Tresvita v3.0

A Three Dimensional Cellular Automata

Programmed by Alexander Mieczyslaw Kasprzyk, ©1996

1 Introduction

A cellular automata is a lattice of cells which are used as both memory and processing elements. This lattice of cells can exist in any dimension and can be of infinite size. At any given time each cell can be in one of any of a finite number of states. The transitions between states from one time step to the next (from one iteration to the next) depends upon the state of the cell and the neighbouring cells states. Each state is defined by clear rules, and these rules apply to all the cells on the lattice and at all times. The configuration of cells in the next time step is determined entirely by the current arrangement of cells – past arrangements have no direct influence over future cell arrangements.

Perhaps the most famous cellular automata was developed by John Conway. In Conway's "Life", which is played in an infinite two–dimensional board where each cell is a square (and therefore has eight neighbouring squares). There exist only two possible cell states – on (or "alive") and off (or "dead"). The rules are very simple: if a cell is off it remains off in the next time step unless there are exactly three neighbouring cells in the on state, if a cell is on it remains on unless there are more than three "on" neighbours or if there are less than two "on" neighbours. The patterns produced from these simple rules are amazing, with many "life–like" structures emerging (such as "gliders" which "walk" diagonally across the board).

Tresvita is very similar in idea to Conway's "Life". In Tresvita there exist only two possible cell states, "alive" and "dead", and the rule sets are defined in a very similar way. The major difference is that Tresvita is a three dimensional cellular automata.

2 Loading Tresvita

Tresvita is a FAT application. This means that it runs on both traditional 68K Macintosh computers and also on the newer Power Macintosh (PPC) computers. When running on a PPC machine it takes advantage of the more powerful features available and so should run considerably faster than on standard 68K Macs.

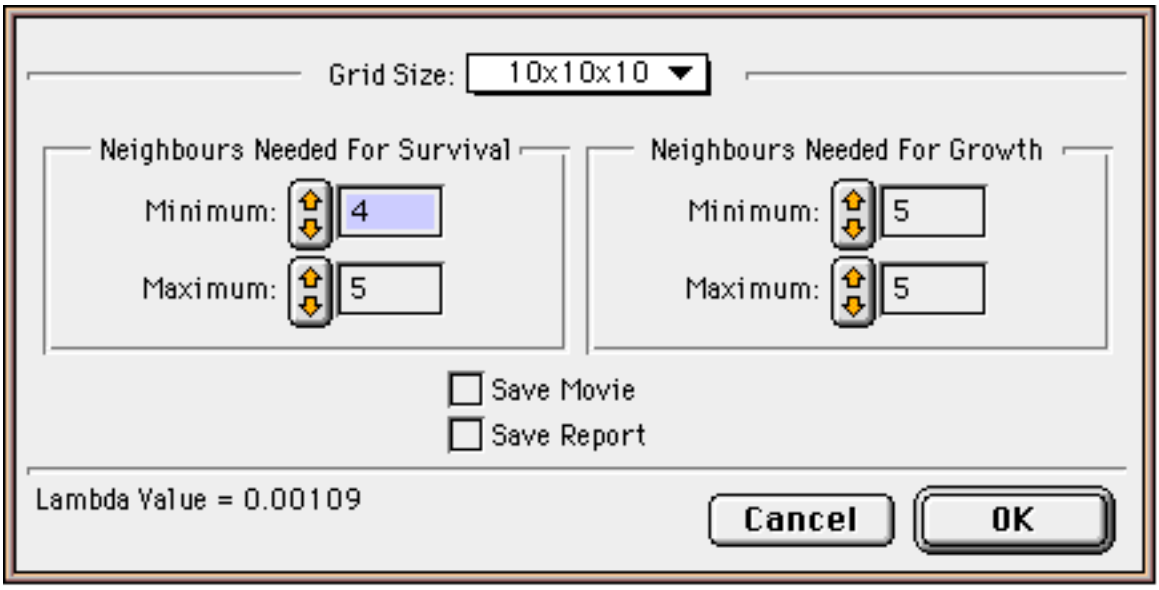
Tresvita requires a minimum of System 7.0 to run. If you are running Tresvita using a version of the system software older than System 7.5 you will need to install the Thread Manager extension available free from many sources.

