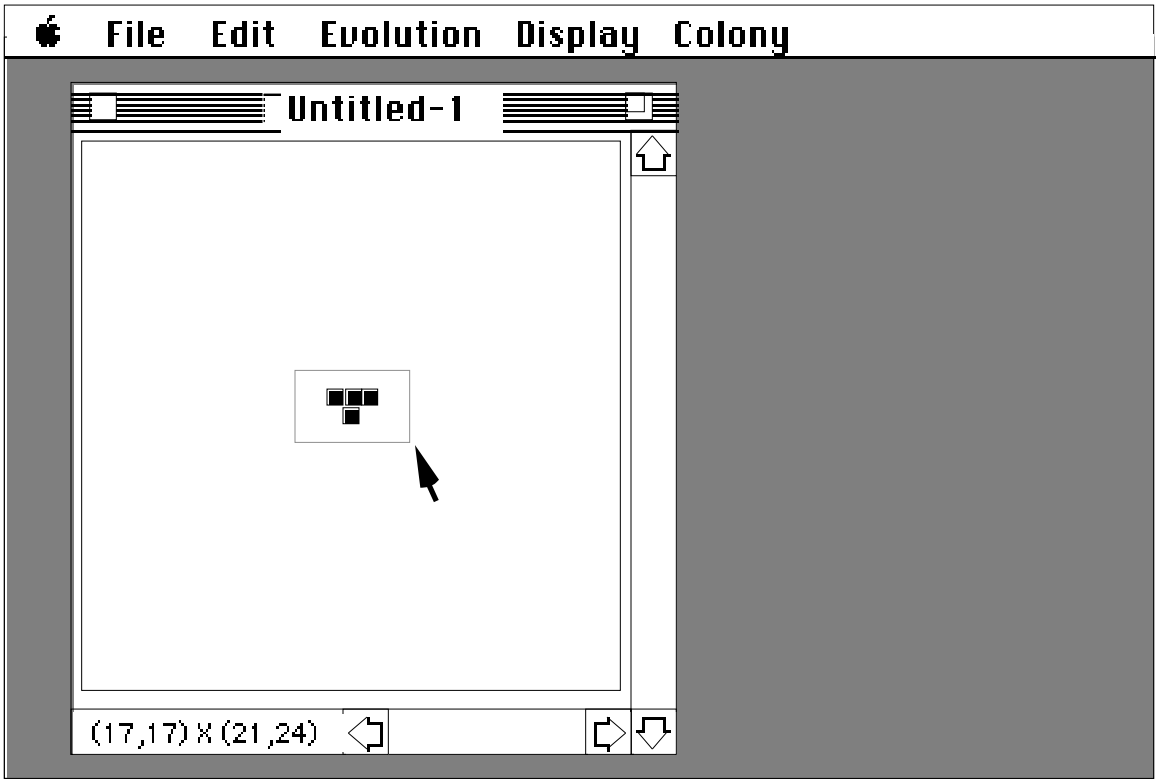
If you wish, you can manually enter the corners of a smaller rectangle. Unfortunately, it is not always easy to determine exactly the row and column numbers, so we have tried to take some of the hassles out of your life. If you hold down the Option key and click and drag, a selection rectangle will be displayed, and the corners of that selection rectangle will be used in the Resize dialogue box. If you use the Option-click-and-drag, the Resize

dialogue box will come up automatically when you release the mouse, with the From Rectangle fields already filled in.

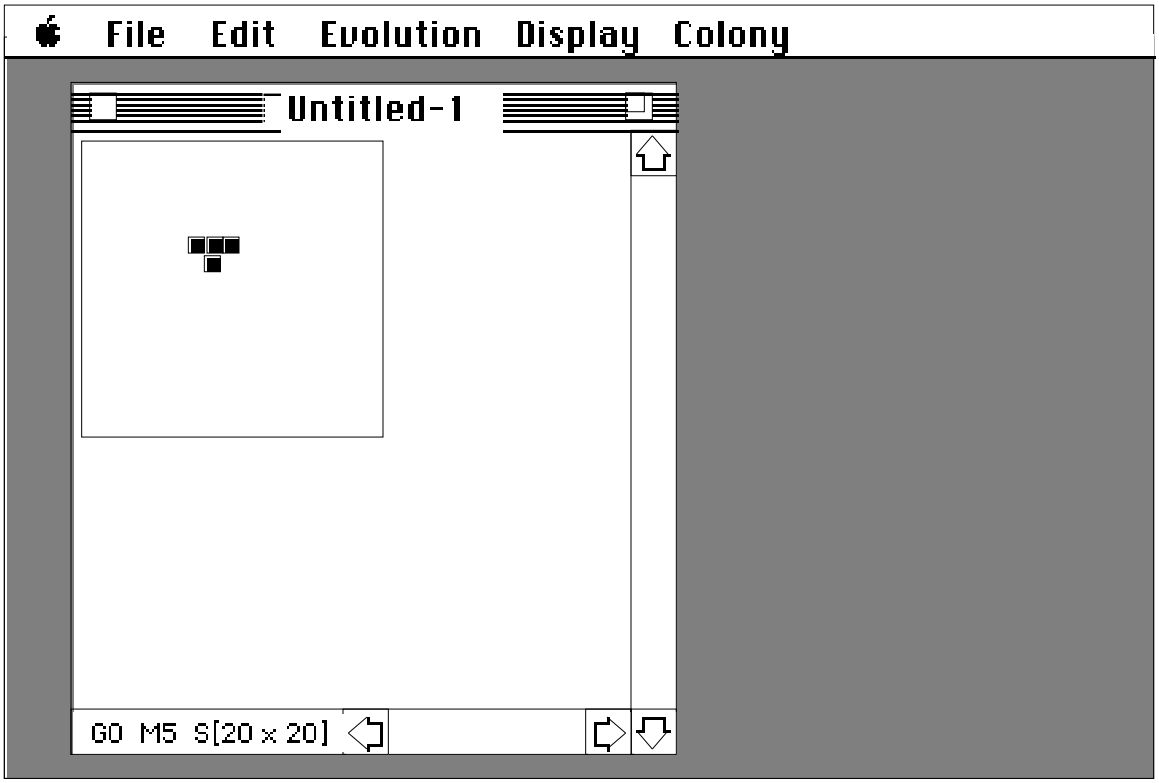
The last piece of information necessary to resize is the location to put the selected rectangle. This location is defined as the point where the upper left corner of the rectangle belongs in the new universe. Using point (1,1) will put the selection into the upper left-most corner of the new universe.

