

## 2. Quick Tour through CAT

### 2.1 Starting CAT

\* To start CAT, doubleclick the CAT icon or choose the file manager and doubleclick CAT.EXE in the directory where CAT has been installed in.

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Figure 2.1 CAT icon

CAT comes up with its welcome panel. Depending on the CAT's last state and from the size of your data display, the CAT welcome panel may vary. Starting CAT you should be familiar with the picture below anyway.

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Figure 2.2 CAT welcome panel

The CAT welcome panel consists of

- ⌞ a title bar with program name, version number and, separated by a colon, rounds of program execution,
- a menu and
- ® a button bar,
- a window RECIPE containing program text (may be empty),
- a window STATE containing the matrix of cells,
- ± a window LIST containing program output or error messages (may be empty).

## 2.2 Loading and Compiling a Program

### Loading a Program

To load an existing program

\* Select *Open* in menu *File*.

CAT shows a file selection box to choose a program file.

The extension ".cat" is preset for models in CAT. Files with the extension .CAT are a kind of project or workspace file. The list of directories shown in this example is probably different from your configuration.

Figure 2.3 File selection box

\* Select a file <model name>.cat (e.g. life\_1.cat). The dialog box is used as in Windows. The chosen program file will pop up in the RECIPE window and the last state of the cell matrix will be displayed in the STATE window. Moreover, other attributes specific to this model will be restored (color palette, size and arrangement of CAT windows etc.).

### Compiling a Program

\* Click the button *Comp* in the left corner of the grey icon bar (see button 1 in figure 2.5). If compilation was successful nothing noticeable will happen.

Otherwise you will hear a short beep and this box will be shown:

Figure 2.4 CAT ERROR box

\* Click the button *OK*.

The box will disappear and you can now scroll inside the LIST window until you find the offending instructions. They will be flagged by the marks "(\*\*\* ERROR" and "\*\*\*\*)" pointing out an error key number and the offending instruction. A sample: "(\*\*\* ERROR 140: Parser => unknown identifier \*\*\* Colordds \*\*\*)". The last word is the offending program instruction. Hints for error corrections can be found in Appendix F 'Compiler Error Message List'.

Compiling can also be achieved by clicking one of the buttons from "E0" to "E5". Before executing the code of the corresponding event (the button "E0" e.g. stands for event 0, see button 3 in figure 2.5), CAT checks whether the current CAT program has been already compiled. If not, CAT will compile it.

## 2.3 Executing and Controlling a Program

### Event as Main Objective of a Cellular Automaton Tool Program

Within the CAT environment, Cellular automaton models can be programmed by the **Cellular Automaton Programming Language (CARP)**. CARP is a high-level language resembling PASCAL or MODULA.

One important element of CARP is the event. This importance is reflected by the fact, that these events can be directly controlled by their corresponding buttons E0 to E5 and by the special event button SetUp. The SetUp event provides initialization of the cell matrix. It is implicitly executed if any other event is carried out.

To get more information about the CARP programming interface see the 'CARP Instructions Reference Guide' on pp. 28 - 64 and the corresponding parts of the online manual.

### **Enlarging the Size of the STATE Window**

Before working with the STATE window, bring it up and maximize it.

- \* Select *STATE* in the menu *Window*.

The focus is set on the STATE window. (This might also be achieved by clicking in the STATE window if it is already visible.)

- \* Maximize the STATE window by clicking the maximize button in the top right corner (upward pointing triangle, see 6 in figure 2.5).

The STATE window becomes maximized.

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Figure 2.5 Event control buttons ( Comp(ile) (1), SetUp (2), Event 0 Single Step (3), Event 0 Run (4), Stop (5), Maximize (6)

## Starting Event 0

\* Click the button E0 (button 3 in figure 2.5) in the grey button bar (depending on the size of your data display or on CAT's current window size, the bar may be stretched so that all buttons are aligned). Clicking E0 as opposed to clicking the run button (see button 4 in figure 2.5) means **stepwise** execution of event 1.

A pattern of pink and blue cells fills the STATE window representing a random dissemination of 'dead' and 'alive' cells. Event 0 should be used only once to initialize the cell matrix with a randomized dissemination of 'dead' and 'alive' cells. Depending on the properties of your hardware it may take few seconds until the STATE window gets filled.

Moreover, you will notice four pieces of written information:

À After the colon, the title bar on the top of the CAT window contains the sum of rounds of all events whose code has been executed. Now it shows one round being completed.

Á A label "Round" to the right of the ten STATE-window-related icons repeats the number of completed rounds.