The minimum amount of free memory needed to safely run Tresvita is 1Mb, but I suggest 2Mb if you want to run several large "growths" at once.

3 The Program

3.a Starting a New Growth

First load Tresvita (if you have not already done so) by double–clicking on the application's icon. To start a new growth select **New** from the **File** menu (or press command–N). A dialog box will appear.

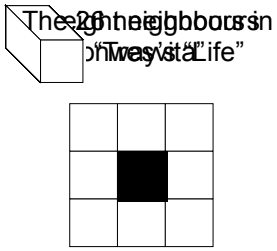


When you are satisfied with the settings in the dialog box click on the **OK** button (or press return) to start the growth. Press the **Cancel** button to cancel.

3.a.i Setting the Rule–Set

The four text boxes display the current rule set (in the picture above they contain the numbers "4", "5", "5" and "5"). You can change these values by either typing in a new number or using the arrows to the left of the text box.

What do these values mean? In Conway's "Life" there were only two dimensions, so each cell only had eight neighbours, however in Tresvita there are three dimensions. This means that each cell has 26 neighbouring cells.



The numbers in the four text boxes allow you to customise the rule set that will be used. You can enter a maximum value of 26, and an minimum value of 0. There are basically two sets of rules to define – the

number of neighbours a cell needs to survive, and how many neighbouring cells are needed for growth. The text boxes allows you to define the minimum and maximum values for each.

For example, if you wanted to set the rules so that the values were the same as those for Conway's "Life" you would set the values as follows:

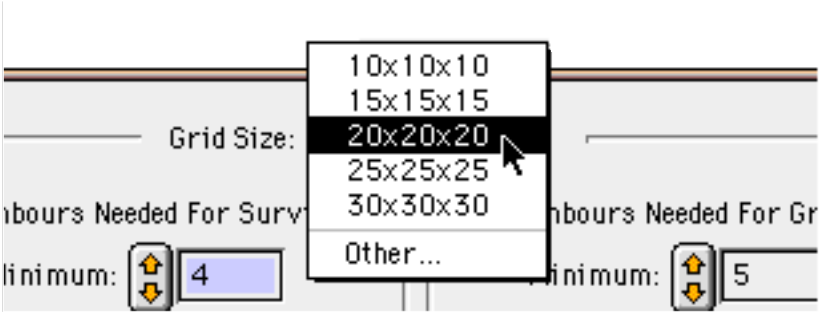
Neighbours Needed for Survival		

This setup is exactly the same as the rules described for "Life" but don't forget that these values probably won't yield interesting results since the rules were devised for a two dimensional board where there are only eight neighbours, now we are dealing with a three dimensional board with 26 neighbours.

3.a.ii Selecting a Grid Size

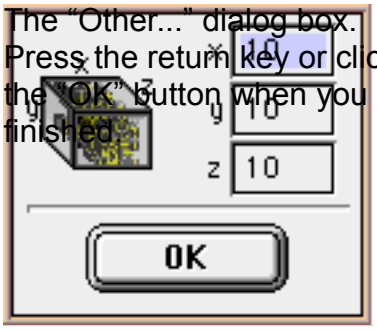
Tresvita also lets you change the size of the grid the growth is ran on. Although a cellular automata is ideally ran on an infinite sized grid this is impractical using a modern computer. In the picture of the dialog box above the grid size is set to 10x10x10 – the number of cells along the x axis is 10, the number along the y axis is 10, and the number along the z axis is 10.

The size of the grid can be easily changed. Hold down on the pop–up menu and you can select one of a number of pre–defined grid sizes.



3.a.iii Selecting a Custom Grid Size

By selecting "Other..." from the pop–up menu you can enter a customised grid size. Please note that the maximum value for each dimension is 100, and the minimum is 1.



The “Other...” dialog box. Press the return key or click on the “OK” button when you are finished.

