AutoCell 2.0 Contents

Cellular Automata for Windows 3.1

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Introduction to AutoCell 2.0

"Cellular automata are stylized, synthetic universes... They have their own kind of matter which whirls around in a space and a time of their own."

- Tommanso Toffoli (quoted from an A.K. Dewdney article)

Cellular automata represent some of the most interesting and colorful mathematical phenomena. AutoCell 2.0 allows you to explore a virtually infinite number of cellular automaton universes beyond Conway's "Life." Using simple rules, and with drawing and editing tools, you can quickly construct a miniature universe or a cellular computer. States of cells in AutoCell 2.0 are defined as colors chosen from a palette.

You are encouraged to explore AutoCell 2.0 by reading the tutorial document and by examining various sample files.

AutoCell 2.0 is shareware, and may be registered for $20 U.S. ($24 Can.) payable to:

Paul Keet
12726 Southridge Dr.,
Surrey, B.C., Canada
V3X 3C6

Your shareware registration fee will help ensure a supply of quality products like the one you are now using.

Please feel free to send me any interesting discovers or offer any suggestions on improving AutoCell 2.0 at the above address. You may also contact me through CompuServe at 70530,3622.

Creating a New Board

To create a new cellular automaton universe, select **New** menu item from the **File** menu and choose a playing board of the dimensions you desire. Please note, that for structural reasons, your board can't contain more than 61,440 cells (e.g. 320 cells wide by 192 cells high). AutoCell 2.0 will automatically enforce this limit.

After creating a board, you must add rules and initialize the playing board.

See also:

Importing Rules
Randomize
Tools

Exporting a Bitmap

You may export a bitmap for use in other programs by selecting **Export Bitmap** menu item from the **File** menu. You will be prompted for the name of the bitmap and a destination. Bitmaps are saved in 256 color device-independent bitmap (DIB) format.

Editing a Board

You may use any of the five drawing tools from the Toolbar to place cell of a color selected from the palette on the playing board. You may copy, cut, paste or clear a section of the playing board by selecting the capture ⬚ tool on the Toolbar and choosing the appropriate function under the **Edit** menu.

See also:

Tools

Grid

Select the **Grid** menu item from the **Options** menu to place a grid over the board. Grids will not show on windows set to the lowest magnification.

Airbrush

The airbrush allows you to randomly place cells of different colors. You can change the rate of flow of the airbrush by selecting the appropriate level in the Airbrush menu item under the **Tools** menu.

See also:
Tools

Using a Board

✍ Leave the title of the playing board, the author and text notes about the board.

□→■ Access the Rulebook for a board.

⏮ Rewind. This will return the playing board to the state it was in it first generation.

⏭ Step. This will move the playing board forward one generation.

■▶ Stop/Play. Start and stop a board.

⏩ Fast Forward. Move as quickly as possible from generation to generation. Note: the fastest possible speed is less than ten frames per second.

See Also:

- Creating a New Board
- Editing a Board
- Grid
- Importing Rules
- Notes
- Tools

Rulebook

After selecting which color of cells you wish to view the rule for from the palette at the top right hand corner of the Rulebook dialog box, you may perform one of the following functions.

Default Choose the default color. If no rules apply to the current cell from the Rulebook, the cell will automatically turn this color.

+ Add a rule to the Rulebook. This will create a rule after the currently selected rule and call up the Rule Editor dialog box.

= Edit a rule. This will call up the Rule Editor dialog box and allow you to edit the currently selected rule. You may also double-click on the rule in the list to call up the Rule Editor.

− Delete a rule. This will remove the currently selected rule from the rule list.

↑ Move a rule up. This will change the order of the rule list by moving a rule up in the list. Sometimes the order that rules are placed in will matter.

↓ Move a rule down.

Exit

In addition, you may also set the neighborhood that the rules will apply within by selecting a neighborhood of eight ▦ or a neighborhood of four ✚ cells.

See also:

Importing Rules

Rule Editor

The first color box on the Rule Editor dialog represents the initial state of a given cell. The second color box represents the state the cell will become if the rule is met. This color may be changed to the color selected on the palette by clicking on the up arrow beneath it.

The remainder of the rule is initially blank, but can be created by clicking on the second up arrow. Clicking on the up arrow will generate a string of color boxes with numbers. The first time a color is chosen, that color will appear with the number **0**. The second time it is chosen, the number associated with the color will change to a **1**, and so on. The colors and numbers thus chosen represents a pattern that must be matched for the rule to apply.

You may clear the rule if you wish to change it by selecting the **Clear** button. If you wish to leave the Rule Editor dialog without changing the rule, select **Cancel**.

See also:

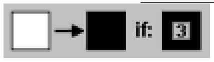
- Importing Rules
- Rulebook
- Rules

Notes

By choosing ✍ on the ribbon above a playing board, you may input a title of the board, your name and a description of the board. You are encouraged to keep copious notes about your projects, and to send interesting projects to the author of AutoCell 2.0 at the address enclosed in the Introduction.

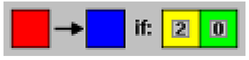
Rules

A rule for a cellular automaton looks like this:



The above rule is interpreted as "a white cell becomes black if it is touching three black cells." This rule is, incidentally, one of the rules used in Conway's Life.

A rule with a **0** in it, like:



is interpreted at "a red cell becomes black if it is touching two yellow cells and no (zero) green cells.

If none of the rules are applied, a cell becomes the default color. The default color is determined for each cell color in the Rulebook.