Â A label on the right hand side of the icon bar contains the event number and the mode of execution. The keyword "Step" stands for stepwise execution, "Run", however, for execution in run mode.

Ã A label "Time" contains the time passed by in hh:mm:ss,mm format, representing hours: minutes: seconds, milliseconds.

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Figure 2.6 Event-related information

## Starting Event 1 in Stepwise Mode

\* Click the button E1 in the grey button bar.

After a short time the dispersion of 'dead' (blue) and 'alive' (red) cells changes according to the algorithm contained in the program text of event 1. For each cell the number of 'alive' neighbors is counted: is it 2 or 3, an 'alive' cell remains 'alive', otherwise it will 'die'.

However, if a 'dead' cell is surrounded by just 3 'living' cells, it will become 'alive'. The equivalent labels are changed to 'Round: 2' and 'Event 2: Step'.

Note:

Each clicking of the buttons E0 to E5 will cause only **one** execution of the corresponding program text.

If you click a button (for example E4) that is not assigned to a corresponding event description in a CARP program, the cell matrix in the STATE window will remain unchanged.

## Continuing Event 1 in Run Mode

\* Now, click the run button below E1 (see button 4 in figure 2.5).

The program code of event 1 will now be executed continuously. The state of all cells will be computed and shown in the STATE window round by round. You will be informed about the actual round by the corresponding label 'Round'.

## Stopping Program Execution

\* Click the button "Stop" (see button 5 in figure 2.5).

The execution of any program code will be stopped. The STATE window will freeze the last state of the cell matrix. From here, you can restart any event in stepwise or run mode. You may also skip from one event to another by clicking different event buttons. If you click, for example, first the run button below E0 and then the run button below E1, the program code of event 0 will be executed until the next mouse click. When the current execution of event 0 is completed CAT will continue to execute the program code of event 1 without any interim step.

## Hiding the Display of the Cell Matrix

Computing the new state of the STATE window for each generation of the cell matrix is quite CPU-time-consuming. If you want to elapse output of some generations, you can suppress the display of the cell matrix and speed up computation.

\* Click the show / hide matrix button in the icon bar (see button 1 in figure 2.7).

Instead of the cell matrix, a grey background is displayed with a hint how to rebuild the cell matrix. Execution of the current event in run mode is continued as can be seen from the round counter in the title bar.

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Figure 2.7 Graphic control buttons: show/hide matrix (1), numeric state (2), color mapping (3), hexadecimal format (4), magnifier (5), color customizing (6), repaint (7), state control (8), palette customizing (9), menu (10)

\* Click the show / hide matrix button in the icon bar again.

The cell matrix is displayed in the STATE window again.

Note: Be patient if the code of any event is executed in run mode. It takes some time until the last execution of the event's program code is executed before CAT can switch to displayless mode. Another way to accelerate program execution is to show only every 10th or <n>th generation of the model by the corresponding use of the 'ShowPlane' instruction.

## 2.4 Editing a Program

Bring up the RECIPE window by means of the menu *Window* or click on this window if any part of it is visible.

\* Click on any part of the text.

You will get a blinking text cursor and be able to write new text in insert mode.

To learn the different functions, change for example the value of the XYSIZE and return to the RECIPE window. If you chose a valid value (positive value < 130), program execution is continued with new XSize and YSize values after pressing the corresponding event button. Otherwise, you will get an error message in the LIST window.

In general, most editing functions like *Cut*, *Copy* and *Paste* accessible by items of the *Edit* menu or by a local menu (see page 23) can be executed as in Windows 3.x, shortcuts may differ.

Note: Only the RECIPE window is ready for text editing, the LIST window is read-only. Any modification of the text will be indicated by a "Modified" mark in the status bar on the bottom of the RECIPE window. To the left of this mark, the cursor position is shown with its current x- and y-coordinates.

Pattern matching functions (*Find*, *Replace*, *Next*) can be found in the menu *Search*.

## 2.5 Printing

CAT provides two forms of printed output:

- printing the contents of the RECIPE (CARP program) or LIST window by aid of a local menu
- printing the contents of the STATE window by means of the state control button (see button 1 in figure 2.8). The state of each cell may be alternatively printed with its decimal or its hexa-decimal value. There is no facility for printing the colored cell matrix.

### Printing the Contents of the LIST or the RECIPE Window

\* Bring up the text window you want to print (LIST or RECIPE window).

The corresponding window will have the focus indicated by a blue title bar.

\* Click the right mouse button upon the corresponding window.

A local menu pops up.

\* Select *Print* and click OK in the print dialog box.

The corresponding file is printed on your standard printer.