3.a.iv The Rule–Set's Lambda Value

The bottom left hand corner of the "New" dialog box shows the rule set's lambda value. This number represents the degree of information movement and retention on a 0 to 1 scale. The lambda value depends solely upon the rule set chosen. If the lambda value is very low then information (ie. the state of cells on the grid) is static; it is easily retained through time, but moves little. On the other hand a high lambda value represents a chaotic regime. Information is moved freely, but retaining it is difficult. However there is a certain point in between where complexity runs riot. Conway's "Life" has a lambda value of 0.273.

3.a.v Saving a Movie

The "Save Movie" check box allows you to save a movie of your growth to disk. This movie is saved in Apple QuickTime format, and is supported by many applications. This is a useful feature for very large grids or for growths which run over a long period of time.

3.a.vi The Text Report

The "Save Report" check box allows you to save a simple text report about the growth. A text report will record the rule set, the size of the grid and the lambda value. Also the population size and probability of a change in state will be recorded. The text report can be easily copied and pasted into a spreadsheet program so accurate graphs can be plotted.

The text report is always arranged in the same way, with lines added to the bottom each iteration concerning the population size and probability of a change in state.

Grid X: 10

Grid Y: 10

Grid Z: 10

Min Survival: 4

Max Survival: 5

Min Repro: 5

Max Repro: 5

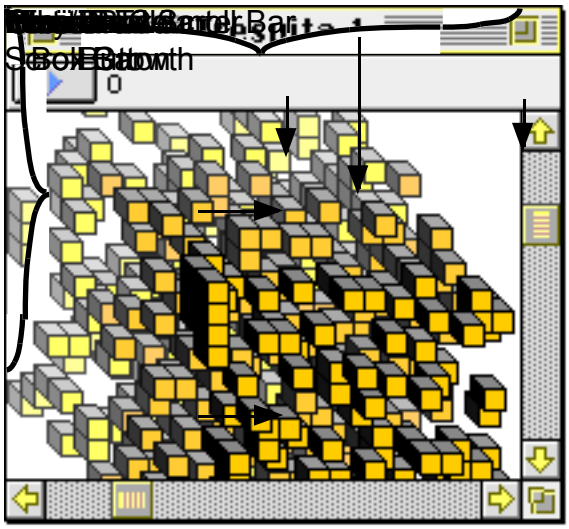
Lambda Value: 0.00109

Population	State Change
158	0.235
195	0.248
165	0.210
175	0.233
150	0.180

3.b The Windows

3.b.i The Growth Window

When you run a Tresvita growth, the window is arranged as bellow.



The window behaves like a normal Macintosh window, with scroll bars, a title bar and so on. The only non–standard parts of the window are the iteration counter, the play/pause button and the actual Tresvita growth displayed in the window.

The growth shown in the window is draw to the current render mode and is updated each iteration. A Tresvita growth is drawn as a 3–dimensional shape with the viewer looking down upon the shape from the top left hand side of the growth.

The iteration counter displays the current iteration. When a new growth is started, or a file opened, the iteration counter reads 0.

The play/pause button allows the calculation on the growth to be paused or started. When a new window is opened the growth will be in the paused state. Clicking once on the “play” button ( ) will start the growth running, and the iteration counter will start counting. The play button will change to a “pause” button ( ). Clicking on the pause button will stop all calculation on the growth once the current iteration has been computed.

3.b.ii The Population Window

To display the population window for the front–most growth (ie. the currently active window) choose **Show Population Graph** from the **Grid** menu. This will display the population window.

To hide the population window either click on its close box, or select **Hide Population Graph** from the **Grid** menu.

The population window shows a simple bar graph of the growth population over the past 100 iterations. At the top of the window (underneath the title bar) the title of the corresponding growth window is displayed.

The graph is useful when identifying patterns in a growth, looking for blinkers, or when attempting to find long term population trends.

N.B. For a more accurate population graph use the “Save Report” feature in the **New** dialog and plot a graph using a spread sheet program.