Rules are stored in a Rulebook for a playing board. The order rules appear in determine the order the rules are applied in. If a rule is successful none of the rules that follow will be applied for that cell; the order that rules appear in can therefore sometimes be important.

These rules form the heart of AutoCell 2.0, and are constructed in such a way as to be quickly interpreted by the program. A virtually unlimited number of cellular automatons can be constructed using these rules. I recommend that you examine some of the sample AutoCell 2.0 files included; pay close attention to their rules.

See also:

- Importing Rules
- Rule Editor

Import Rules

You may import rules from a saved AutoCell 2.0 (*.brd) file. It is not necessary to rewrite all the rules when you create a new playing board, you may simply borrow them from another playing board. Note that existing rules for a playing board are lost when rules are imported.

See also:
    Rules

Default

The default color is the color a cell will turn if no rules are applied. You may change the default color by clicking on the 'Default' button in the Rulebook.

See also:
Rules

Palettes

The floating palette is used to select colors for drawing. Double clicking on a palette entry will allow you to change the Red-Green-Blue composition of that color. The palette may be shown or hidden by selecting the **Show Palette** menu item. Palettes may also be stored or saved.

Please note that AutoCell 2.0 is designed to work with a 256 color palette, I recommend switching video modes to 256 color mode or better to enjoy AutoCell 2.0. It should, however, work in virtually any color mode except CGA.

See also:
  Randomize
  Tools

Randomize

You can randomize a playing board by selecting the **Randomize** menu item under the **Edit** menu. Each cell on the playing board will be changed to a random color. Only colors for which rules apply will be used.

See also:

Palette

Tools

The following tools are available on the floating Toolbar:

+ Turn a cell into a specified color.

⬚ Capture a group of cells for editing.

╲ Draw a line of color.

▒ Airbrush color onto the playing board.

□ Draw an empty rectangle of color.

■ Draw a filled rectangle of color.

⊕ Zoom in onto a location on the board. You may zoom in to a maximum of 32 pixels per cell.

⊖ Zoom out from the board. Note that clicking this button will not change the tool selected.

The Toolbar can be shown or hidden by selecting the **Show Toolbar** menu item under the **Options** menu.

Life

"Life" refers to a type of cellular automaton discovered by John Conway, a mathematician at the University of Cambridge, in the sixties. Life is based upon the following rules:

a) Cells may be either black or white;
b) A black cell will remain black if it is touching two or three other black cells, otherwise it will turn white;
c) A white cell will remain white unless it is touching three black cells, in which case it will become black.

These simple rules lead to complex behaviors. Life is the most popular cellular automaton; much has been written about it in books and the Mathematical Recreations column in the Scientific American. Life is, however, only one type of a large variety of cellular automata.

Cellular Automata

Cellular automata are collections of cells whose individual state is determined by its previous state and the state of the cells surrounding it. States in AutoCell 2.0 are represented as colors. Some rules lead to self-replicating patterns, e.g. 'gliders' in Conway's Life, while other rules can yield patterns which exhibit complex and even cooperative behavior.

Cellular automata are divided into four categories:

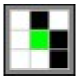
Class I	Automata form into fixed, homogeneous patterns;
Class II	Automata form simple oscillating patterns;
Class III	Automata become unpredictable, although tending towards certain patterns;
Class IV	Automata form complex, regional patterns.

Class IV cellular automata, Conway's "Life" as an example, are the most interesting type and also the hardest to classify.

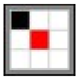
Tutorial

The purpose of this tutorial is to give you a brief introduction to AutoCell 2.0 by constructing the board and the rules for Conway's "Life," a popular type of cellular automaton. To refresh your memory, Life is played on a black and white playing board with the following rules:

a) a black cell will be "born" when a white cell is touching three black cells:



b) a black cell will die unless it is touching two or three other black cells:



To make the best use of this tutorial print it out and place it beside you. Follow the instructions step by step.

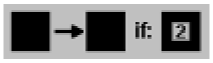
1. Open AutoCell 2.0.
2. Select "New" from the "File" menu.
3. Use scroll bars to set the desired playing board size.
4. Click on 'Okay.'
5. Click on the Rulebook button: You will now be in the Rulebook dialog.

6. Note that the default color setting for black will be white, that is to say a black cell will turn white unless a rule determines otherwise. If the default is not white, change it to white.

7. Click on the Add Rule button: ✚ You will now be in the Rule Editor.

8. Ensure that you have black selected in the color palette.
9. Click on the first arrow: ▲ The white colored box above the first arrow should go black.

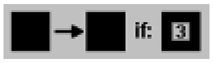
10. Click on the second arrow three times. Your rule should look like this:



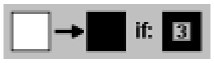
If it does not, click the "Clear" rule button and repeat from step 8. This rule should be interpreted as "a black cell will turn black if touching two other black cells."

11. Click on the "Okay" button.

12. Click on the Add Rule button again and make a rule that looks like this:



13. Click on the "Okay" button and go back to the Rulebook.
14. Select white from the palette at the top right-hand corner of the Rulebook.
    You should now have no rules in your rule list. Also ensure that the default color is set to white.
15. Click on the Add Rule button and construct a rule that looks like this:



This rule should be interpreted as "a white cell will turn black if touching three black cells."

16. Click on the "Okay" button and go back to the Rulebook.
17. Click on the "Exit" button and return to AutoCell 2.0.
18. Either select "Randomize" from the edit menu, or use drawing tools to place black cells on the white board.

19. Click on the Stop/Play button: ■▶

Conway's "Life" should erupt throughout your miniature universe. If it does not, backtrack through this tutorial and your steps to find out what you did wrong.