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Figure 2.8 STATE window with numeric cell and color mapping representation

## Printing the Contents of the STATE Window

- \* Bring up the STATE window.

The STATE window gets the focus indicated by a blue title bar.

- \* Click the state control icon (see button 1 in figure 2.8).

A menu pops up.

- \* Select *Print* and click OK in the print dialog box.

A text file representing the current state of the .CAS file (CAT State file) is printed on your standard printer. The cells are represented by their decimal value (default). Click the hexadecimal format button (button 4 in figure 2.7) before printing if you want to shift to hexadecimal output.

Note: There are restrictions on printing large STATE files although CAT automatically tries to choose an appropriate smaller font. Setting XYSIZE to values below 30 should work anyway.

## 2.6 Window Handling

Each CAT model of a cellular automaton contains at least three windows. This number might be increased by windows created by means of the *Show* or *Print* function. In this case, you may find it difficult to work your way through the CAT environment. Therefore, there are some functions in the menu *Window* to aid your orientation.

### Bringing up all CAT Windows at a Time

- \* Select *Tile* in menu *Window*.

All windows currently contained in your CAT environment are shown at the expense of the space of each window. You can now select and then maximize the window you want to work with or resize one window at the expense of other windows.

### Bringing up all CAT Windows in Overlapping Mode

- \* Select *Cascade* in menu *Window*.

All CAT windows are now shown overlapping each other, the first being presented in an acceptable size. If you want to put the focus on a different window, click on any of its parts to bring it up.

### Bringing up a Specific CAT Window

- \* Click the menu *Window*.

All windows currently contained in your CAT environment are identified in the bottom part of this window by their names.

- \* Drag the mouse pointer to the name of the window you want to bring up.

The corresponding window comes up and may be maximized if necessary.

Note: The last method is advisable if you are already sure about the window you want to work with. To save window space, you also may iconify a window, e.g. the LIST window.

CAT windows may not be closed by using the close button.

## **2.7 Changing Properties and Appearance of the Cell Matrix**

Apart from defining size, state and colors of the cell matrix by certain instructions of the CARP program you can interactively change the appearance and some properties of the cell matrix. This is done by the group of buttons from the numeric cell state button to the palette customizing button (see buttons 2 to 9 in figure 2.7).



## Showing the Cell State by Numbers

\* Click the numeric cell state button (button 2 in figure 2.7)

A small figure in the top left corner of each cell comes up, representing its current state. The figure is partially surrounded by the color that is associated with this value (see the cell matrix in figure 2.8 showing the numeric cell state and the color mapping).

Regaining the previous appearance can be achieved by clicking the same icon a second time.

Note: If your CAT model has a great number of cells, CAT may find no font being small enough and may thus refuse to show the cell state by figures (error message is "Window is too small to display the state"). A workaround is in some cases to reduce XYSize in the CARP program or to maximize the STATE window.

## Showing the Color Mapping Entry Associated to each Cell

\* Click the color mapping button (button 3 in figure 2.7).

A small figure in the top left corner of each cell comes up, representing the according color palette entry. This entry is a pointer to a RGB triple defining how a certain state of a cell is represented by a specific color (see the cell matrix in figure 2.8 showing the numeric cell state and the color mapping).

Regaining the previous appearance can be achieved by clicking the same icon a second time.

Note: If your CAT model has a great number of cells CAT might refuse to show the color palette entry (error message is "Window is too small to display the color mapping"). A workaround is to reduce XYSize in the CARP program or to maximize the STATE window. If the cells are big enough it is possible to show the figure of the cell state and the color palette entry at the same time. The cell state is shown at the top of a cell, the color palette entry at the bottom. For more information on how to handle the color mapping and color palettes see page 50 and 51.

## Switching from Hexadecimal to Decimal Figure Display

Depending on your preferences, it might be adequate to change the number format from hexadecimal to decimal.

\* Enable figure display of the cell state or the color mapping. Then click the hexadecimal format button (button 4 in figure 2.7).

The representation of the figures will change from decimal format to hexadecimal.

\* To return to the previous state click the same button again.

The representation of the figures will change again.

## Removing the Frame around the Cell Matrix

Depending on the (optional) value of XYBound in the CARP program, your STATE

window has a narrower or broader frame of darker cells. These cells are a kind of "virtual" continuation of the cell matrix beyond its edges according to the chosen topology. This border area may be displayed or hidden.

\* Click the magnifier icon (button 5 in figure 2.7).

The frame of the plane window caused by the XYBound value disappears and the cells become slightly bigger.

This, of course, works only if XYBound is defined.