3.b.iii The Rule–Set Window

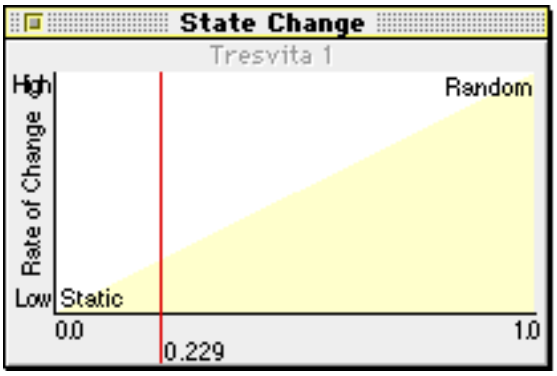
To display the rule–set window for the front–most growth (ie. the currently active window) choose **Show Rule–Set** from the **Grid** menu. This will display the rule–set window.

To hide the rule–set window either click on its close box, or select **Hide Rule–Set** from the **Grid** menu.

The rule–set window is very simple. It displays the rule–set for the growth, as well as the lambda value (to 5 decimal places). At the top of the window the title of the corresponding growth window is displayed.

3.b.iii The State Change Window

To display the probability of a change in state window for the front–most growth (ie. the currently active window) choose **Show State Change** from the **Grid** menu. This will display the state change window.



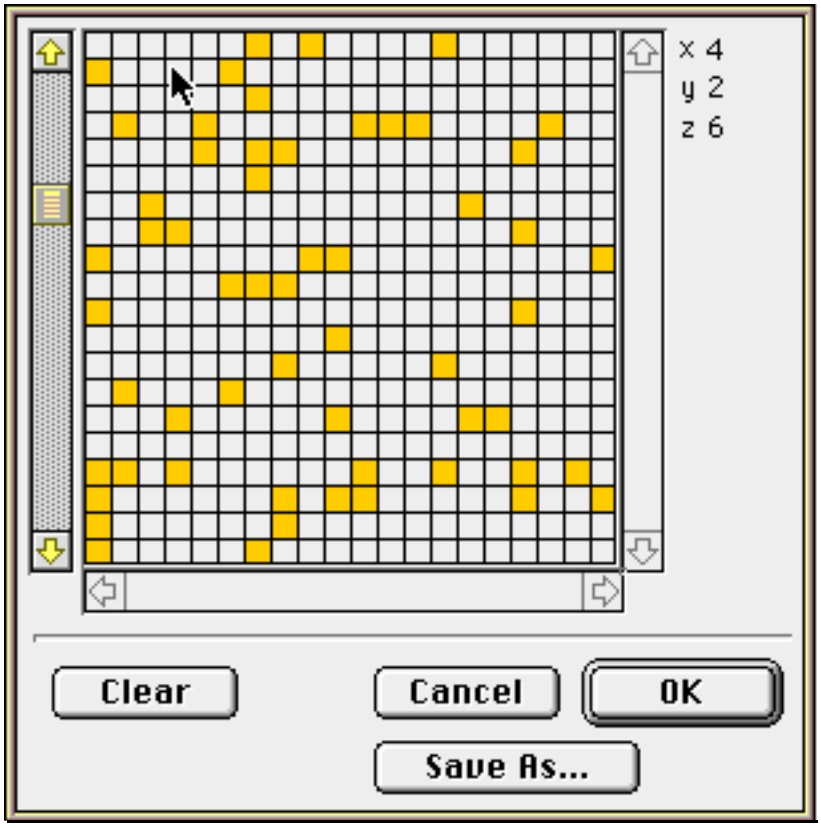
To hide the state change window either click on its close box, or select **Hide State Change** from the **Grid** menu.

The state change window shows what the probability of any cell on the grid changing its state during the last iteration was. A change in state is when an “alive” cell “dies”, or when an empty cell becomes “alive”. A probability of 1 indicates no similarities between the current iteration and the previous one, a probability of 0 indicates a stable pattern. The overall rate of change of the grid increases from static to random and can be used to judge whether a growth has become predictable or not. At the top of the window (underneath the title bar) the title of the corresponding growth window is displayed.

N.B. For a more accurate view of the probability of change of state use the “Save Report” feature in the **New** dialog and plot a graph using a separate spread sheet program.

3.c The Grid Editor

It is often necessary to “seed” a grid with a simple pattern, and often interesting to watch a pattern of cells you arranged grow and change under the influence of the rule set. You can edit the arrangement of cells in a grid by selecting **Edit Grid** from the **Grid** menu. This will display a dialog box enabling you to add and remove cells to the currently selected window’s grid.