To take a closer look at this option, let's create a quick example colony. Click to select a cell near the middle of the universe. Then, click on the cell to the left, the cell to the right and the cell below. Now, position the tip of the cursor arrow above and to the left of that colony. Hold down the Option key and click and drag down and to the right until the dotted rectangle contains the entire pattern. This is shown in the diagram on the next page. When you release the mouse button, the resize dialogue box will appear.

Let's shrink the size of the universe. Enter 20 for the new V size and the new H size. If you click Resize now (or press the Return key), a new colony will be created on a 20 x 20 universe, and the pattern will be nestled in the upper left corner. Since we really don't want the pattern put there, you should enter 7 as the To V and To H points. Click Resize. Notice that the new universe takes up much less room in the window, but that the cells are the same size as they were before. This is very different from changing the magnification.



These screens show the universe before and after the example resize from the previous page. On the screen above, the colony is included in the selection rectangle. The user is holding down the Option key to activate the selection rectangle. On the screen below, the universe has been shrunk to be 20 x 20.



Evolution Preferences

The evolution preferences dialogue box allows you to change the evolution rules. That's right-you can make cells die of loneliness with 4 neighbors, or die of overcrowding with 8. You make the rules. It's even better than playing chess with your 6-year-old cousin.

The standard rules are:

Loneliness at less than 2 Neighbors
Overcrowding at more than 3 Neighbors
Birth requires exactly 3 Partners
Death at generation 0

Since there can be no more than 8 neighbors to a cell, you can set the loneliness and overcrowding numbers to be between 0 and 8. Remember that the loneliness number can never be greater than the overcrowding number. The birth number cannot be 0, so its range is between 1 and 8. Also, it makes more sense for the birth number to be somewhere between the loneliness and overcrowding numbers, inclusive, but you can set it as you wish.

The Death at generation number sets an age limit on a cell. Any cell that has been alive for that many generations will not be alive in the next. Thus, even stable patterns will disintegrate eventually. You may set the age limit to be up to 9,999 generations. Setting this field to 0 indicates that there is no age limit.

About Memory and the Game of Life

This is just a note about the memory usage by the game of Life, since it may surprise you. The game uses a grid of integers to represent the universe; each integer is a cell. Since each integer is two bytes long, a 40 cell x 40 cell universe would be 80 x 80 bytes, which is 6400 bytes in the universe, using the old math. In addition, the program needs two copies of the universe, one of whichholds the new generation as it evolves and another to make certain commands undoable. The total memory required by a 40 x 40 universe is 19,200 bytes of memory. Still, 19,200 isn't really that much memory. The problems arise when you get into larger universes. Try doubling the dimensions.

Doubling a 40 x 40 universe (to 80 cells on a side) would give you 160 x 160 bytes, which is 25,600 bytes per universe, and you need three of them, so you will be using 76,800 bytes of memory for an 80 x 80 universe. A 300 x 300 universe requires about a megabyte of memeory.

The message is: don't be surprised if larger universes will not run on your system, especially under MultiFinder.

The Game of Life
Product Registration

S/N #_____

Why should you register?

There is no earthly reason that you should register. There are no phone help lines with computerized menus to help you choose the right department, no dedicated AppleLink address. Besides, why should there be any support for such an easy-to-use program? Any how-to-use questions can be answered by any 14-year-old computer expert (and we're older than that) and any why questions would need a mathematical theorist to answer (which is not our chosen profession). So why should you register?

You should register because we want to know who you are and what you thought of our product, so we can make bigger and better products that you will like more. We want to know our customers. And, please don't hesitate to share with us any nifty findings about the game of Life. Just because we can't explain them doesn't mean we aren't interested in them. If you need more space for your answers, feel free to attach extra pages.

Please tell us who you are:

Your Name:_____ Your age:_____

Your Company:_____

Address:_____

_____

City, State, Zip_____Phone #:_____

Were you familiar with the game before using our product? If so, how?_____

_____

How do you like the game of Life?_____

What, if anything, would you change or add?_____

_____

What do you think of the manual? Was it easily understood?_____

_____

What other kinds of software are you interested in?_____

_____

Did you remember to make a charitable contribution?_____

What did you have for breakfast this morning?.....

General comments:_____

_____

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