The interface for the grid editor is relatively straight forwards, however there are a few features which need pointing out.

The grid editor contains three scroll bars. Two are for the normal horizontal and vertical scrolling (the two inactive scroll bars in the image above). The third scroll bar (positioned to the left) allows scrolling through the ‘z’ axis of the grid. How does this work? Image the grid is a series of cards in a filing system. By using the ‘z’ scroll bar we can select anyone of the cards to work on, then the card is inserted back into the filing system; back into the correct ‘z’ axis position. By moving though the ‘z’ axis layer by layer you can build up quite complicated shapes.

The numbers displayed in the top right hand corner of the grid editor show the current z–axis position, as well as showing the cursor’s position in the x and y axes. In the screen shot above the mouse cursor is over the the cells matching co–ordinates (4, 2, 6) in the grid.

By clicking over an “alive” cell (yellow) you can turn that individual cell off, or by clicking and dragging turn a number of cells off. By clicking over a "dead" cell you can turn it on (“alive”) or, by clicking and dragging, turn a number of cells on.

Clicking on the **Clear** button will turn off every cell in the grid.

Clicking on the **Save As...** button will save the grid you have designed to disk, but will not effect the file currently being used. This allows you to design a number of different grids easily within the grid designer without changing the currently open grid.

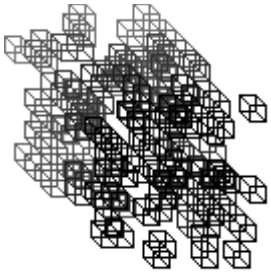
When you are finished click on **OK** to put the changes you have made into effect, or click on **Cancel** to ignore any changes you have made to the grid's cells.

3.d The Render Menu

The Render menu allows the user to change the way Tresvita displays the grid. All changes to the Render menu take place on the currently selected window. The default render settings are **Depth Render** switched on, **Display Grid** switched off and the **Solid Cell** render mode selected.

The Render menu is divided into two parts separated by a separator line. The top part has two render options that apply to any render mode. These are **Depth Render** and **Display Grid**. Their effects are shown bellow (the **Solid Cell** render mode is being used, but the effects would be the same whatever the mode).

The second part of the Render menu consists of a variety of drawing modes. These are **Wire Frame**, **Front Face**, **Fuzzy Cell**, **Solid Cell**, and **Solid Object**. Only one of these modes can be selected at a time. Their effects are shown below.



3.e The Edit Menu

The Edit menu is used little in Tresvita.

By choosing **Copy** the data being displayed in the currently selected window will be copied to the clipboard for later pasting into another application. This allows the user to copy the image of the cell growth and paste it into a document with ease.

No other Edit menu items are currently supported.

3.f The File Menu

The File menu contains all the items you would expect in a Macintosh application (the only exception being the omission of a Print option).

Selecting **New** will open a dialog box allowing you to set the rule set, grid size etc. for a new Tresvita growth. This menu item is disabled if there are already 10 growths running, since Tresvita can not handle more than 10 growths at a time.

Selecting **Open...** allows you to select a file to view. This can be a Tresvita growth previously saved to disk, or it can be a QuickTime movie. This file will be disabled if there are already 10 growths running, since Tresvita can not handle more than 10 growths (including QuickTime movies) at a time.

Selecting **Close** will close the front window. If no windows are open, this menu item is disabled.

Save will save any changes you have made to the currently open file. If you have made changes to a new Tresvita file (ie. one created with the **New...** item rather than a file that has been opened) this item will behave like the **Save As...** item. This item is disabled if no windows are open.

Save As... will save the current growth as a new file. Any later calls to **Save** will update this saved file. This item is disabled if no windows are open.

Quit exits Tresvita. You will be asked whether you want to save changes any open files.

4 Acknowledgments and References

I would like to offer a special thank–you to Simon Fraser for the help and advice he gave whilst I was programming Tresvita.

The glider files accompanying Tresvita are taken from Carter Bayes' paper:

Bayes, C. (1994)
Further notes on the Game of Three-Dimensional Life.
Complex Systems 8 (1) 67-73.